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ZRENJANIN, REPUBLIC OF SERBIA
in cooperation with
POLITECHNICA UNIVERSITY
TIMISOARA, ROMANIA

I International Conference „ECOLOGY OF URBAN AREAS 2011"

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INTRODUCTION

University of Novi Sad, Technical faculty “Mihajlo Pupin” from Zrenjanin have started the organization of I International Conference Ecology of Urban Areas 2011 (URBANECO 2011).

This international conference is organized in cooperation with Politechnica University from Timisoara in Romania. This cooperation significaly improves the quality of conference organization and work, as well as contribution in area of regional cooperation with other universities and scientific institutions.

The objectives of the Conference URBANECO 2011 are: presentation of current knowledge and the exchange of experiences from the field of sustainable development of urban areas which is one of the major problems of modern civilization. The ecological aspect is the dominant factor in achieving sustainability. The importance of ecological aspect has developed a need for an International Conference "Ecology of Urban Areas 2011" which has the goal to integrate scientific, technological and experimental knowledge in this field. Another importance is gathering researchers from this field with aim of expanding regional and international cooperation, raising the level of professional and scientific work at University of Novi Sad and Technical faculty “Mihajlo Pupin”, expanding cooperation with institutions and encouraging young researchers within this field. Taking into account that this Conference is international, the importance of this event is obvious for the town of Zrenjanin, Banat region, Vojvodina and Serbia. Organization of URBANECO 2011 by University of Novi Sad, Technical faculty “Mihajlo Pupin” from Zrenjanin represents this scientific-educational institution as one of the major representatives of economic and social development in Banat.

Within this Collection of papers are presented all accepted papers received for I International Conference Ecology of Urban Areas 2011. The papers are divided into following sessions: Air quality, Management of solid urban waste, Water quality in urban areas (ground water, drinking water, waste water and facilities), System of ecological management (ISO 14000), Economics of sustainable development of urban areas, Noise and vibrations in urban areas, Electro and electro-magnetic pollution in urban areas, Climate changes and urban pollution, Spatial planning and greening in urban areas, Development of urban ecology through educative and information activities, ICT in the ecology of urban areas, Accidents in urban areas, Environmental aspects of traffic in urban areas, Impact of agricultural activities to urban area , Public health and the ecology of urban areas.

We wish to thank Ministry of Education and Science, Republic of Serbia and University of Novi Sad for supporting the organization of URBANECO 2011 Conference as well as to University of Novi Sad, Technical faculty “Mihajlo Pupin” from Zrenjanin.

We are also expressing our gratitude to all authors who have contributed with their papers to the organization of our first Conference URBANECO 2011.

We would like our Conference to become a traditional meeting of researchers, every year. We are open and thankful for all useful suggestions which could contribute that the next, II International Conference Ecology of Urban Areas (URBANECO 2012) become better in organizational and program sense.

President of the Organizing Committee
Ph.D Milan Pavlović

Zrenjanin, September 2011.

WORD OF THANKS

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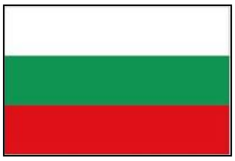
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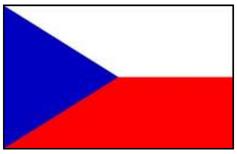
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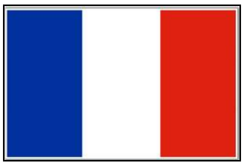
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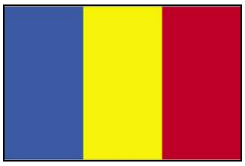
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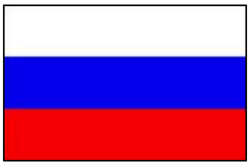
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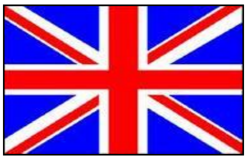
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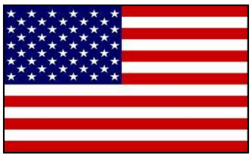
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CONTENTS

AIR QUALITY

I International Conference
„ECOLOGY OF URBAN AREAS“ 2011

RESULTS AND ADVANTAGES OF URBAN AEROSOLS ANALYSIS BY NEUTRON ACTIVATION METHOD

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ABSTRACT

Elemental composition of 12 samples of urban dust sampled in different parts of Moscow has been determined. Instrumental neutron activation analysis method was used. 30 elements identified: REE, Na, K, Ca, Ba, Sr, Rb, Cs, Fe, Cr, Ni, Co, Zn, Se, As, Sb, U, Th etc. The range of their average contents is between 0.01 (Lu) to 1470 (Fe) ng/m^3. A comparison with the data of marine and coastal aerosols was made. Results show that urban air in Moscow is not very different from them in composition. Additional research and more careful analysis of a greater data set are necessary. Efficiency of INAA method application of is shown.

Key words: urban dust, aerosols, chemical composition, neutron activation method.

INTRODUCTION

The composition of aerosols - suspended particles of different composition, size and shape is an important indicator of air quality in individual regions and the environment in general.

The main natural sources of atmospheric aerosols are volcanoes, crumbling rocks and soil, sea salt, dust storms, forest fires. Anthropogenic (technogenic) sources are industrial production (IP), transport (TR) and municipal and household activities (MHA), and they are the main suppliers of hazardous substances into the air of cities. The share of IP, the TR and MHA in industrial areas account for over 75% of suspended atmospheric particles they contain polychlorinated organic compounds, toxic chemicals and heavy metals. Aerosols are constantly migrating, and even in urban areas are actively transported by air masses, locally fall or washed away by rain. Their composition depends strongly on the safety of life of urban residents.

METHODS OF STUDYING THE CHEMICAL COMPOSITION OF AEROSOLS. PURPOSE OF WORK

This paper focuses on the study of urban air, more dust (aerisols). For their study we used the method of neutron activation analysis (in part, the mass-spectrometry), that is universal (high sensitivity, multi-element, able to study samples of various compositions, chemical forms of the elements, regardless of their color and size) (Kolesov, 1994).

Samples were collected with the generally accepted norms and rules (Fomin, Fomina, 2002). To collect aerosols commonly used Petryanov filters or Whatman paper. Main attantion was paid to the elements given in (Kolesov, Shubina, 2001). Among them are REE, Na, K, Rb, Cs, Ca, Sr, Ba, Cr, Fe, Co, Ni, Zn, Se, As, Sb, Th, U, Br, Hf, Ta, Zr, Au, Ag and other elements (*Table 1*). Level of determined elements content is 10^{0} - 10^{-7} %.

To identify possible sources of aerosols fractionation factor was used:

$$(K_{fr\cdot}) = (C_i / C_r)_{\text{aerosol sample}} \; / \; (C_i / C_r)_{\text{matter source}},$$

where C_i and C_r are concentrations of element *i* and reference element *r* in aerosols and source. We used Na, Br; Al, Fe, Sc, Ti, K, Ca, Mg, Ba, Sr as reference elements.

Table 1: Elements used for environment evaluation and determined by instrumental neutron activation analysis (INAA)

Ele-ment	Information on			Ele-ment	Information on		
	total contami-nation[1]	terrestrial matter contamination[2]	toxic substances[3]		total contami-nation[1]	terrestrial matter contamination[2]	toxic substa nces[3]
Al		*		Hg	*	*	*
Ag		*		I		*	
As	*	*	*	K		*	
B+	*			Mn	*	*	
Ba		*		Na		*	
Be			*	Ni	*	*	*
Br		*		Pb+++	*	*	*
C++		*		Rb		*	
Ca		*		S	*		
Cd	*		*	Sb	*	*	
Cl	*		*	Se	*		*
Co		*		Sn	*	*	
Cr	*		*	Te	*		*
F	*	*		V	*	*	*
Fe		*		Zn		*	*

+ Results of atomic emission, ++ of activation with charged particles, +++of gamma activation methods.

1) The elements characterising the ecological conditions in general. 2) The elements indicating contamination of polluting substances. 3) The elements, most toxic and hazardous and provoking diseases.

Analysis procedure

Part of the test filter (with a known volume of air expired), "blank" filter and a reference sample (usually coal dust - CTA-FFA-1, weighing about 10-20 mg) were placed in a bag from Al-foil, packed in foam and irradiated in the nuclear reactor IRT-MIFI with neutron flux 1.2*1013 neutrons/cm^2s (Figure 1). The irradiated samples were then measured with a semiconductor Ge - detector and multichannel analyzer. Processing of gamma-spectra of studied samples and elements content calculation (minus background concentrations) were performed automatically using computer programs (Kolesov, Shubina, 2008).

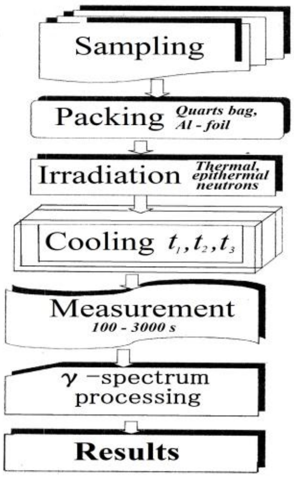

Figure 1. INAA procedure

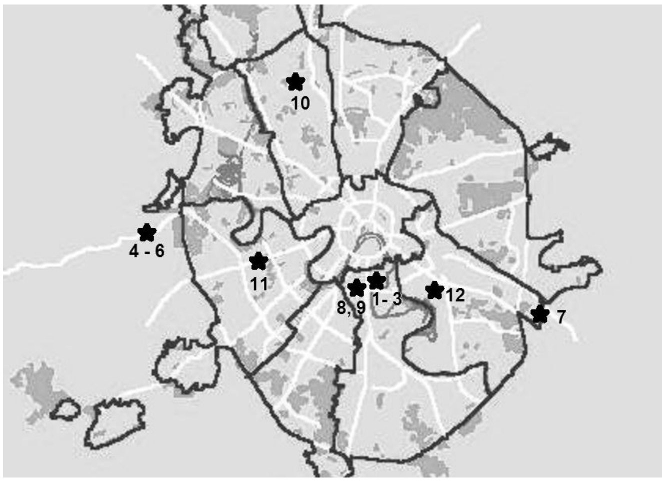

Figure 2. Sampling places in Moscow

RESULTS

Previously, we have determined the elemental composition of aerosols from different ocean regions (Atlantic, Indian, Pacific, (Anikiev, Kolesov, Kuzmina et.al, 1998), as well as from parts of the Northern Caspian Sea, where exploration began active oil and gas fields (Anikiev, Kolesov, 2008). They were mainly coastal and marine aerosols. In this paper we attempt to investigate the dust particles (aerosols), selected in some places of great city – Moscow (*Figure 2*). We took into account the meteorological conditions (wind speed and direction, air temperature, its humidity, atmospheric pressure), as well as sampling time and the amount of air passing through the filters. More than 100 samples were selected and analyzed. Some of the data (12 samples) are shown in *Tables 2-4.*

Table 2. Dust concentration in Moscow air samples
(April - May 2007, sampling time from 9AM to 12PM)

Sample No	Air volume, m^3	Sample weight, g	Dust concentration, m^3
1.	44,9682	0,0072	$1,6*10^{-4}$
2.	45,5932	0,0059	$1,3*10^{-4}$
3.	45,7644	0,0038	$8,2* 10^{-5}$
4.	93,2591	0,0112	$1,2*10^{-4}$
5.	48,197	0,0020	$5,3* 10^{-5}$
6.	70,53	0,0072	$1,0*10^{-4}$
7.	129,982	0,0069	$5,3*10^{-5}$
8.	127,936	0,0122	$9,5*10^{-5}$
9.	100,749	0,0086	$8,5*10^{-5}$
10.	112,514	0,0073	$6,5*10^{-5}$
11.	35,9318	0,0054	$1,5*10^{-4}$
12.	212,049	0,0136	$6,4*10^{-5}$

Table 3: Elements content in air samples (Fe - mkg/m^3, others - ng/m^3)

Sample No	Fe	Co	Ni	Zn	Se	As	Sb	Th	U	Br	Hf	Ta	Au	Ag
1	2,05	1,08	24,39	182,6	0,33	1,63	6,62	0,55	0,32	7,53	0,15	0,13	0,04	-
2	2,13	0,98	24,05	163,5	-	1,05	7,21	0,53	0,29	7,23	0,20	-	0,01	0,86
3	1,01	0,43	23,5	78,3	0,05	0,92	3,34	0,23	0,22	3,09	0,20	-	0,02	0,38
4	0,52	0,25	-	30,06	0,17	0,28	1,55	0,14	-	4,59	0,12	-	0,007	-
5	-	0,19	15,25	43,54	0,06	0,26	0,94	-	0.03	4,63	-	0,04	0,05	0,28
6	-	0,17	22,13	50,07	0,44	0,15	0,69	-	0,282	1,69	-	-	0,009	-
7	-	0,27	8,13	133,2	-	0,19	1,8	-	-	2,87	0,03	-	0,003	0,07
8	2,08	0,75	-	96,64	0,03	-	16,38	0,44	-	19,6	0,20	0,01	0,001	-
9	2,31	0,83	-	101	-	0,772	6,58	0,27	0,081	3,51	0,18	0,06	0.007	-
10	0,64	0,196	-	41,27	0.06	0,27	1,65	0,15	0,123	3,19	0,11	0,04	0,002	-
11	1,44	1,04	-	51,6	-	1,48	3,6	0,43	0,14	3,91	0,17	-	0,008	-
12	1,02	0,43	6,45	67,26	0,29	0,32	7,7	0,17	0,05	2,78	0,08	-	0,003	0,56
Среднее	1,47	0,55	17,7	86,6	0,18	0,67	4,84	0,32	0,17	5,38	0,144	0,06	0,013	0,43
Макс.	2,31	1,08	24,39	182,6	0,44	1,63	16,38	0,55	0,32	19,6	0,20	0,13	0,05	0,86
Мин.	0,52	0,17	6,45	41,27	0,03	0,15	0,69	0,14	0,03	1,69	0,03	0,01	0,001	0,07

Table 4: Elements content in air samples (Na, K, Ca - mkg/m^3, others - ng/m^3)

Sample No	La	Ce	Nd	Sm	Eu	Tb	Yb	Lu	Na	K	Rb	Cs	Ca	Sr	Ba	Sc	Cr
1	3,40	4,09	1,38	0,43	0,062	-	0,13	0,03	0,92	-	-	0,07	8,72	-	26,8	0,58	10,04
2	1,87	1,57	2,48	0,39	0,09	0,023	0,14	0,02	1,88	-	-	0,566	4,13	26,8	15,5	0,43	11,23
3	1,25	-	0,48	0,14	0,02	0,03	0,07	0,006	0,46	-	-	0,065	2,06	33,5	5,35	0,21	7,04
4	0,59	0,66	-	0,12	0,01	0,02	0,03	0,004	0,23	-	-	-	1,36	9,22	-	0,15	2,10
5	0,21	0,48	0,24	0,05	0,014	-	0,028	0,001	0,21	0,34	-	-	0,52	25,3	41,6	0,08	-
6	0,12	0,15	-	0,02	0,007	-	0,061	0,01	0,42	-	-	0,2	1,31	17,8	-	0.06	-
7	0,86	1,16	0,87	-	0,003	-	0,008	0,001	0,06	0,96	-	0,02	-	-	2,23	0,012	1,32
8	1,22	1,06	0,48	0,17	0,009	-	0,03	0,02	0,43	1,926	0,55	0,128	4,43	-	28,6	0,318	7,63
9	1,33	1,55	-	0,24	0,033	-	0,06	0,0008	0,5	2,31	-	0,11	3,29	-	25,76	0,28	6,09
10	0,77	1,01	0,07	0,12	0,014	-	0,27	0,005	0,28	-	-	0,19	1,75	-	7,29	0,17	2,61
11	1,97	1,99	-	0,26	0,043	0,06	0,09	0,03	0,72	-	--	-	2,79	75,3	28,4	0,45	4,92
12	1,25	1,27	0,21	0,11	0,004	-	0,03	0,01	0,31	-	0,26	0,15	2,33	5,42	23,08	0,16	3,85
Ave-rage	1,24	1,36	0,78	0,19	0,03	0,03	0,08	0,01	0,535	1,168	0,405	0,17	2,97	27,6	20,46	0,24	5,68
Maxi-mum	3,40	4,09	2,48	0,43	0,09	0,06	0,27	0,03	1,88	2,31	0,55	0,566	8,72	75,3	41,6	0,58	11,23
Mini-mum	0,12	0,15	0,07	0,02	0,003	0,003	0,008	0,0008	0,06	0,96	0,26	0,02	0,52	5,42	2,23	0,06	1,32

DISCUSSION

First of all some advantages of INAA must be noted.

First, the total mass of solids collected on the filters when pumping air in the usual urban conditions, was small and ranged from 3 to 13 mg per filter (when the volume of air from 36 to 130 m^3). To study the chemical composition by the INAA method about 1/4-1/2 part of the filter was used, ie samples of low mass were from 1 to 6 mg. A similar analysis is possible practically with INAA only. *Secondly*, the number of determined elements is of a high value - 30; *in - the third*-defined elements concentrations were at low level - the order of several nanograms per gram.

Interpretation of the data

As seen from Table 2, the dust concentration in air samples from different parts of Moscow not fluctuated significantly (3 times) and ranged from 5,3 10^{-5} to 1.6 10^{-4} g/m^3. The values of minimum and maximum concentrations of determined elements varied 5-10 times; average contents of elements are reflected in the 13th row of *Tables 3 and 4*. Data on the contents of major elements Fe, Na, K, Ba in these samples indicate that their low (approximately 5-7 times) differences. Concentrations of trace elements vary in approximately the same range. Nevertheless, attention draws to increased content of REE - La, Ce, Nd, Sm, as well as "heavy" metals - Ni, Zn, As, Sb and U, Th, Br, Sb, and possibly, Se. Enhanced levels of the tagged elements are correlated with the location of industries producing or processing products of suitable composition.

Table 5: Comparison of the elemental composition of air samples (ng/m^3)

Sample	Na	Sc	Cr	Fe	Co	Zn	Se	Br	Ag	Cs	Ba	Ni	U	Th	Tb
4M*	470	0,60	4,9	1600	0,4	34	0,36		0,34	0,11	13				0,06
5C	890	0,68	4,5	1600	0,37		0,43	2,8	0,37	0,12	12				0,16
15MC	1200	0,08	1,6	2100		16	0,44	20	0,28	0,08	12				0,36
NC	600	0,05	2,23	686	21	218		0,16			30	18,1	0,36	1,16	0,01
UA	535	0,24	5,7	1470	0,55	86,6	0,18	5,38	0,43	0,17	2,5	17,7	0,17	0,32	0,03

*4M – Marine aerosol, Indian Ocean; 5C – costal aerosol, Suez canal;
15MC – marine – costal aerosol, South China Sea; NC – North Caspian aerosol, costal (august); UA - urban aerosol, Moscow

Some results on the content of trace elements in certain samples of marine and coastal aerosols, which we studied earlier (Anikiev, Kolesov, Kuzmina et.al, 1998; Anikiev, Kolesov, 2008) are shown in *Table 5* for comparison. From these data we can draw the following conclusions about the content and distribution of elements. *Sodium* - its content is the highest in the sample 15MP (South China Sea), and probably associated with the removal of material by wind from the coast with high population density. *Scandium* - in urban dust it was higher than in other studied areas. *Chrome* - nonuniform distribution. *Iron* - the content is about the same as in marine aerosols, but higher than in the northern Caspian aerosols. *Cobalt* - in the city dust its content is as much as in marine and coastal aerosols, but lower than in the Caspian Sea. *Zinc* - Zn content is high and higher than in other investigated samples. *Selenium* - its contents can be considered the same for all the studied areas. *Bromine* - the content is high, but 4 times lower, than in sample 15 MP (perhaps due to the influence of algae). *Silver* - in urban dust content is higher than in remote marine areas; enhanced level may be due to the presence of jewelry of urban residents. *Cesium* - its contents in urban air is enhanced. *Barium* - concentration in the city dust increased slightly. *Nickel* - the content is in the range of data, character for composition of Caspian Sea aerosols. *Uranium*, *thorium*, and *terbium* - their content in city dust is 2-3 times higher than in the samples of other studied aerosols.

Summary

In general, we can conclude that Moscow urban air in the composition of some rock-forming, rare, rare earth and radioactive elements (including the "heavy" metals) slightly differes from the composition of investigated remote marine and coastal areas. To provide a better conclusion more research is needed and careful analysis of large data sets. It should be noted that composition of organic components of air pollution is not considered here.

The data obtained in this work formed the basis of recommendations for city services to develop activities to improve air quality in specific areas, and to reduce possible contamination. In particular, among the necessary ones: a) continuously monitor the composition of air (and other objects of the environment), b) systematic control of harmful emission of industries and transport in the local and regional level (within individual parts of the city), c) strong implementation of the list of environmental protection activities by the organizes and proper control from the public services.

CONCLUSION

a) The effectiveness study of elemental composition of atmospheric aerosols using instrumental neutron activation analysis was shown.
b) Using of fractionation coefficient and data directly obtained by INAA, can contribute to better detection of locations (sources) of air pollutants and assess the level of air environment contamination.
c) The interaction of producers, inspection services (ecologists), and researchers is the key to solve the task of successful environment protection.

REFERENCES

Anikiev V.V., Kolesov G.M. (2008). Natural Factors Controlling the Temporal Variability of the Major-Element Chemical Composition of Mineral Aerosols over the Northern Caspian. *Geochemistry International*, (11), 1304 - 1321.

AnikievV.V., Kolesov G.M.,Kuzmina T.G. et.al. (1998). Factor Affecting Element Distribution in the Atmospere. Geokhimiya, (3), 271-285.

Fomin G., Fomina O. (2002). Air. Pollution Control according to International Standards. In (Eds), Fomin G., Fomina O. *Air. Pollution Control according to International Standards.* Handbook. Second edition, 2002. - Moscow: Protector, 3 - 402.

Kolesov G.M. (1994). Determination of Microelements: Neutron Activation Analysis in Geochemistry and Analytical Chemistry. *Journal of Analytical Chemistry (Russia),* 49 (1), 55-67

Kolesov G.M., Shubina N.A. (2008). Application of Neutron Activation Analysis for the Solution of Some Metodological Aspects of Geochemical Ecology. In Ermakov, V.V., and Korobova, E.M. (Eds), *Selected Presentations of the 2 nd Russian School of Thought "Geochemical Ecology and the Biogeochemical Study of Taxons of the Biosphere*", Moscow, January 26-29, 1999. - Moscow: Publ.GUN NPS NMG MZ RF, 2001, 270-290.

I International Conference
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MODELLING AIR POLLUTION AT SZEGED, HUNGARY

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ABSTRACT

The aim of the study is to determine spatial and temporal characteristics, as well as statistical interrelationships of air pollutants in Szeged and Csongrád county and to give human biometeorological assessment on air pollution load there. Monthly averages of NO_2, SO_2 and deposited dust from RIE (Regional Immission Examining) network operating in Szeged (10 stations) and Csongrád county (11 stations), furthermore 30-minute averages of CO, NO, NO_2, SO_2, O_3 and total suspended particulate (TSP) measured by the monitoring station in Szeged are analysed. Emission time courses of the pollutants and temporal variability of TSP are shown. Joint daily behaviour of O_3-irradiation, O_3-NO and NO_2-irradiation are presented. Spatial factor analysis is used for NO_2, SO_2 and deposited dust time series to produce their homogenous subregions. Air quality stress index for mean (annual) and short-term (diurnal) air pollution load was calculated. Average diurnal cycle of the pollutants in percentage of the health limits are also displayed.

Key words: emission time courses, temporal variability, joint daily behaviour, spatial factor analysis, air pollution load.

INTRODUCTION

Air pollution is one of the most important environmental problems, which concentrates mostly in cities. Generally, human activities induce monotonous accumulation of pollutants. Possible reasons of worsening air quality are population growth in cities and, in connection with this, increasing built-in areas there. A considerable part of population growth is coming from the migration to the cities. The ever-increasing urban population, together with the growing industrialisation and energy consumption and the extensive transportation, raise air pollution, which becomes a more and more serious challenge for the interest of survival.

The aim of the study is to determine spatial and temporal characteristics, as well as statistical interrelationships of air pollutants in Szeged and Csongrád county (Fig. 1.) and to give human biometeorological assessment on air pollution load there.

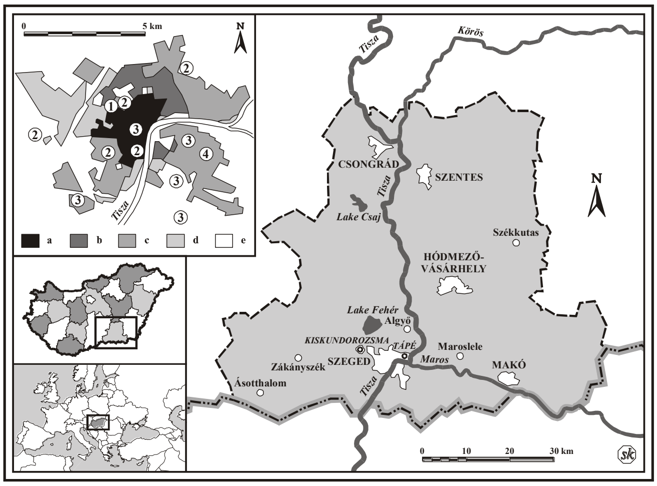


Figure 1. Geographical position of the monitoring and RIE stations in Csongrád county and Szeged (top left) with built-in types of the city (a: centre (2-4-storey buildings); b: housing estates (5-10-storey buildings); c: detached houses (1-2-storey buildings); d: industrial areas; e: green areas; (1): monitoring station, (2): measurements for NO_2, SO_2 and deposited dust, (3): measurements for only deposited dust, (4): measurements for only NO_2 and SO_2.

The database of the study results, on the one hand, from the monitoring station in Szeged downtown, for the period between 1997-2000. This station is located at a busy traffic junction and measures mass concentrations of CO, NO, NO_2, SO_2, O_3 and TSP (Fig. 1.). Another source of the database is the RIE (Regional Immission Examination) network for Szeged and Csongrád county. From this network, we used monthly mean concentrations of NO_2 and SO_2, as well as monthly totals of deposited dust (g / m^2 / number of days of the month) for the period between 1985-1999. Szeged is located in the Carpathian Basin, at 20°06'E and 46°15'N, at an altitude of ca. 80 m above sea level. Its population is about 155,000 inhabitants and the built-in area is around 46 km^2. The city is situated near the confluence of the Tisza and Maros Rivers, in southern Hungary. Szeged is the largest city and the centre of light industry in the southern part of the Great Hungarian Plain (Fig.1.).

The industrial area is located in the north-western part of Szeged. Thus, the prevailing westerlies and northerlies transport pollutants, from this area, towards the centre of the city.

STATISTICAL METHODS

Factor analysis

We investigated summer and winter half-year data sets of NO_2, SO_2 and deposited dust both for Szeged and the countryside stations with factor analysis of the spatial variability. Our aim was to identify subregions with more or less sovereign variations of these parameters.

One of the best methods to study time series data for a large number of stations or grid points, where strong spatial and temporal correlation prevails, is *factor analysis* (Bartzokas and Metaxas, 1993). One of the main benefits of this method is the reduction of the initial variables into much fewer uncorrelated ones, namely the factors. In this way, regions can be defined where, for any point within each region, the analysed meteorological variable covaries. Each original variable, P_i, i = 1, 2, ... , n, can be expressed as $P_i = a_{i1}F_1 + + a_{i2}F_2 + ... + a_{im}F_m$ (m < n), where F_j, j = 1, 2, ... , m, are the factors and a_{ij} are the loadings. One important stage of this method is the decision for the number (m) of the retained factors. On this matter, many criteria have been proposed. In this study, the *Guttman criterion* or *Rule 1* is used, which determines to keep the factors with eigenvalues > 1 and neglect the ones that do not account for at least the variance of one standardised variable. Another vital stage in this analysis is the so-called rotation of the axes (factors). This process achieves discrimination among the loadings making the rotated axes easier to interpret. In this analysis the *Orthogonal Varimax Rotation* was applied, which keeps the factors uncorrelated.

Numerical expression of air pollution load

The air quality stress index (AQSI) can be determined for mean (annual) and short-term (diurnal) air pollution loads. It considers only the following components: sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and total suspended dust (TSP) (Mayer, 1995). The air quality stress index (further: AQSI) for mean (annual) air pollution ($AQSI_1$) is given as follows:

$$AQSI_1 = 1/3 \cdot [I1(SO_2)/50 + I1(NO_2)/50 + I1(TSP)/50] \qquad (1)$$

The AQSI for short-term (diurnal) air pollution ($AQSI_2$) is given below (Makra and Horváth, 2001):

$$AQSI_2 = 1/3 \cdot [I2(SO_2)/125 + I2(NO_2)/150 + I2(TSP)/150] \qquad (2)$$

RESULTS

Emission time courses of air pollutants

Emissions of air pollutants can be originated from different source groups. These groups are as follows: residential, services, transport, power plants, other heating, industry and agriculture. The environmental station in Szeged, placed at a busy traffic junction, monitors and stores concentrations of CO, NO, NO_2, O_3, SO_2 and TSP. Among them, CO, NO, NO_2 and O_3 are more important because of their role in traffic. Average diurnal course of them shows a definite picture with double wave for CO, NO and NO_2 and one wave for O_3. They all can be connected to traffic density. Opposite daily course of NO and O_3 is also very clear.

The most important air pollutants are nitrogen oxides (NO_x), sulphur dioxide (SO_2), total suspended particulate (TSP) and carbon monoxide (CO). Their trends are presented in Fig. 2.

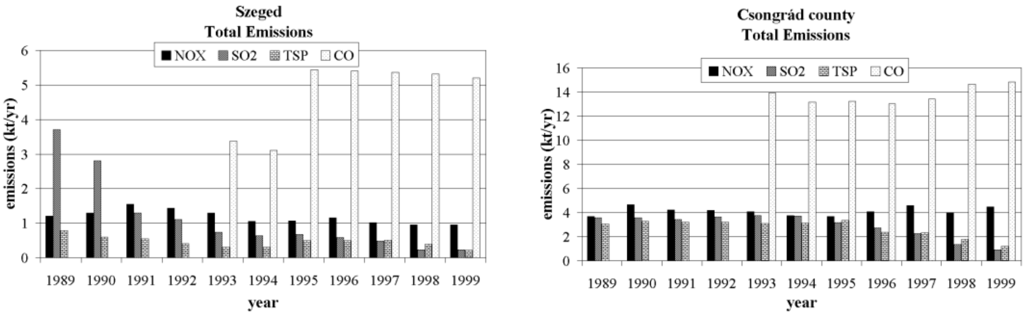


Figure 2. Emissions of nitrogen oxides (NO_x), sulphur dioxide (SO_2), total suspended particulate (TSP) and carbon monoxide (CO) in Szeged and Csongrád county from 1989 until 1999 (after the Environmental Protection Inspectorate of Lower-Tisza Region, Szeged, 2001).

Only SO_2 emissions show significant decrease both in Szeged and Csongrád county. This might be explained by the change of fuel pattern and technology after1990. Concentration of the other three air pollutants displays no temporal change. During the decade (1991-2000), many advances have been achieved in the field of transportation, such as the widespread use of unleaded petrol, enforcement of stricter vehicle emission standards and the growing ratio of more recent vehicle models. Hence, the increasing traffic density might be the reason of stagnating or even increasing CO and NO_x concentrations in the region.

Transport, especially with NO_x- and CO-emissions, can be considered a substantial pollution source. In Hungary, emissions of CO and NO_x caused by motor vehicle traffic amount to 44% and 53% of the total, respectively. Consequently, motor vehicle traffic seems to be one of the most important sources of air pollution, mainly in cities. Szeged, together with the population and the number of motor vehicles, is continuously growing. Hence, perspectives indicate a more significant role for traffic.

Temporal variability of total suspended particulate (TSP)

The average annual cycle of total suspended particulate shows the greatest values in November, December and January, with its maximum in January (Fig. 3.). Higher winter values might refer to atmospheric stability with frequent inversions. The lowest values in summer (June, July, August and September) can be explained by dilution because of intensive vertical exchange in the atmosphere. The diurnal and weekly cycle of total suspended particulate (TSP) (Fig. 4.) has the shape of a double wave. Both primary and secondary maxima can be observed during peak hours and, in the same way, primary and secondary minima occur, when traffic is least (at night) or decrease (around midday). Also, due to the traffic density, the concentration of TSP is relatively higher on weekdays, than on weekends.

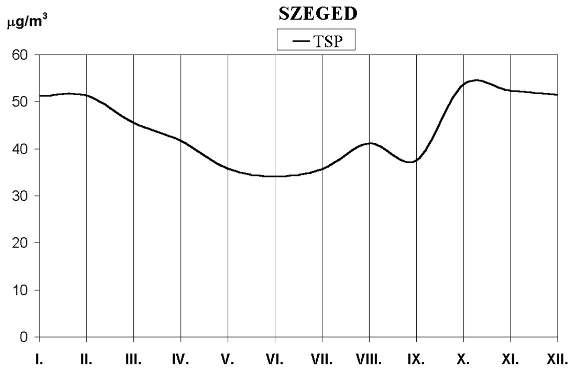


Figure 3. Average annual cycles of TSP at the monitoring station, Szeged downtown, for the period 1997-2000.

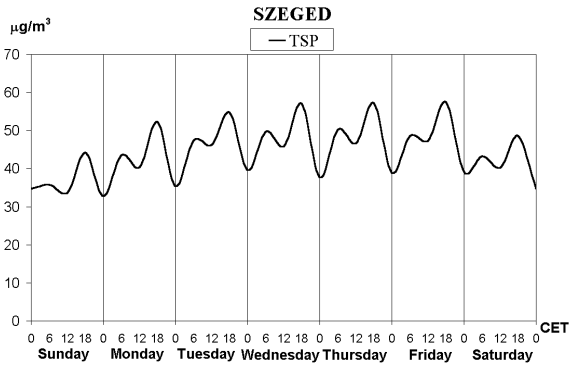


Figure 4. Average weekly and diurnal cycles of TSP at the monitoring station, Szeged downtown, for the period 1997-2000.

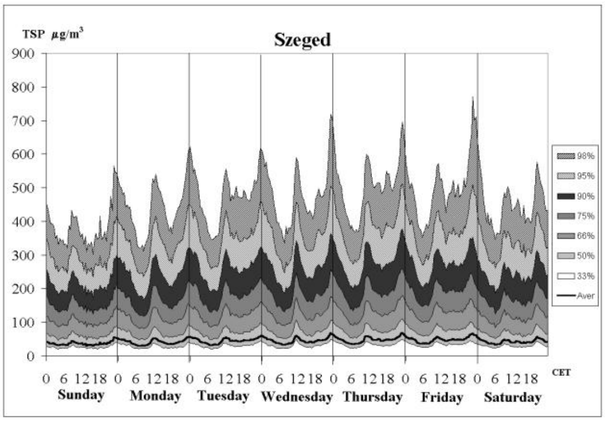


Figure 5. Average weekly and diurnal cycle of percentile values of TSP at the monitoring station, Szeged downtown, for the period between 1997-2000.

Peak values for TSP show a double wave displaying maxima late in the evening, while secondary maxima can be observed late in the morning. Least TSP concentrations are measured early in the mourning, whilst secondary minima occur in the evening (Fig. 5.). The average annual, weekly and diurnal cycles, as well as average weekly and diurnal cycle of percentile values of TSP are very similar to those of NO, which highlights connection of TSP with traffic (Makra et al., 2010).

Joint daily behaviour of pairs of variables

In order to receive more detailed information on interrelationships among O_3, NO, NO_2 concentrations and irradiation, joint daily behaviour of their pairs were studied (Fig. 6.). In the graphs, serial numbers of the measurements are presented. (No. 1: value of the measurement at 0^{30}, … , No. 48: value of the measurement at 24^{00}.) O_3-light pair shows a clear linear connection with some lag, while both O_3-NO and NO_2-light pairs basically display an opposite connection.

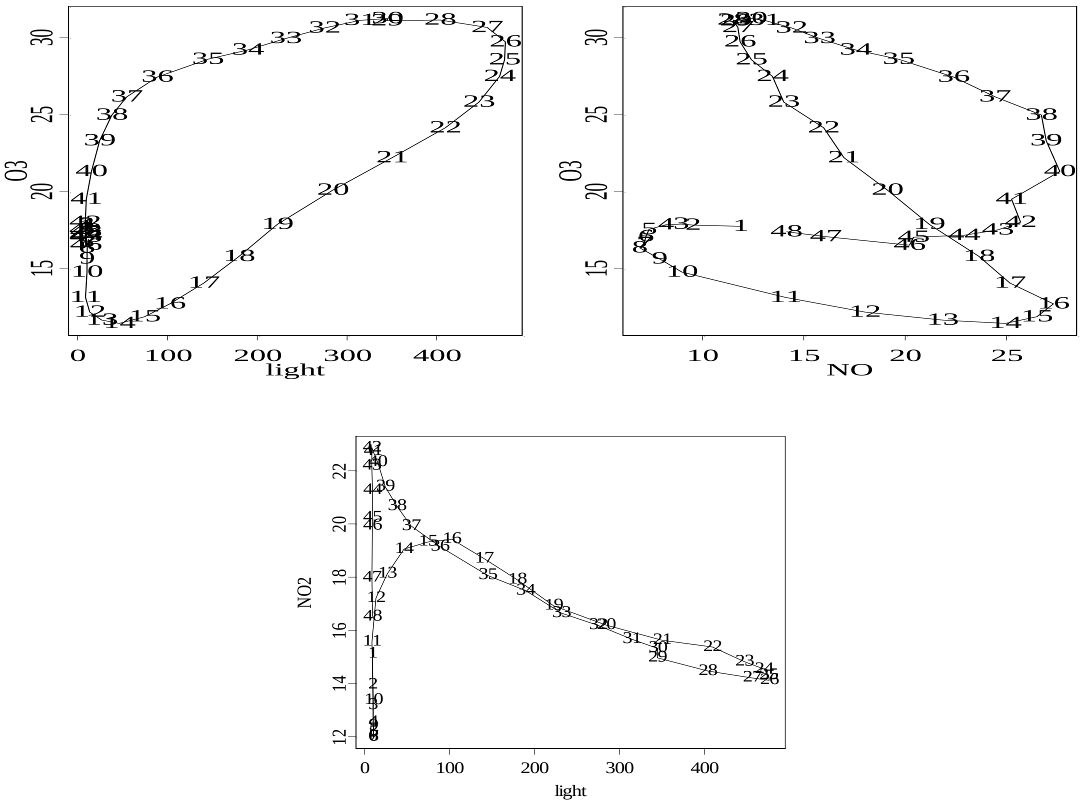


Figure 6. Joint daily behaviour of pairs of variables (O_3, NO, NO_2: ppb; light: W m^{-2})

Spatial classification

Joint daily behaviour of the pairs can be explained as follows. Ratio of NO_2/NO depends, through ozone concentration, on radiation (on the figure: light) and NO emissions. Daytime, the ratio NO_2/NO >1 can be explained by the rapid oxidation of NO ($NO + O_3 \longrightarrow NO_2 + O_2$) (intensive, ozone producing processes). While the turn of this ratio in the evening and at night indicates decrease of oxidation capacity of the atmosphere (following nightfall, photochemical processes, leading to ozone formation, stop) (Horváth et al., 2002).

Kholmogorov-Smirnov test was applied for data sets of NO_2, SO_2 and deposited dust in Szeged and Csongrád county, according to which all of them proved to be of normal distribution at 0.01 % significance level. The spatial factor analysis for NO_2 and SO_2 yielded mainly two subregions (Table 1a-b).

Table 1a: The significant eigenvalues and the total percentage of variances explained by the retained and rotated factors, Szeged

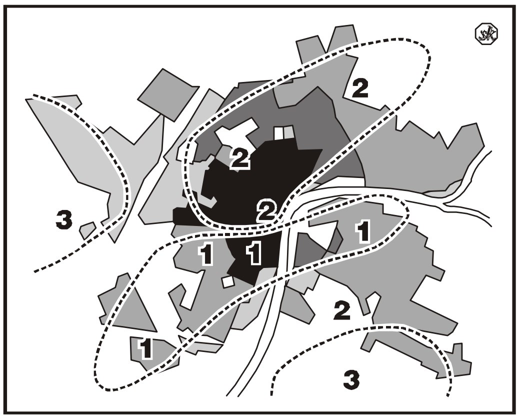
Factors	NO_2 Summer half-year	NO_2 Winter half-year	SO_2 Summer half-year	SO_2 Winter half-year	Deposited dust Summer half-year	Deposited dust Winter half-year
1	2.5	3.4	-	3.4	2.08	3.68
2	1.6	1.5	-	1.6	1.28	1.22
3	1.1		-		1.21	1.08
4			-		1.05	
Expl. var., %	87	81	-	83	56.24	59.79

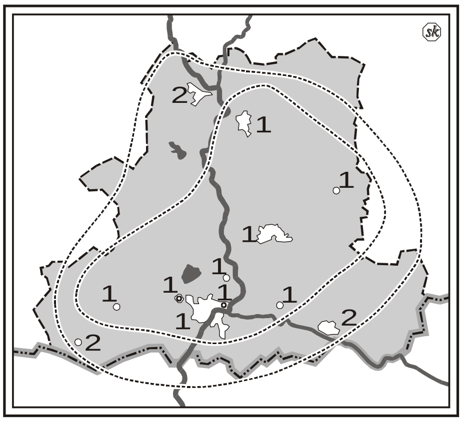
However, the *Rule 1*, described in Section 2.1.1, resulted in four subregions for deposited dust in the summer half-year. For each pollutant, summer and winter half-year maps of subregions differ considerably. Most similarity is found between the winter half-year maps of the rotated factor loadings for NO_2 and SO_2. The summer half-year maps of subregions for deposited dust are the most confused (Fig. 7.). The eigenvalues and the percentages, explained by the retained and rotated factors explain 55-65 % of the total variance for deposited dust (this value is similar for Szeged and countryside), whilst 60-70 % for NO_2 and SO_2 in countryside, which differs significantly from 80-90 % for those in Szeged (Table 1a-b.) (Makra and Horváth, 1999).

Table 1b: The significant eigenvalues and the total percentage of variances explained by the retained and rotated factors, countryside

Factors	NO_2 Summer half-year	NO_2 Winter half-year	SO_2 Summer half-year	SO_2 Winter half-year	Deposited dust Summer half-year	Deposited dust Winter half-year
1	2.12	3.35	3.13	2.82	3.59	6.38
2	1.59	1.11	1.22	1.47	1.62	1.26
3					1.16	
4					1.01	
Expl. var., %	61.89	74.34	72.49	71.49	61.47	63.64

The method of spatial factor analysis derives the regions from similarities and differences on given time scales. In some cases the regions differ considerably, in other cases they show great similarity. Central parts of the subregions are indicated by the 0.8 factor loading isolines. The regions are perhaps realistic in statistical sense. This means, that they are not direct consequences of the method, itself (Fig. 7.).





a. concentration of deposited dust, winter half-year, Szeged

b. concentration of deposited dust, winter half-year, Csongrád county

Figure 7a-b. Subareas formed according to the rotated factor loadings when the number of retained factors is > 1.

Human biometeorological assessments for air pollution load

Mean (annual) air pollution load ($AQSI_1$) became better in 2000 (0.471) and in 1999 (0.448) comparing to its value in 1998 (0.606). This means that the examined busy traffic junction in Szeged can be listed into the air pollution category I. (Mayer, 1999).

A study was made to investigate the difference in daily air pollution load ($AQSI_2$) between weekdays and non-weekdays (including Saturdays, Sundays and holidays), using data for the years 1998, 1999 and 2000 at the air quality monitoring station, Szeged. In Hungary, working time is 40 hours per week. It is supposed that the short-term (diurnal) air quality ($AQSI_2$) might change during the weekend. The results indicated that $AQSI_2$ is higher on weekdays and lower during weekends (Table 2.). The air quality is definitely better on holidays in the winter half-year, while role of Saturdays, Sundays and holidays is very similar in the summer half-year. On weekends, air pollution load is lower up to 18 %. Consequently, traffic is supposed to contribute mostly to the change in air pollution load.

Table 2: Difference of air quality stress index (AQSI) values

Monitoring station	Difference of daily averages, %		
	(1)	(2)	(3)
Year	-8.72	-16.22	-12.92
Summer half-year	-13.52	-13.43	-13.47
Winter half-year	-4.64	-18.34	-12.40

(1) Difference between Saturday and weekday (Saturday – weekday), %
(2) Difference between holiday and weekday (holiday – weekday), %
(3) Difference between holiday + Saturday and weekday [(holiday + Saturday) – weekday)], %

In order to get an overview of the diurnal air pollution load in Szeged, categorisation of the days were made (see categories in Section 2.1.2.) on the basis of mean diurnal concentrations of air pollutants for the years 1998, 1999 and 2000 (Table 3.) Our results show that number of days with worse air pollution load is higher in the winter half-year (categories II, III. and IV.) comparing to that in the summer half-year. The air quality became substantially better in 1999 as compared with that in 1998, while stagnation can be experienced in 2000. Better air quality is characterised by significantly higher number of days with low air pollution load and, synchronously with this, by considerably lower number of days with extreme pollution load (Table 3.). The winter half-year is more characteristic in occurrences of days with heavier pollution load, than the summer one. This is presented clearly by the number of days, on which daily standards (in $\mu g\ m^{-3}$, CO: in $mg\ m^{-3}$) for air pollutants were exceeded.

Table 3: Number of days with different pollution levels

Monitoring station	Pollution levels, day											
	Level I.			Level II.			Level III.			Level IV.		
	1998	1999	2000	1998	1999	2000	1998	1999	2000	1998	1999	2000
Year	293	343	335	41	14	8	31	8	24	5	0	2
Summer half-year	173	181	182	5	1	1	5	1	0	1	0	0
Winter half-year	120	162	153	36	13	7	26	7	24	4	0	2

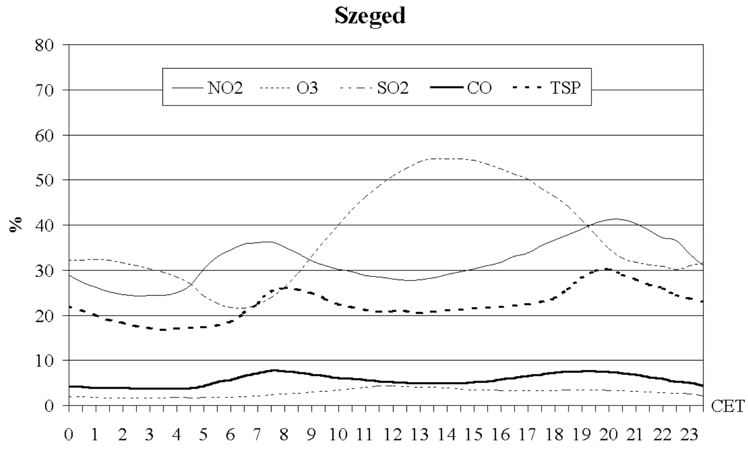


Figure 8. Average diurnal cycle of the pollutants in percentage of their health limits at the monitoring station, Szeged downtown, for the period between 1997-2000.

Daily averages of the pollutants, on the basis of their 30-minute values for the period 1997-2000, were calculated in percentage of the health limits (Fig. 8.). It is concluded that they hardly reach 40 % of the health limits. Even the maximum values, which belong to O_3, are well below 60 %. This result confirms the above-mentioned consequences of Section 2.2.5, according to which not only the examined busy traffic junction in the neighbourhood of the monitoring station Szeged, but the city itself can be listed into the air pollution category I. (Mayer, 1999).

Hence, diurnal averages of the pollutants between 1997-2000 are far below the 24-hour limit values [CO: 0.45 ppm (limit value: 4.295 ppm); NO_2: 16.25 ppb (44.34 ppb); (SO_2: 1.92 ppb (56.19 ppb); O_3: 20.42 ppb (50 ppb); TSP: 36,72 $\mu g\ m^{-3}$ (100 $\mu g\ m^{-3}$)].

CONCLUSIONS

- Trends of SO_2 emissions show definite decrease both in Szeged and Csongrád county.
- Diurnal and weekly cycles of total suspended particulate are connected with traffic density, as secondary reason, while its annual cycle is influenced by dilution, as cause of intensive vertical exchange in the atmosphere.
- Joint daily behaviour of O_3-light, O_3-NO and NO_2-light pairs show characteristic diurnal courses, which can be explained by their interrelationships.
- The eigenvalues, explained by the retained and rotated factors explain less part of variance for deposited dust than for NO_2 and SO_2. Spatial factor analysis yielded mainly two subregions for NO_2 and SO_2, while three-four subregions for deposited dust. Summer half-year maps of factor loadings are more confused than winter half-year ones.
- The air quality stress index for mean (annual) air pollution ($AQSI_1$) has definitely decreased in Szeged. Short-term (diurnal) air pollution ($AQSI_2$) increased in weekdays and decreased on weekends.
- Daily average concentrations of the pollutants increased in weekdays and decreased during weekends. The concentration of O_3 presented an opposite trend. On weekends, air quality improves better in the winter half-year.

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REFERENCES

Bartzokas, A., Metaxas, D.A., 1993. Covariability and climatic changes of the lower troposphere temperatures over the Northern Hemisphere. Il Nouvo Cimen. 16C, 359-373.

Makra, L., Horváth, Sz., 1999. Spatial and temporal characteristics of air quality status over a middle-sized urban area. The 15th International Congress of Biometeorology (ICB'99) and the International Conference of on Urban Climatology (ICUC'99), Sydney, Australia. 8-12th November 1999. Proceedings. ISBN 1 86408 543 6

Makra, L., Horváth, Sz., Zempléni, A., Csiszár, V., Rózsa, K., Motika, G., 2001: Levegőminőségi trendek Magyarországon, különös tekintettel a dél-alföldi régióra. (Air quality trend sin Hungary, with special interest to the region of Southern Hungary.) Légkör, 46/2, 12-19. (in Hungarian)

Mayer. H., 1999. Air pollution in cities. Atmospheric Environment, 33(24-25), 4029-4037.

Horváth, Sz., Makra, L., Motika, G., 2002: An objective assessment of the connection between meteorological elements and the concentrations of the main air pollutants at Szeged, Hungary. *AMS Fourth Symposium on the Urban Environment and the 12th Joint Conference on the Applications of Air Pollution Meteorology with the Air and Waste Management Association*, Norfolk, Virginia, USA, 20–24 May 2002. Proceedings, J4.3, J58-J59.

Makra, L., Horváth, Sz., 2001: A levegőszennyezettség becslése Szegeden. (An assessment of air quality at Szeged.) Légkör, 46/4, 14-18. (in Hungarian)

Makra, L., Mayer, H., Mika, J., Sánta, T., Holst, J., 2010: Variations of traffic related air pollution on different time scales in Szeged, Hungary and Freiburg, Germany. Physics and Chemistry of the Earth, 35(1-2), 85-94.

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A STUDY FOR TRANSMISSION OF SUNLIGHT THROUGH THE ATMOSPHERE USING SUN PHOTOMETER

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ABSTRACT

This paper presents the transmission of sunlight through the atmosphere as a function of optical thickness (AOT) for each wavelength monitoring with the sun photometer in the Romanian city of Timisoara. The selected values for this study were recorded during June, 2011. The instrument is installed at the Mechanical Engineering Faculty (45.74 N; 21.22 E) and is connected to the federal network AERONET. Monitoring of the aerosol optical properties is still less experienced in Eastern European countries. The University “Politehnica” from Timisoara understood the importance the study of aerosol properties.

Key words: aerosol, transmission, AOT, AERONET.

INTRODUCTION

The paper is an attempt to describe different types of aerosols and their path through the atmosphere in the Romanian city of Timisoara. The town is one of the most developed ones in Romania, famous for its history and rapid progress into a modern but traditional location of human development (Popescu F., 2009). Air pollution in a modern city has become a serious environmental problem, because of the combined effects of various pollutants upon the physical and mental health of citizens and the quality of urban life in general (Popescu F., 2011 a), (Popescu F., 2011 b), (Ionel, I., 2010). Main possible aerosol sources are urban pollution from roads and power plants. The burning of fossil fuels produces around 21.3 billion tones (21.3 gigatones) of carbon dioxide per year, but also produces nitrogen oxides and sulfur dioxide emissions, which contribute to smog and the formation of fine particulate matter (Nisulescu C., 2011)

Aerosols are liquid or solid particles suspended in the air, with radii normally ranging from 0.1 to 10 μm. They have a direct radiative forcing because they scatter and absorb solar and infrared radiation in the atmosphere. The size distribution of aerosols is critical to all climate influences. Fine aerosols scatter more light per unit mass and have a longer atmospheric lifetime than coarse aerosols (Kokhanovsky A., 2008). Measurement of aerosol optical thickness can provide important information about the concentration, size distribution, and variability of aerosols in the atmosphere.

In the federal network AERONET (Holben B.N. et al., 1998) are connected over 650 instruments in the world, of which, currently, 4 are located and running in Romania (Figure 1), among them one in Timisora, at the POLITEHNICA University, in the multifunctional lab for thermal machines and renewable energies (www.energieregen.mec.upt.ro). The network imposes standardization of instruments, calibration, data acquisition, processing and distribution according a special technique and mathematical model. AERONET collaboration provides globally distributed observations of spectral aerosol optical depth (AOD), inversion products, and precipitable water in diverse aerosol regimes. For Romania, the network is based on the infrastructure and techniques developed in the frame of two main research projects RADO (www.inoe.inoe.ro/RADO) and ROLINET (www.inoe.inoe.ro/ROLINET).

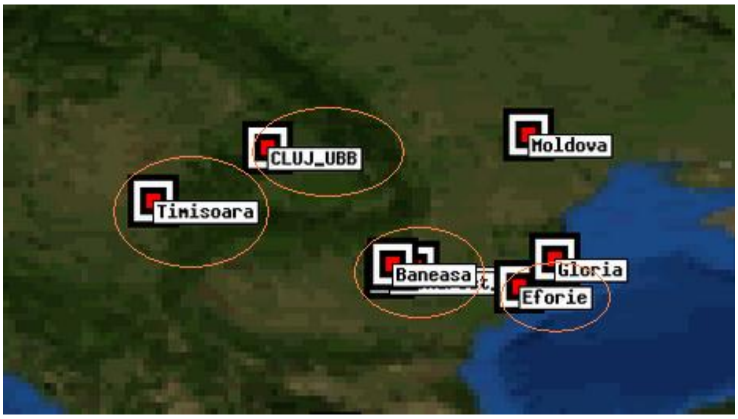

Figure 1. Sun photometer stations in Romania

GENERAL DESCRIPTION

The instrument used in this paper is a CIMEL ELECTRONIQUE 318 spectral radiometer manufactured in Paris; France. This is composed of an optical head, an electronic box and a robot (figure 2) and it is described in detail in (Holben B.N. et al., 1998). The optical head has two channel systems: the sun collimator (33 cm), without lens, and the sky collimator (33 cm) with lenses. This instrument has approximately a 1.2° full angle field of view. The electronic box contains two microprocessors for real time operation for data acquisition and motion control. In automatic mode, a ‘wet sensor′ detects precipitation and forces the instrument to park and to protect the optics. The robot is moved by step-by-step motors in two directions: in the zenith and azimuth planes.

Figure 2. Sun photometer located at the Politehnica Univerity of Timisoara

The sun photometer accomplishes two basic measurements, either direct sun or sky, both within several programmed sequences. The direct sun measurements are made in nine spectral bands (340, 380, 440, 500, 670, 870, 940, 1020 and 1640 nm) requiring approximately 10 seconds. The 940 nm channel is used for column water abundance determination. These interference filters are located in a filter wheel which is rotated by a direct drive stepping motor (Figure 3). A sequence of three measurements is taking 30 seconds apart, creating a triplet observation per wavelength, which is used to calculate the aerosol optical depth, the precipitable water and the Ångström parameter. Triplet standard observation are made during morning and afternoon at a 15 minute interval and for an air mass between m = 2 a.m. and m = 2 p.m.

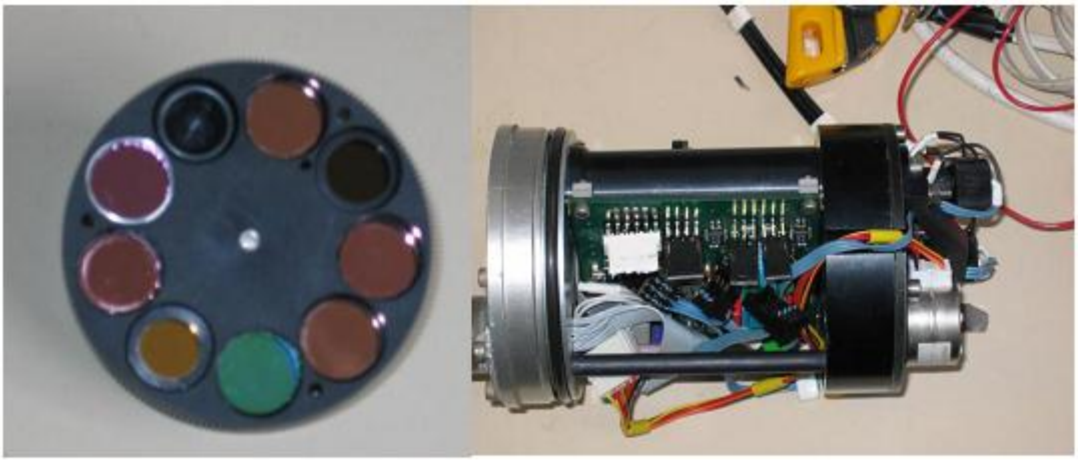

Figure 3. Filter wheel which is rotated by a motor

Sky measurements are performed at 440 nm, 670 nm, 870 nm, and 1020 nm. Two basic sky observation sequences are recorded: the “almucantar” and the “principal plane”. An “almucantar” is a series of measurements taken at the elevation angle of the Sun for specified azimuth angles relative to the position of the Sun. The range of scattering angles decrease as the solar zenith angles decreases. During an “almuncatar” measurement, observation from a single channel are made in a sweep at a constant elevation angle, across the solar disk and continues through 360° of the azimuth in about 40 seconds. This is repeated for each channel. An almuncatar is made hourly between 9 a.m. and 3 p.m. local solar time.

The standard “principal plane” sequences measures in much the same manner as the “almuncatar”, but in the principal plane of the Sun at a constant azimuth angle, with varied scattering angles. This measurements sequence begins with a sun observation, moves 6° below the solar disk, and then sweeps through the sun taking about 30 seconds for each of the four spectral bands. “Principal plane” observations are made hourly, when the optical air mass is less than 2 to minimize the variations in radiance due to the change in optical air mass. These measurements are used to calculate the size distribution, the phase function and the aerosol optical.

RESULTS AND DISCUSSIONS

Transmission of the direct solar beam through a vertical slice of the atmosphere can be calculated with the eq. (1).

$$V = V_0(\lambda)\left(\frac{d_0}{d}\right)^2 e^{(-m\tau_t(\lambda))} \tag{1}$$

where: V is the digital voltage, in V,
V_0 - extraterrestrial voltage, in V,
λ – wavelength, in nm,
m – optical air mass,
d_0 - the average earth–sun distance, expressed in astronomical units (AU),
d - the earth–sun distance on the day of observation, expressed in astronomical units (AU),
τ_t - total atmospheric optical thickness (AOT).

The air mass is calculated as function of the solar zenith angle.

The accuracy of the AERONET aerosol optical thickness measurements is 0.01 - 0.02 for the wavelength $\geq$ 440 nm and the uncertainty in measured sky radiances due to calibration error is ~ 5 % (Dubovik O. et al., 2000)

Table 1 presents the AOT and transmission average in June 2011, at different wavelength.

Table 1: AOT and transmission average for June 2011

Wavelength (nm)	1640	1020	870	675	500	440	380	340
AOT	0.231	0.262	0.277	0.339	0.443	0.507	0.588	0.662
Transmittance	79.42	77.01	75.86	71.32	64.29	60.32	55.64	51.68

Figure 3 show the AOT variation in June 2011, within the 0 – 2. It is evident that AOT presents large day to day variation. According to the Cloud Modification Factor (Figure 4), it was cloud free and the atmosphere was relatively clean from 1 to 6, 13 to 18, 20-23 and 26 to 27 June. On 10 - 11, and 23 – 25 June was rainy days. The maximum value for AOT was recorded on June 9, being over 2. The aerosol life time is short. The aerosol always accumulates for a few days, and then breaks down due to a passing cold front or to precipitation. In addition, the large day to day variation of AOT is also driven by many other meteorological factors.

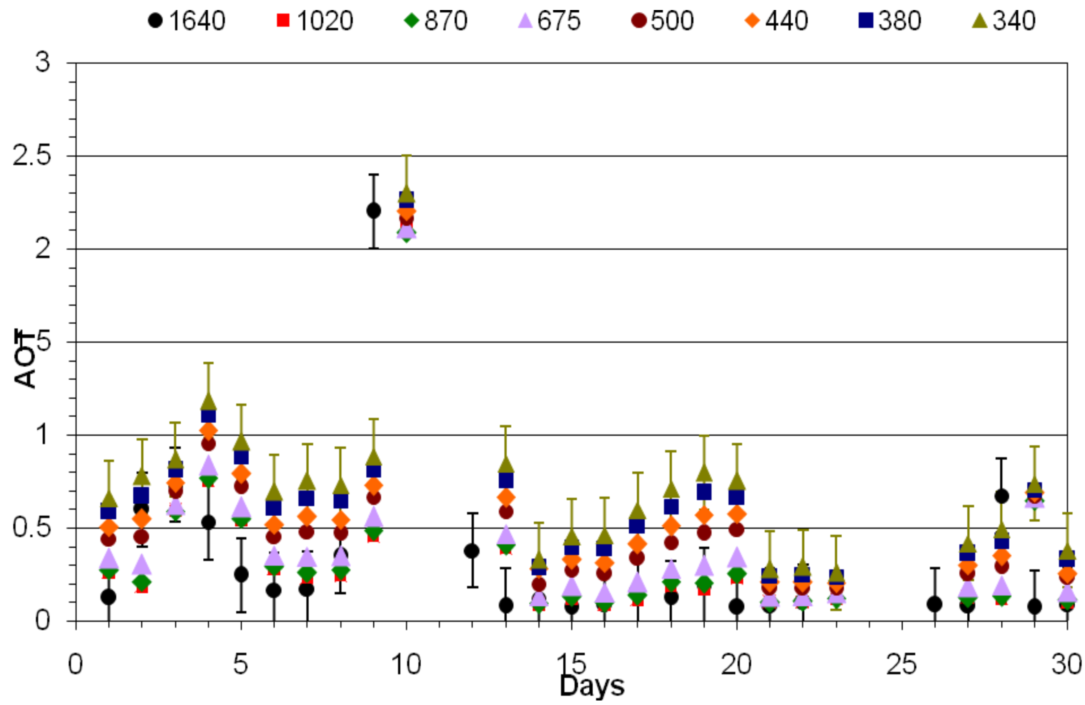

Figure 3. AOT variation in June

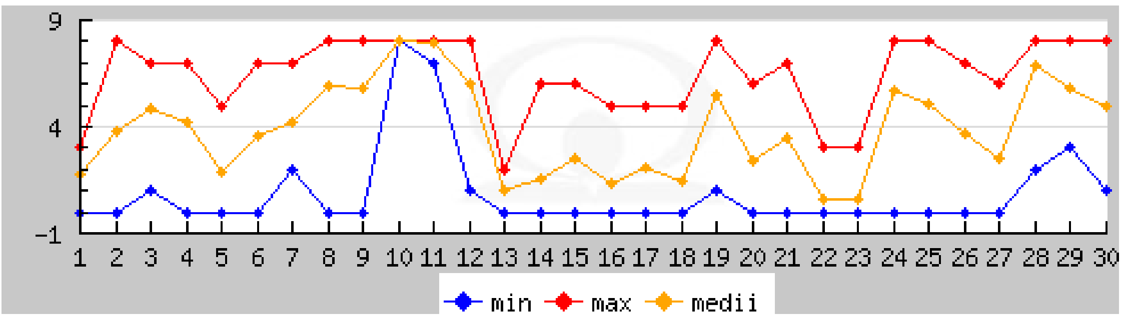

Figure 4. Cloud Modification Factor (a number between 0 and 8)

A typical aerosol optical thickness value for visible light in clear air is roughly 0.1. A very clear sky may have an AOT of 0.05 or less. Very hazy skies can have AOTs of 0.5 or greater. It may be easier to understand the concept of optical thickness when it is expressed in terms of the percentage of light that is transmitted through the atmosphere, according to this formula:

$$\%Transmission = 100 * e^{-\tau(\lambda)} \qquad (2)$$

This calculation gives the percentage of light at a particular wavelength that would be transmitted through the atmosphere if the sun were directly overhead. For an optical thickness of 0.1, the percent transmission is about 90.5%. The transmission depends on the type of clouds and aerosols (Figure 5). Cloud Modification Factor for different cloud types and amounts of cloud it is from 0 to 8 (0 octas representing clear sky, 8 octas representing overcast).

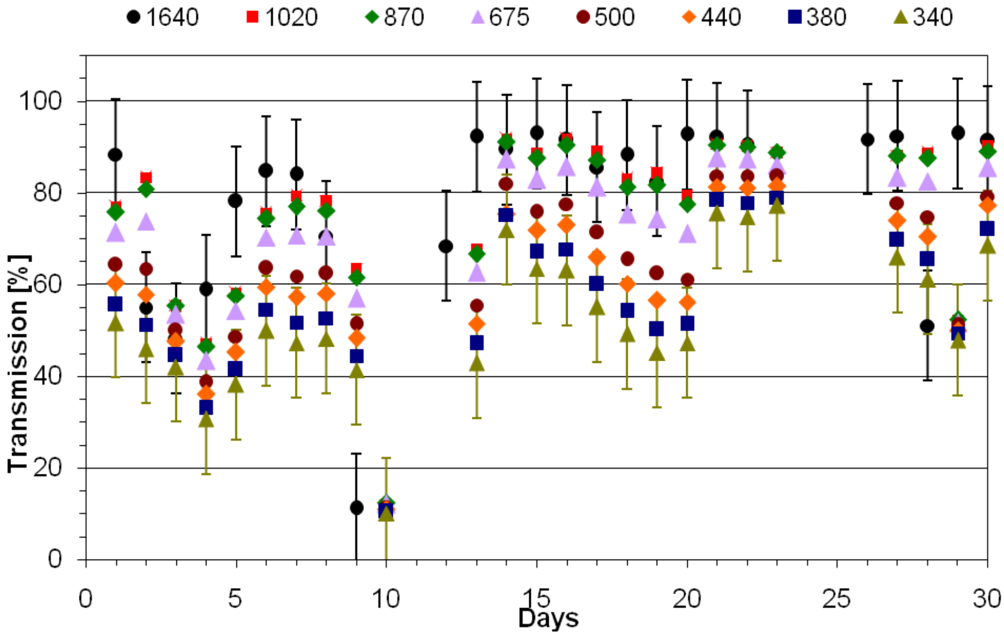

Figure 5. Transmission of sunlight through the atmosphere in June

Figure 6 illustrates the average aerosol thickness of MODIS satellite data (Moderate Resolution Imaging Spectroradiometer) for June 2011. This image was acquired using GES – DISC Interactive Online Visualization and Analysis Infrastructure (GIOVANNI) as part of the NASA. The MODIS retrieval (v4.2) of the AOT over land employs primarily three spectral channels centred at 0.47, 0.66, and 2.1 mm. AOT is derived at 0.47 and 0.66 mm, and interpolated to 0.55 mm. The average AOT at wavelength 550 nm is between 0.2044 and 0.2392 for Timisoara. The temporal correlation between MODIS and sun photometer is good. The AOT average from sun photometer at 440 nm is 0.507.

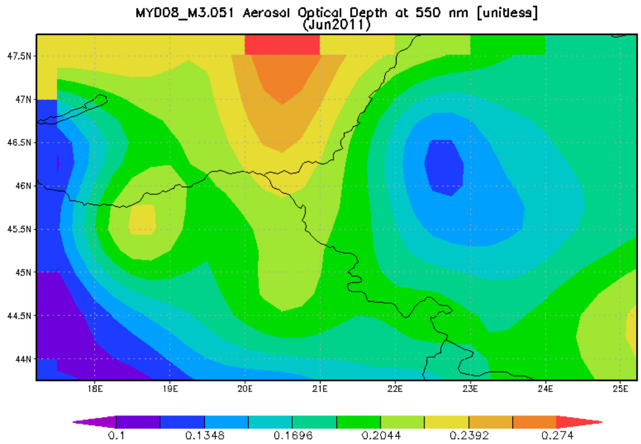

Figure 6. MODIS - average aerosol thickness during June 2011[http://aeronet.gsfc.nasa.gov]

CONCLUSION

Aerosol properties can be analyzed in the whole column atmospheric using a sun photometer. This instrument gives important data, but can only be performed when the sky is totally clear.

An optical thickness of less than 0.1 indicates a crystal clear sky with maximum visibility, whereas a value of 1 indicates very hazy conditions. In June the value of transmission was high, only in June 9 with value over 12 % meaning hazy condition (dust, biomass burning or urban pollution).

ACKNOWLEDGEMENT

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REFERENCES

Popescu F., Ionel I., Ungureanu C., (2009). *Ambient air quality monitoring in Timisoara. Current situation and perspectives,* Journal of Environmental Protection and Ecology, Vol. 10, No. 1, p. 1–13.

Popescu F., Ionel I., Lontis N., Calin L., Dungan L., (2011 a). *Air Quality Monitoring in an urban Agglomeration,* Romanian Journal of Physics, Vol. 56, No. 3 - 4, p. 495 – 506, Bucharest.

Popescu F., Ionel I., Talianu C., (2011 b). *Evaluation of air quality in airport areas by numerical simulation*, Environmental Engineering and Management Journal, Vol.10, No.1, p. 115 -120.

Ionel, I., Popescu, F., (2010). *Air Quality*, Publisher SCIYO, ISBN 978-953-307-131-2, Croatia.

Nisulescu C., Ionel I., Calinoiu D., Vetres I.,(2010). *Air pollution monitoring in a town nearly power plant*, Advances in Biology, Bioengineering and Environment, ISBN: 978-960-474-261-5, p.181-185.

Kokhanovsky A., (2008). *Aerosol optics. Light absorption and scattering by particles in the atmosphere,* Springer, ISBN: 978-3-540-23734-1, Berlin, Heidelberg, New York.

Holben B.N. et al., (1998), *Aeronet -A federated instrument network and data archive for aerosol characterization,* Elsevier Science, Vol. 66, p 1 – 16.

Angström A., (1929*). On the atmospheric transmission of Sun radiation and on dust in the air,* Geographical Annals, Vol. 11, p. 156–166.

Dubovik O., Smirnov A., Holben B., King M.D., Kaufman Y.J., Eck T.F., Slutsker I.,(2000*). Accuracy assessments of aerosol optical properties retrieved from AERONET sun and sky-radiometric measurements*, Journal Geophys. Res., Vol. 105, p. 9791 – 9806.

***http://aeronet.gsfc.nasa.gov

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IMPACT OF AIR POLLUTANTS ON THE AIR QUALITY IN THE CITY

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ABSTRACT

The process of rapid urbanization and city the growth of industrial production in them are directly proportional to the concentration of pollutants in the air. The aim of this paper is to point out the differences in the air quality caused by some air pollutants in the industrial environment in terms of full production; when the production is stopped; and the projection for the future, when the production is restored. The results of the testing of the impact that air pollutants have on the air quality in the city have shown that the application of appropriate measures and activities in the environmental protection, provide a satisfactory quality of life.

Key words: air pollution, industry, air quality.

INTRODUCTION

Atmosphere – a layer of a mixture of gases around the globe spreads to three thousand kilometers in height and contains: 78% nitrogen, 21% oxygen, 0,9% argon and variable amounts of water vapor and carbon dioxide, and other gases account for about 0,04%.

By continuous discharging of huge amounts of pollutants into the atmosphere, man has significantly changed the composition of the atmosphere above the densely populated areas. The presence of pollutants in the air has a number of direct and indirect impacts on the health of all living beings. There are more pollutants in the air at the same time, and an exponentiation of the effects is often possible. Pollutants in the air can act in a form in which they are emitted or as new compounds resulted from physical-chemical processes in the atmosphere. Local effects of pollutants from the air are reflected in cities where there is an increase in average temperatures, reduced humidity, of excessive rainfall, reducing soil pH and specific toxic effects of each substance individually. [4]

Air pollution implies the presence of gases and other content in the air that is not unique for its natural composition. Constituents of the atmosphere in trace in the gaseous, liquid or solid form can have a significant impact on wildlife and /or climate.

The biggest source of pollution is certainly industry, so that adverse effect of the air pollution depends on the type and capacity of the industry, the number of motor vehicles, the number and density of individual pollutants whose impact depends on the amount and the type of fuel.

Sulfur dioxide causes very dangerous air pollution. The sources of pollution are industrial processes, primarily sulphite ore smelting and combustion of fuels with high sulfur content. In addition to harmful effects on human health sulfur adversely affects the plants by destroying the green fund, increases the corrosion of metals and so on.

Soot contains very fine, small particles, whose size is around 5μg and they suspend in the air in the form of aerosols.

The sources of nitrogen dioxide are, apart from industry, traffic, boiler houses, individual furnaces, and spontaneously occurring chemical reactions in the atmosphere, where there is an increased presence of other polluting substances.

Sedimentary particles of matter are solid fuel ash, street dust and other materials in excess of 20μg which are frequently spontaneously deposited near the emission sources. The total deposited materials depend on the measurement area and the meteorological conditions. In winter months, the wind direction is from the industrial zone to the city.

The highest contamination results from ammonia production of mineral fertilizers.

Hydrogen fluoride is released into the atmosphere during the production of phosphoric acid and fertilizers. Harmful effects are manifested in the form of acute poisoning.

In addition, an increasingly important source of air pollution is the contamination of pollen, which amount represents an essential indicator of the air quality.

THEORY

In literature and in practice, a number of models is known upon which it is possible to get knowledge of input parameters to the concentration of pollutants in the production point in space. Gaussian diffusion model for point sources has proven to be the most reliable model so far. [2]

For assessment of possible environmental threats caused by the harmful substances from an emitter and delimiting endangered zone or range of concentrations (X_{max}) above the GVI in the environment, we use the following formula:

$$X_{max} = \frac{1}{\Psi}\sqrt{\frac{K[g-(C_{GVI}-C_O)]Q_H}{W_S(C_{GVI}-C_O)}} \quad (m) \qquad (1)$$

where:
$\Psi -$ dimensionless parameter that characterizes the turbulence of the atmosphere near the source:

$$\Psi = \frac{K' W_S}{W_1} + b \text{, za } W \geq 1\text{, } K' = 0{,}05\text{, } b = 0{,}05, \qquad (2)$$

K - coefficient that depends on air flow patterns,
g - emission hazards in mg/s,
Q_H - the amount of air, the fan capacity in m^3/s,
Ws - mean wind speed 2,5 m/s,
Co - a natural fon of total particulate matter 0,010 mg/m^3.

The expansion of the dust cloud from the emitters is done in the form of Gaussian plume in the direction of blowing wind, and the clouds make the sedimentation (I - immission) of larger particles of dust on the ground, which can be determined by the formula:

$$I = \frac{(C_{GVI}-C_O)W_S \cdot 3600 \cdot 24}{X^2\Psi} \quad (mg/m^2 / day) \qquad (3)$$

At a distance H from the source of airborne, the dust will remain to float in what is a natural fon of areas.

The calculation of ground concentrations of pollutants in the environment is based on the equation by Teverovski [11] which says:

$$C_{max} = 3.4 \times \frac{M \times Z}{V_v \times H^2} (mg / m^3) \qquad (4)$$

where:

M –the amount of the gas (g/s),
V_v – the wind speed (m/s).
$Z = f(\frac{X}{H})$ (a function of stack height and distance measurement points for which is the calculated concentration)

The value of Z is determined from the diagram in Figure 1, which gives the dependence of the Z - axis stack (X) and the emission level of H.

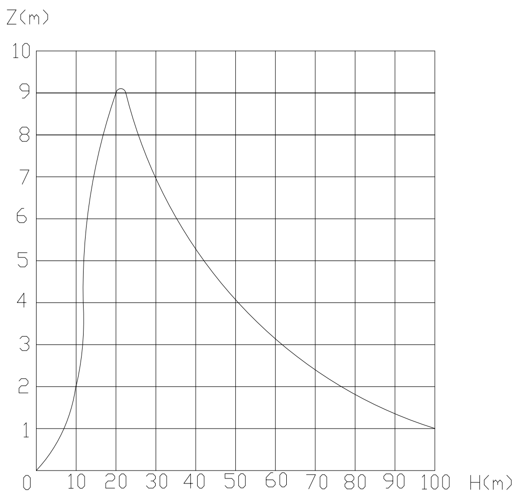


Figure 1. Diagram of correlation between the height of the chimney and the measuring point

The maximum concentration of pollutants in the ground layer of air is achieved for X = 20H, which in this case for the emitter height is 11 m is 20H = 220 m, therefore Z = 9,2 H.

The emission level is the sum of the height of the emitter and H_d and increase in height due to the speed of the gas leakage from the emitter:

$$H = H_d + 1{,}9 \times \frac{D_O \times V_g}{V_V} (m) \qquad (5)$$

where:

H_d – the emitter's height (m),
V_g – the speed of the gas in emitters (m/s),
D_o – the diameter of the emitter (m).

If contamination occurs, the analysis can be derived from Gaussian gas equation [Pavlovic, 2002]

$$C(x,y) = \frac{Q}{\pi U \sigma_y \sigma_z} e^{\frac{-y^2}{2\sigma_y^2}} e^{\frac{-H^2}{2\sigma_z^2}} \tag{6}$$

where:
C(x,y)- the concentration at the country level t = 0 at some point with coordinates (x, y),
x – the distance along the axis of wind (m),
y - the horizontal distance from the axis of flow (m),
σ_y - normal dispersion coefficient (m),
σ_z - vertical dispersion coefficient (m),
H – the height of the center line flow (m).

The three - dimensional coordinate system shows the change of nature and concentration along the directions of wind flow and its scattering along y and z. The concentration of spreading contamination and its elevation is given for z = 0.

The height of the chimney that emits a variety of polluting components is determined by the components that require the highest level.

The effect of air pollutants on human health can be acute and chronic. Acute are possible only at much higher concentrations of pollutants. Chronic effects of air pollution on humans can be divided into: irritant, allergic, fibrogenic, teratogenic, mutagenic and carcinogenic effects.

Only a small proportion of pollutants that the body is exposed to is absorbed. It is known that adults breathe about 20 m^3 per day and the children about 5 m^3 of particles from the environment. By law the Robert Brown (1773-1858) I quote: “Colloidal particles remain dispersed in the dispersing agent partly due to random collisions with other molecules and atoms” most of the particles $PM_{2.5}$ flows out, but most of PM_{10} particles gets swallowed up. Because of this, while analyzing the state of the air quality and its impact on human health and the environmental quality, we must be guided by the principles of precaution and worst-case scenarios.

METHODS

The sources of pollution can be considered as stationary and mobile. According to the character of emission sources are classified as: continuous, discontinuous and accidental.

On the territory of Šabac, there has been a multi-year continuous monitoring of the air quality at five sampling locations by accredited and certified laboratories and automatic measuring stations of the Agency for Environmental Protection. All tests are performed according to the applicable legislations harmonized with EU legislation, with the standard appliances and the result is expressed as the mean daily value. The average number of samples analyzed for all the pollutants is approximately 1000. The network of measuring points in the town is defined by the following criteria: population density, emission sources, urban solutions, methods of heating, and uses of space. Systematic measurements of basic and specific pollutants are carried out continuously.

The concentrations are monitored by measuring: sulfur dioxide (SO_2), nitrogen oxides: NO_x, NO, NO_2, ammonia (NH_3), hydrogen chloride (HCl), soot and sediment materials. From 2010, the monitoring of the ground-level ozone O_3 fraction of suspended particles $PM_{2.5}$ and PM_{10} started.

The examination of the products of combustion from the district heating plant was made: RBR ECOM J2KN, in accordance with SRPS M. E3.432 t. (6.6.2) (1990). Reference document Q3.04.10. – Instruction for testing the products of combustion. The capacity of Benska Bara boilers is 8.2 MW. The boilers in Benska Bara are of recent date (the year of production is 2003), while the boilers on the other side of town are little older (the years of production are 1986, 1991). Natural gas and crude oil are used as fuel.

The emission measurements were made in the heating season (October, November and January) for each energy source.

The examination of the SO_2 gas in 2006 on the emitter of the fluidic furnace, shown in Figure 2, is conducted through flue gas analyzer TESTO 350XL, Germany, in compliance with the Regulation 30/97, QMS ME 13.01.

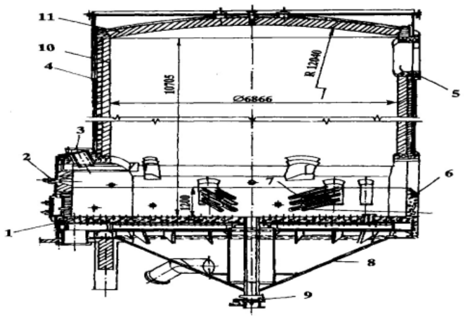


Figure 2.Furnace for the roasting of zinc concentrates in the fluidic layer: 1 - floor, 2 - brener for the ignition of the furnace, 3 - chamber charge, 4 - hull furnace, 5 passage for allowing gases, 6 - overflow threshold, 7 - cooler (caisson), 8 - air chamber, 9 - valve for air supply, 10 - furnace owall, 11 – furnace vault[13]

FINDINGS

In late 2004, when the production was launched and intensified in two industries-ferrous metals and fertilizer, tests showed that in the moments of movement, until the production stabilized, there were increased concentrations of sulfur dioxide, soot, ammonia, and partially hydrogen fluoride, which can be seen in the results of the analysis shown in Figures 3, 4, 5 and 6. [4, 5]

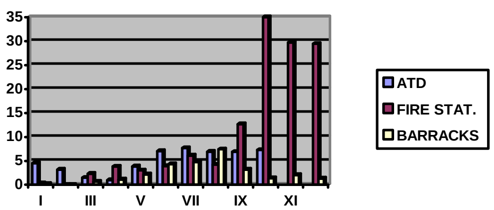


Figure 3. The values of the average monthly concentration of SO_2 per month and measuring points for 2004 ($\mu g/m^3$)

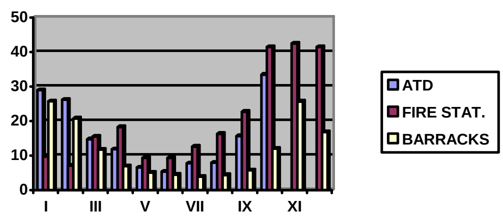


Figure 4. The values of the average monthly concentration of soot per month and measuring points for 2004 ($\mu g/m^3$)

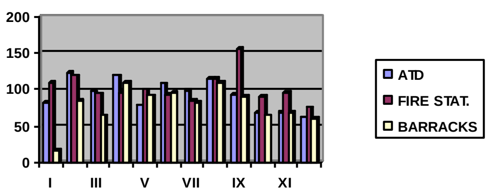


Figure 5. The values of the average monthly concentration of ammonia by month and

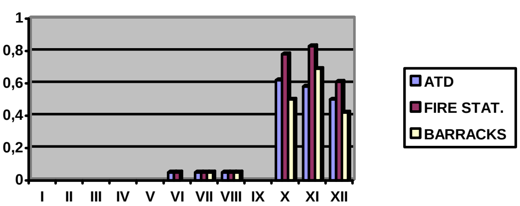


Figure 6. The values of the average monthly concentration of Hydrogen Fluoride by month

measuring points for 2004 ($\mu g/m^3$)	*and measuring points for 2004 ($\mu g/m^3$)*

The trend of pollution, despite the opinion that it would be increasing, decreased from year to year, although they were productive years. In 2005 - 2006, after implementing measures to protect the environment, changing the catalytic mass in the section for sulfuric acid, the test results showed that the pollution was reduced to the limits of the permissible concentration. Regular testing in the factories within the HC „Zorka" Šabac, and seeking solutions for the future given in the study by BCconsulting showed the following results, shown in Figures 7, 8, 9, 10, 11, 12 and 13. The data are from 2006. [10]

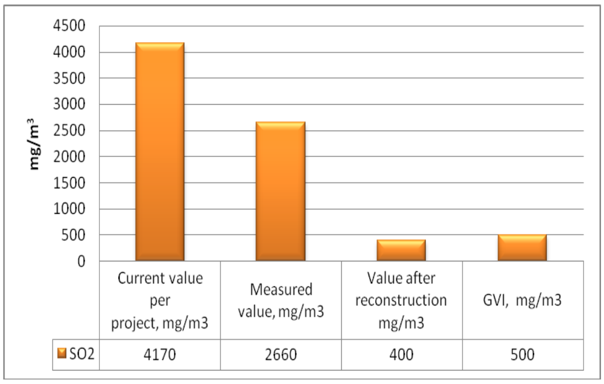


Figure 7. Emissions of SO2 in sulfuric acid plant

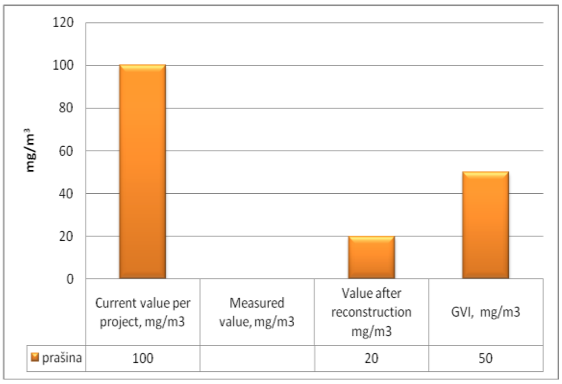


Figure 8. Emission levels of dust in the sulfuric acid plant

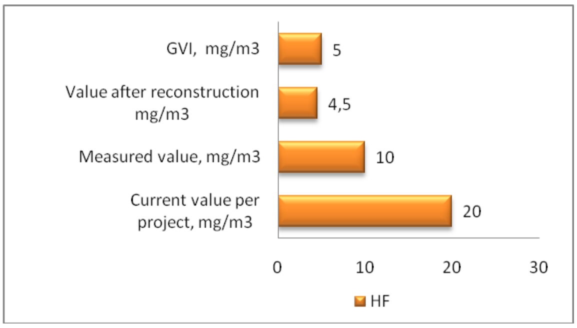


Figure 9. HF value of the phosphoric acid plant in

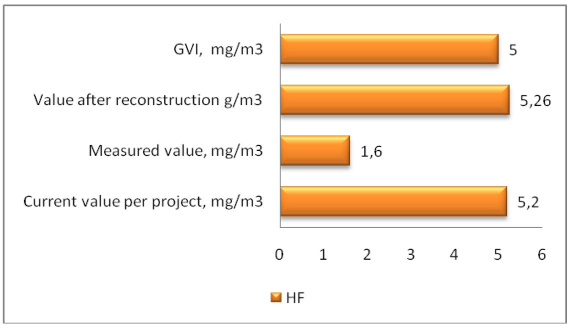


Figure 10. The value of HF emissions at the facility NPK fertilizer

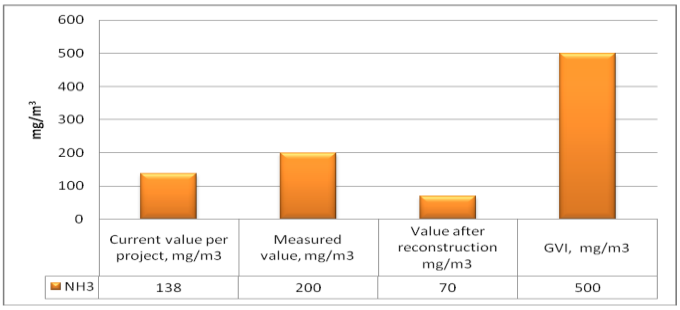


Figure 11.The values of NH_3 emissions in the NPK fertilizer plant

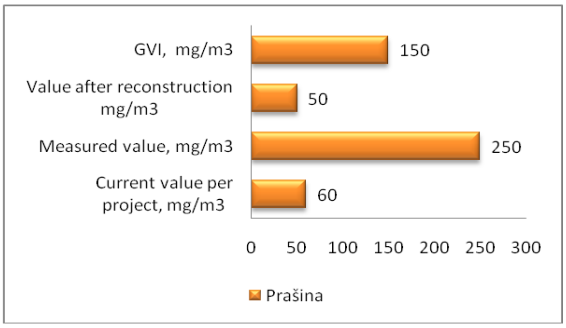


Figure 12. The value of emission of dust in the mills of phosphoric acid

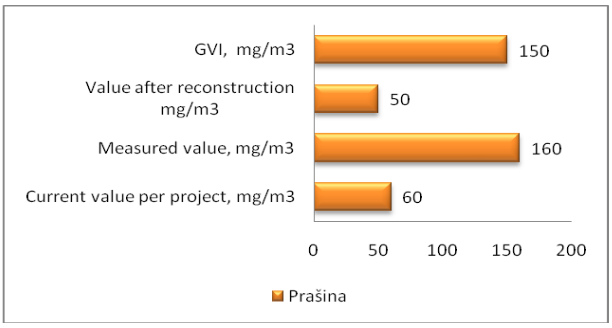
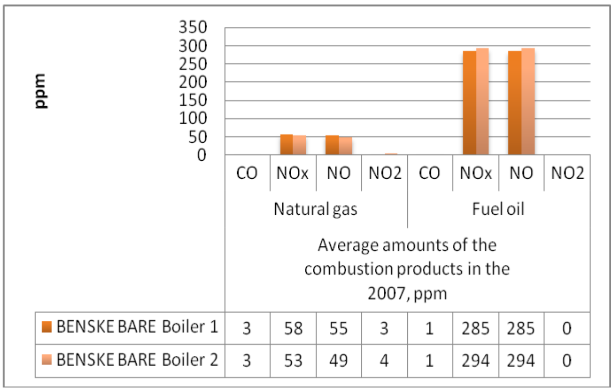


Figure 13. The values of dust emissions at the facility Dicalcium phosphate

In year 2007, there was only a slight pollution, mainly soot from the district heating plant and individual furnaces, so the question was the use of fuels for combustion. In Figure 14 and 15 the comparative average quantity of products of combustion of natural gas and fuel oil are shown.



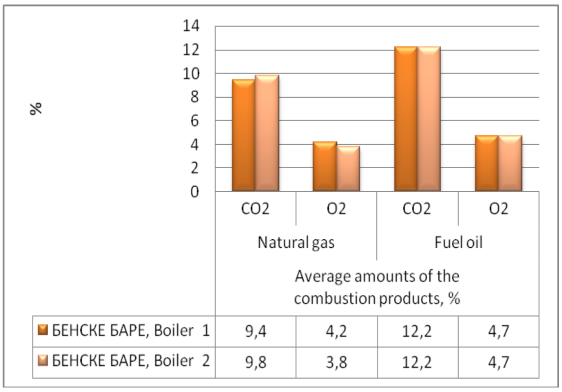


Figure 14. Average amount of district heating products of combustion

Figure 15. Average amount of district heating products of combustion

After production years 2004 - 2006, there was a reduction in industrial output and results of pollutant emissions for 2009 are shown in Table 1.

Table 1: Results of monitoring of air pollutants during the 2009[3,9]

Measurement points / Parametres, µg/m^3	Fire Station		ATD		Barracks		Benska Bara Heating Plant		PUC Stari grad	
	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max
SO_2 GVI =**150 µg/m^3**	15,47	38,69	14,66	51,00	14,24	40,69	14,27	45,4	16,98	44,15
NO_x GVI = **150 µg/m^3**	15,98	28,74	13,67	23,76	15,95	28,74	12,78	25,62	18,82	33
NH_3 GVI =**150 µg/m^3**	12,93	29,81	12,31	30,95	11,79	23,48	10,86	27,46	11,81	32,14
Soot GVI = **50 µg/m^3**	22,74	**78,30**	19,07	**76,60**	20,74	**78,70**	14,17	47,00	14,51	46,2
HCl GVI = **50µg/m^3**	5,1	11,1	5,14	11,66	4,67	11,87	4,52	10,98	5,40	11,4
Sediment Matter GVI = **450 µg/m^3**	282,93	**628,6**	147,41	329,39	204,78	356,98				

Statistical data on the number of patients suffering from various diseases obtained by breathing poor quality air are shown in Table 2.

Table 2: Data on the number of patients with inflammation of bronchi, emphysema and other obstructive pulmonary diseases (J40-J44) on the territory of Mačva region in the period of 2001-2009.

2009	8.867
2008	6.847
2007	7.659
2006	9.286
2005	10.156
2004	11.952
2003	9.075
2002	4.028
2001	4.306

DISCUSSION

By monitoring and analyzing the results obtained by continuous monitoring of pollutants, we can see that the air quality in the city which has developed chemical industry, a large number of individual furnaces and a heating plant, a large number of motor vehicles (for which there are no valid data on carbon emissions), a large area with developed weeds, depends on all of them as far as we keep them within tolerable limits.[6,12]

The biggest air polluter, and indirectly the soil and water is industry. [Morag - Levine, Noga, 2003] The results showed that:

- During the time when the production started, the value of the pollutant in relation to the GVI increased: 532% = SO2, NH3 = 40%, soot and HF =200% (2004, see Figure 3-6.)
- Implementation of environmental protection measures (changing the catalyst mass, the revitalization of certain plant parts, repair gas tract or reconstruction and modernization of plants...) predicts the emission levels allowed by law (2005-2006, see Figure 7-13.) Quantities of polluting materials compared to GVI in this period were: SO2 = 80%, NH3 = 14%, HF = 90%.
- When the production process was stopped, there was no pollution from the industry (2007 to 2009, see Table 1).

For the district heating plant and individual furnaces results show the advantages of combustion of natural gas as the environmentally most acceptable fossil fuel (see Figure 14 and 15). The amount of nitrogen oxides emitted by using fuel oil compared to natural gas increased by about 5 times, while the amount of CO_2 and O_2, increased 1,2 and 1,1 times.

The air pollution cannot be considered as the only cause of people getting ill. The most exposed part of the human organism from the air pollution is the respiratory system. [1] There is a global trend of increased number of patients with respiratory diseases, but in their creation there are many associated factors, and it is difficult to determine how much of an impact has the state of the air quality. The fact is that air containing a higher content of pollutants strongly influences the worsening of symptoms and respiratory diseases. The available data show that the number of cases doubled, and that the chronic obstructive lung disease from 5 to 7, entered the list of the four most common diseases.

Modern man spends the day indoors more than 16 hours, so that this indicator is of great importance. Indoor air can have very different compositions of ambient air and features a number of specific indicators:

- Combustion of fuel for heating and cooking,

- Presence of harmful substances in the construction of facilities, as well as in furniture,
- Increased concentration of allergens in the air compared to ambient (feathers, dust mites, ...),
- The possibility of an increased number of microorganisms, especially if there is an increased moisture content in the room,
- The possibility of harmful substances from the air through the system for ventilation and cooling,
- Unhealthy human habits (smoking),
- The possibility of the radioactive radon presence.

The importance of the quality of indoor air tells about verified existence of the pathological condition of “sick building syndrome". Previously exhibited problems in the town do not have monitoring and valid data based on that.

CONCLUSIONS AND IMPLICATIONS

Every human activity in space involves some negative impacts on the environment and it is inevitable interactivity. Since the elimination of pollution entirely is impossible, it is necessary to focus all available opportunities to reduce pollution emissions of harmful substances and keep them within acceptable limits. All limits represent the current categories and therefore more attention should be paid to adverse health effects of pollutants that are below the permitted values “low-level exposure“.

It is not the goal by stopping the production in the chemical industry, to attain the air quality, but various measures to improve, repair, reconstruct and provide safe and quality work, and as a consequence, the quality of life in a production environment.

The results of research on effects of air pollution on the quality of life in the city showed that in non-productive years, the only pollution that exists, and that there are valid results for it, is the soot pollution from the burning of fossil fuels in winter months and sedimentary materials. By applying partial protective measures and activities in terms of production, pollution is reduced, and the downward trend is going to limiting values only if all the planned adjustments are executed. By changing the fossil fuel, the pollution of stationary emitters is reduced about 5 times for nitrogen oxides, and about 1.2 times for the carbon dioxide.

REFERENCES

Biočanin, R., Amidžić, B., (2004), *Pollutants in the labor and the environment*, Scientific conference of health workers of Serbia with international participation, Zlatibor.

Bogner, M., (1992), *Termotehničar*, ETA, Belgrade.

Law on Air Protection (Sl.glasnik.RS 36/09).

Local Environmental Plan of Šabac (2011);

Ministry of Environment, Republic of Serbia (2007), *Hazardous waste in the Republic of Serbia in plants that are subject to the Law on Integrated Prevention and Control of Environmental Pollution (IPPC)*, Ministry of Environmental Protection, Belgrade;

Markovic, L., Marjanovic, T., Trumić, M., (2003), DPSIR *Method as a base document for Leap*, Ecological Truth, Special Session and National environmental plans;

Morag-Levine, Noga, (2003), *Chasing the Wind: Regulating Air Pollution in the Common Law* State, Princeton University Press, Princeton;

Pavlovic, M., (2002), *Resources and Ecology*, University of Novi Sad, Technical Faculty "Mihajlo Pupin", Zrenjanin;

Regulation on conditions and requirements for monitoring air quality (Sl.glasnik.RS 11/10)

Tomic & Partners (2006), *Information Memorandum "Zorka" Holding AD*, Bcconsulting, Belgrade;

Trajkovic, M., Todorovic, B., *Control discharges of pollutants of the atmosphere from the chimneys and ventilation systems*, The Institute for health and safety documentation, Niš;

Trumbulović - Bujić, Lj., Acimovic-Pavlovic, Z., (2008), *Influence of air pollutants on air quality in industrial environment*, MjoM Metallurgy - Journal of Metallurgy, the Association of Engineers of Serbia Metalurgical AMES, Belgrade;

Vračar, R., (1997), *Extractive metallurgy of zinc*, Naučna knjiga, Belgrade;

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PREDICTION OF AIR POLLUTION WITH ODORS FROM ENDERING PLANT

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ABSTRACT

Animal wastes are removed in special plants – rendering plants, where high-value protein and mineral nutrients are obtained from raw materials for animal nutrition. Unpleasant odors and harmful gases, resulting from the decomposition of organic material, are one of the important problems characteristic for this plant.

Aim of this study is to determine the intensity of odors in the air from the rendering plant with a conventional dry batch process in the surroundings of the plant. The work is based on empirical data of the concentration of polluting components in this plants, from the critical areas that can be seen as sources of pollution. Using calculations values of emission and imission were derived, which is the base to determine the "air pollution index" and the intensity of odors.

These results suggest a monitoring program to reduce air pollution and negative impacts on people in the region.

Key words: air pollution, rendering plant, odors, monitoring.

INTRODUCTION

Nowadays, the products obtained in processing of dead animals and slaughterhouse waste require high quality, not only in absolute hygienic products and chemical composition, but also by their biological value. That is why there is growing interest in quality use of waste from livestock production and slaughter industry in the world. They, as a very valuable carriers of proteins, minerals and energy, are important raw material for producing fertilizers, which are used as components in forage mixtures for all types and categories of animals (Ristic et al, 2001).

The necessity of utilization of these raw materials is derived from the knowledge that the non-edible parts of slaughtered animals and dead animals are potential source of infectious diseases in animals and humans. Therefore, the optimum opportunity must be found to turn these wastes into raw materials, whose recycling will reduce their quantity, and in addition, receive a new usable products. Technological methods of safe disposal of dead animals and slaughterhouse waste emit odors in the environment, since the biological decomposition of their raw materials generate harmful gases. Therefore, there is a need to predict air quality in the vicinity of these plants based on the emissions of harmful gases, measurement and calculations on the odors with and without treatment of gases (Ristic et al, 2001).

THEORY

A method for processing animal waste

Processing of inedible by-products of slaughter industry and dead animals is aimed at obtaining high-quality livestock feed and products for the chemical industry. The most important things are that certain actions destroy microorganisms found in raw materials; raw materials have to maintain its biological value; and the raw materials lead to revised state suitable for use in animal feed and other uses. In most rendering plants throughout the country is present conventional batch dry process, which is also known as Dry rendering process. The technological process starts with chopping raw materials. Fine-grained material is filled destructor to about 60% of the total volume. The destructor is done cooking, sterilization and drying of raw materials. After cooking and sterilization, the material is dried and degreased with the press. Pressed material is cooled and crushed into flour. Dehydrated filtered fat is purified and stored. The whole process is schematically shown in the following figure 1 (Ristic et al, 2001).

Indices on the picture: 1. Box for the raw material 2. Conveyor belt with a metal detector 3. Grinder 4.Screw conveyor 5.Top 6. Destructor 7. Fat drain 8. Press 9. Screw cooler 10. Elevators 11.Hammer Mill 12. Sieve13. Cell flour 14. Bagging scale 15. Decanter 16. Grease Reservoir

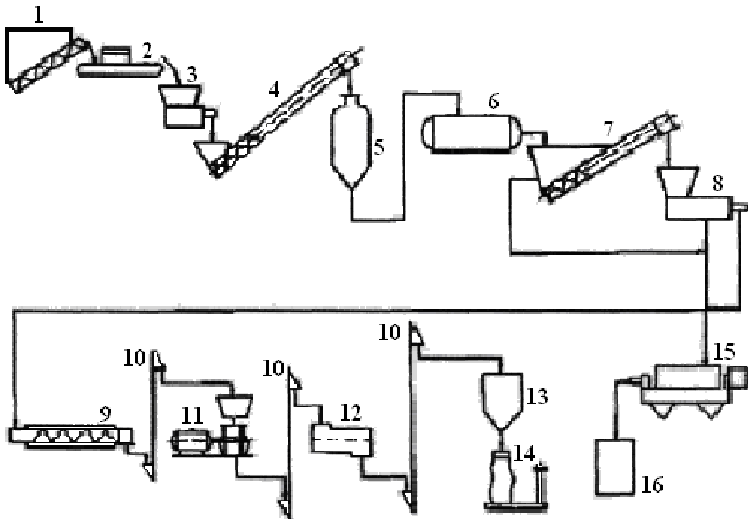

Figure 1. Schematic view of dry rendering process

Unpleasant odors from the plant for processing animal waste

Odour can be defined as an organoleptic attribute perceptible by the olfactory organ on sniffing certain volatile substances. The substances which stimulate the human olfactory system so that an odour is perceived are named odorants. The World Health Organization defines health as: "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". Odour and odorants may affect well-being as well as health. Depending on the type and concentration of odour and odorants, the influence may be positive as well as negative. Air pollution is regarded as an environmental stressor and psychological impact and depressive effects are possible. Odorants may also have physical impact on individuals. Long-term or repeated exposure to an odorant typically leads to a decrease of sensitivity to that odorant. This adaptation makes it possible for individuals to react primarily to changes in stimulation (Nimmermark, 2004).

Odour sensitivity in humans can be determined by the use of olfactometrs diluting the sample. Another method is olfactometer tests where various concentrations of odours are attached to sticks presented to the person being tested. Most studies of environmental odours, like odour from livestock and poultry, have been using olfactometry and the human nose for measuring concentration, intensity and offensiveness. It has been stated that disadvantages with olfactometry are the expense of the operation and difficulty in collecting representative samples (Nimmermark, 2004).

According to Ristic et al. (2001) unpleasant odors at the plant for processing animal raw materials result with decomposition of organic material (dead animals and inedible products of slaughtered animals). Decomposition of organic material result in emitting of ammonia, hydrogen sulfide, sulfur dioxide, carbon dioxide, carbon monoxide, lower fatty acid, acrolein, aldehydes and phenols. Types of gases and vapors which are causing unpleasant odors and their quantity that appears depends on the type of raw materials, processes with the raw materials, processing technology and other factors. The gases that create odors are: Acetaldehyde, Ethyl Mercaptan, Ammonia, Hydrogen Sulfide, Butyl Amine, Indole, Butyric Acid, Methylamine, Dimethylamine, Methyl Mercaptan, Dimethyl Sulfide, Skatole, Dimethyl Disulfide, Triethylamine, Ethylamine, Trimethylamine (Rules of Georgia Department of Agriculture).

According to Ristic et al. (2001), the more important sources and the location of occurring unpleasant and harmful gases are:

- Raw materials that decompose under the action of proteolytic enzymes and the action of microorganisms (tank for receiving raw materials, conveyor belt with a metal detector, grinder);
- Evaporation from the destructor;
- Evaporation from the oven;
- Evaporation of the condensating Brude vapors;
- Condensate of Brude vapors;
- Tank for draining fat from cooked mass;
- Evaporation when degreasing (pressing, spinning mass);
- Fumes from the conveyor system;
- And the fumes from the waste water.

METHODS

Types of gases and vapors that cause odors and their quantity that appears in the processing depends on many elements. They are all related to the type of raw material, the procedure for obtaining the raw material, processing with the raw material, production process management, device status and other factors. Within each element there are substantial differences in certain sizes, so it is impossible to talk about exactly certain values.

An odour unit is defined as the number of times a sample needs to be diluted with odour free air to reach a point at which half of the panel can detect the odour. The European odour unit (OU_E) is the amount of odorant that when evaporated into $1m^3$ at standard conditions, elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM) evaporated in $1m^3$ of neutral gas at standard conditions. One EROM, evaporated into $1m^3$ of neutral gas at standard conditions, is the mass of substance that will elicit the 50% detection threshold (D_{50}) physiological response assessed by an odour panel in conformity with this standard and has by definition a concentration of 1 OU_E /m^3. For n-butanol (CAS-Nr. 71-36-3) one EROM is 123 μg. Evaporated in $1m^3$ of neutral gas, at standard conditions, this produces a concentration of 0.040 ppm (equal to 40 ppb by volume). The relationship between OU_E for the reference odorant and that for any mixture of odorants at the D_{50} concentration:

$$1 \text{ EROM} = 123 \ \mu g \text{ n-butanol} = 1 \ OU_E \text{ (for a mixture of odorants)}$$

By definition odour units are expressed as n-butanol mass equivalents (Entec UK Limited,2010).

An odour concentration level of 1,5 OU_E/m^3 as 98th percentile in the built-up areas or other objects sensitive to odours involved may not be exceeded. Where odour abatement measures are taken this value must be met or improved on. Where the odour concentration is between 0,5 i 1,5 OU_E/m^3 as 98th

percentile the competent administrative body must decide whether measures aimed at further reduction are necessary. Below a calculated odour concentration of 0,5 OU_E/m^3 as 98^{th} percentile measures are not necessary. The value of OU_E/m^3 as 98^{th} percentile is considered to constitute the borderline between that which is desirable from an environment protection point of view and that which is feasible from a business economics point of view (Netherlands Emission Guidelines for Air, September 2004). Therefore, in subsequent calculations of indicators it will be used 1,5 OU_E/m^3 98^{th} percentile as the maximum allowed pollution of unpleasant gases.

Highly developed European countries apply the method to assess air quality based on the calculation of "indicators of air pollution" ("air pollution index") which represents the ratio statistically processed measured concentrations of pollutants and the emission limit values, shown by Equation 1 (Djordjevic, 2008):

$$API_{(a\,\mathrm{or}\,d\,\mathrm{or}\,s)} = \frac{C_{98}}{ELV} \qquad (1)$$

where:
API - air pollution index (annual or daily or short-term);
C_{98} – 98^{th} percentile shows that 98% of cases in recent years has not exceeded the corresponding value (mg/m^3);
ELV - emission limit values (mg/m^3).

Based on indicators of air pollution is determined the degree of pollution. Five classes are distinguished for level of air pollution:

- Class I - affordable - from 0 to 0,4,
- Class II - slight – 0,5 to 0,9,
- Class III - medium – 1,0 to 1,4,
- Class IV - unhealthy – 1,5 to 2,0 and
- V class - a very unhealthy - greater than 2 (Djordjevic, 2008).

When the data on the intensity and concentration of unpleasant gases are available then we can apply the Weber-Fechner's law to determine the mathematical relationship between intensity and concentration. Intensity levels are qualitative descriptions of an odour sensation and are defined numerically in the German standard “Olfactometry – Determination of Odour Intensity” (VDI 1992), as indicated in Table 1(Jiang, Sands,1998).

Table 1: Odour intensity categories

Odour strength	Intensity level
Extremely strong	6
Very strong	5
Strong	4
Distinct	3
Weak	2
Very weak	1
Not perceptible	0

The VDI (1992) standard gives the Weber-Fechner relationship (Equation 2) between odour concentration and odour intensity as (Jiang, Sands,1998):

$$I = 2{,}92 \cdot \log\left(C/C_0\right) + 0{,}5 \qquad (2)$$

where:
C = odour concentration(mg/m^3)
C_0 = odour threshold (mg/m^3).

Gas concentrations will be calculated every 50 m up to 500 meters from the emission source using the Gaussian dispersion model for concentration in the lower layer (Equation 3):

$$C_{(x,0,0)} = \frac{10^3 M}{\pi \cdot \sigma_y \cdot \sigma_z \cdot \nu_H} \cdot \exp\left[-\frac{1}{2} \cdot \left(\frac{H}{\sigma_z} \right)^2 \right] \quad (3)$$

where:
H - stack height (m);
M - the intensity of emission sources (g / s);
σ_y and σ_z - numbered coefficients (-);
υ_H - wind speed (m / s) (Zivkovic, Djordjevic, 2001).

Parameters σy and σz are a numbered coefficients which monitor changes in concentration in the horizontal and vertical directions. It is assumed that the coefficient σy represent the horizontal deviation of a cloud of pollutants, and σz its vertical deviation. Determination of the coefficients can be done based on atmospheric stability, ie. state of the atmosphere by its turbulence by the following Equations 4 and 5:

$$\sigma_y = F \cdot x^f \quad (4)$$

$$\sigma_z = G \cdot x^g \quad (5)$$

where: x - distance from emission sources to the place where the concentration is determining (m) (Zivkovic, Djordjevic, 2001).

Values of coefficients F, f, G and g with the effective chimney height below the 50 m for the appropriate class of stability are taken from the Table 2 (Zivkovic, Djordjevic, 2001):

Table 2: Values of coefficients F, f, G and g

Category	**F**	**f**	**G**	**g**
V(Very unstable)	1,503	0,833	0,151	1,219
IV(Unstable)	0,876	0,823	0,127	1,108
III/2(Neutral)	0,659	0,807	0,165	0,996
III/1 (Neutral)	0,64	0,784	0,215	0,885
II (Stable)	0,801	0,754	0,264	0,774
I (Very stable)	1,294	0,718	0,241	0,662

FINDINGS AND DISCUSSION

For the calculation of emissions for the rendering plant facility the data from the following source will be used: the BREF document Best Available Techniques in the slaughterhouses and animal by-products Industries, European Commission, May 2005. The survey showed that the average emission of odors are between 108-1010 OUE/t of raw material. Assuming that the rendering plant capacity is 2 t / h of raw material and the amount of air output from the plant is 30000 m3 / h we have sequential odor emissions.

Calculations of odor emissions: $108 \, {}^{OU_E}\!/_{t} \cdot 2 \, {}^{t}\!/_{h} = 216 \, {}^{OU_E}\!/_{h}$

$$1010 \, {}^{OU_E}\!/_{t} \cdot 2 \, {}^{t}\!/_{h} = 2020 \, {}^{OU_E}\!/_{h}$$

We will approximate the mixture of odors with n-butanol (ie with the OU_E) and calculate the mass odor emission: n-butanol:
1 ppm = 3,03 mg/m^3
1 OU_E = 40 ppb (n-butanola) = 0,123 mg/ m^3

$216 \cdot 0{,}04 \cdot 3{,}03 = 26{,}1792 mg/m^3$ $\quad$ $2020 \cdot 0{,}04 \cdot 3{,}03 = 244{,}824 mg/m^3$

$26{,}1792 mg/m^3 \cdot 30000 m^3/h \cdot 1/3600 s = 0{,}22 g/s$

$244{,}824 mg/m^3 \cdot 30000 m^3 \cdot 1/3600 s = 2{,}04 g/s$

For the calculation of immissions, air pollution index, the intensity of odor concentration and its distribution is used software US EPA ALOHA 5.2.3. The following obtained data and figures 2 and 3 are copied from the ALOHA program.

Calculations of immission for minimum pollution of 108 OU_E/ t of raw material:

CHEMICAL INFORMATION: Chemical Name: n BUTANOL, Molecular Weight: 74.12 kg/kmol, TLV-TWA: -unavail-, IDLH: 1400 ppm, Footprint Level of Concern: 0.06 ppm, Boiling Point: 117.66° C, Vapor Pressure at Ambient Temperature: 0.0064 atm, Ambient Saturation Concentration: 6,403 ppm or 0.64%

ATMOSPHERIC INFORMATION: (MANUAL INPUT OF DATA)
Wind: 1.5 meters/sec from 0° true at 3 meters, No Inversion Height, Stability Class: C, Air Temperature: 20° C, Relative Humidity: 50%, Ground Roughness: urban or forest, Cloud Cover: 5 tenths

SOURCE STRENGTH INFORMATION:

Direct Source: 0.22 grams/sec
Source Height: 10 meters
Release Duration: 60 minutes
Release Rate: 13.2 grams/min
Total Amount Released: 792 grams
FOOTPRINT INFORMATION:
Model Run: Heavy Gas
User-specified LOC: 0.06 ppm (1,5 OU_E)
Max Threat Zone for LOC: 249 meters

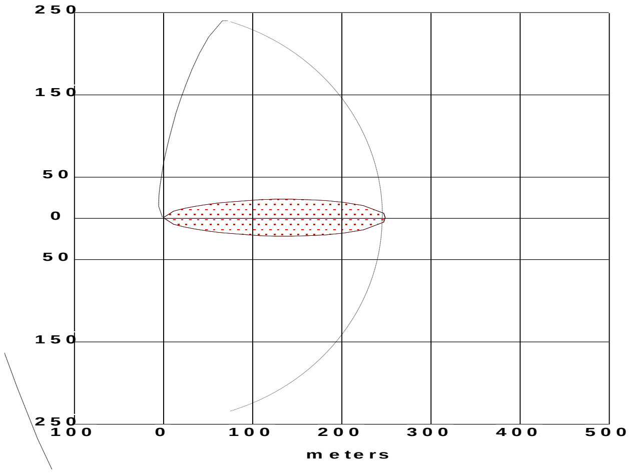

Figure 2. Distribution of odor concentration with emission of 0,22 g/s

Calculations of imission for maximum pollution of 1010 OUE/ t of raw material:

SOURCE STRENGTH INFORMATION:
Direct Source: 2.04 grams/sec
Source Height: 10 meters
Release Duration: 60 minutes
Release Rate: 122 grams/min
Total Amount Released: 7.34 kilograms
FOOTPRINT INFORMATION:
Model Run: Heavy Gas
User-specified LOC: 0.06 ppm (1,5 OUE)
Max Threat Zone for LOC: 807 meters

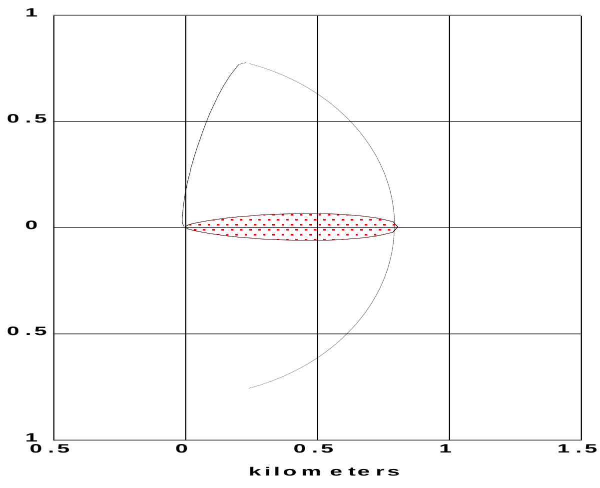

Figure 3. Distribution of odor concentration with emission of 2,04 g/s

Based on the submitted calculations of immissions, we see that at the lowest possible emission of 0.22 g / s odors have an effect up to 249 m, while with the maximum emission we have a spread of up to 807 m. With this data we see that there is a possibility of odor effects on the surrounding population near the rendering plant if there are residential buildings. Factory for production of poultry meat and meat products throughout the world, are mainly located in the vicinity residential areas, and also near the cities due to reduced transportation costs.

Also by using ALOHA will be determined a class of air pollution with including meters of each class.

Calculations of API for emission of 0,22 g/s:
Class I - affordable - > 494 m
Class II - slight – from 494 m to 363 m
Class III - medium – from 343 m to 288 m
Class IV - unhealthy – from 277 m do 239 m
V class - very unhealthy – < 239 m.

Calculations of API for emission of 2,04 g/s:
Class I - affordable - > 1,6 km
Class II - slight – from 1,6 km to 1,2 km
Class III - medium - from 1,1 km to 922 km
Class IV - unhealthy – from 891 m do 766 m
V class - very unhealthy – < 766 m.

The data for the air pollution index shows that in case of odor emission of 2,04 g / s we have far-reaching impact and it could cause negative impacts on human populations if the plant is located near inhabited places. With the emission of 0,22 g / s we have lower concentration and air pollution index for this case is less and therefore the pollution is much less.

Calculations for odor intensity with emission of 0,22 g/s:

Distance from source (m)	50	100	150	200	250
Concentration (mg/m3)	0,1740	0,0880	0,0471	0,0291	0,0198
Odor strength	0,93985 Very weak	0,075283 Very weak	-0,71739 Not perceptible	-1,32788 Not perceptible	-1,81607 Not perceptible

Distance from source (m)	300	350	400	450	500
Concentration (mg/m3)	0,0144	0,0109	0,0086	0,0070	0,0058
Odor strength	-2,2209 Not perceptible	-2,57349 Not perceptible	-2,87413 Not perceptible	-3,13507 Not perceptible	-3,37478 Not perceptible

Calculations for odor intensity with emission of 2,04 g/s:

Distance from source (m)	50	100	150	200	250
Concentration (mg/m3)	1,6137	0,8156	0,4364	0,2696	0,1834
Odor strength	3,764318 Strong	2,89882 Distinct	2,10595 Weak	1,495254 Weak	1,006555 Weak

Distance from source (m)	300	350	400	450	500
Concentration (mg/m3)	0,1333	0,1015	0,0801	0,0649	0,0538
Odor strength	0,60614 Weak	0,256353 Weak	-0,04395 Not perceptible	-0,31087 Not perceptible	-0,54863 Not perceptible

Based on the value of the odors intensity it can be seen that there is no major impact on the surrounding population.

CONCLUSIONS AND IMPLICATIONS

These calculations of environmental pollution are taken from facilities in which they are embedded systems for air purification. Such systems may include neutralization of gases in scrubbers, biofilters, activated oxygen, ozonisation and incineration (burning). One strategy is to set the windscreen (high walls) to a few meters away from the exit from the building ventilation. The effectiveness of these treatment systems is 75-99%. So, if rendering plants do not use the best available technology, they will emit odor and odorants which can be a big problem for the surrounding population. They affect the quality of life of nearby residents, causing disturbances and complaints of neighbors on this kind of facilities is very big problem.

Annoyance has been defined as a feeling of displeasure associated with any agent or condition believed to affect adversely an individual or a group. Studies suggest that malodour may cause stress and that pleasant rated odours may be used for relaxation. The short time effects of stress may be positive, but in the longer perspective illnesses may be the result, and perhaps then especially heart and blood vessel diseases together with diseases depending on a decline in the immune defence (Nimmermark, 2004).

To take adequate preventive measures for environmental protection from air pollution around the rendering plant should be provide a system for monitoring air quality in order to gain an accurate picture of air pollution on the territory of the observed area. A credible odor monitoring program requires four main components (McGinley, M., McGinley, C.,2004):

1) qualified odor observers (trained inspectors/investigators);
Any odor monitoring program must first start with available personnel becoming odor observers. These personnel must receive training related to odors and odor observation. The essential elements of the training curriculum provides the students with a basic understanding and working knowledge of nasal anatomy, odor chemistry, odor parameters, odor observation techniques, meteorology, standard field procedures and documentation formats. The training prepares the odor observer to be consistent in observations and to be aware of and adjust to variable field conditions. An odor observer’s olfactory sensitivity is a factor in making observations of odor strength in the ambient air. A standardized nasal chemosensory test method determines the olfactory threshold of an individual and allows comparison of the individual’s olfactory sensitivity to normative values.

2) objective observational methods (how to describe and measure odors);
Trained odor observers need to describe and measure ambient odors using standard terminology and measurement practices. When the odor observers are proficient in quantifying (describing and measuring) ambient odors the odor monitoring program will be successful and credible.

3) standard monitoring practices (routine survey/inspection routes);
Standard odor monitoring practices include four elements: 1) monitoring protocol, 2) area map, 3) monitoring route, and 4) data form. The odor monitoring program incorporates these elements into a

working plan that is clearly understood and used by the observers and can be easily explained to the general public.
The monitoring protocol is a written document that describes the purpose of the odor monitoring program (e.g. proactive to improve community quality of life), the scope of the odor monitoring (e.g. eighteen months), resources required (e.g. dollars and personnel hours), references (e.g. previous enforcement actions), geographic area (e.g. parts of the community involved), detailed procedures (e.g. when and how frequent to conduct odor monitoring), and outcomes (e.g. how the data will be summarized and the results used).
The area map of the community will need to clearly show the geographic extent of the odor monitoring and the key community features (i.e. buildings, parks, streets, rivers, ravines, etc.).
The odor monitoring route is the path that the odor observers follow as they carryout their odor observation activities. The odor monitoring route needs to include a list of each odor monitoring location, details of each location (including GPS coordinates if possible), and a location code number. The area map will have the location code numbers identified.

4) standard data collection and reporting forms;
An odor monitoring program will have standard data collection forms constructed in a format that is convenient to use by the observer and easy to read by others.

Odors are one of the top causes for air pollution complaints from citizens. Facilities must address odors through complaint response and proactive monitoring. With a credible odor monitoring program in place, a facility will be addressing odor concerns of the community while collecting valuable information that will assist in implementing odor control alternatives and evaluating/monitoring the effectiveness of these controls (McGinley, M., McGinley, C.,2004).

REFERENCES

Ristić, M., Radenković, B., Đorđević, M. (2001): Neškodljivo uklanjanje uginulih životinja i nejestivih proizvoda zaklanih životinja, Fakultet veterinarske medicine, Beograd.
Živković, N., Đorđević, A.(2001): Zaštita vazduha, Fakultet zaštite na radu, Niš.
Đorđević, A.(2008): Kvalitativna i kvantitativna ocena kvaliteta vazduha Niša, Zadužbina Andrejević, Beograd.
Jiang, J., Sands, J.(1998): Report on odour emissions from poultry farms in Western Australia-Principal tehnical report, Centre for water and waste tehnology, University of NSW, Sidney.
Netherlands Emission Guidelines for Air, September 2004.
BREF Best Available Techniques in the Slaughterhouses and Animal By-products Industries, Europian Commision, May 2005.
Mogden Odour Research Steering Group, Mogden Odour Study, Final Report, November 2010, Entec UK Limited.
Nimmermark, S. (2004): Odour impact, Doctoral thesis, Swedish University of Agricultural Sciences
Rules of Georgia Department of Agriculture, Chapter 40-16-4 Rendering Plant Odor Control.
McGinley, M., McGinley, C.(2004): Developing a Credible Odor Monitoring Program, American Society of Agricultural Engineers (ASAE) Annual Conference Ottawa, ON, Canada.

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INFLUENCE OF THERMAL POWER PLANTS ON THE ENVIRONMENT

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ABSTRACT

This paper reviews the impact of sulfur dioxide and other harmful substances emitted by power plants Nikola Tesla and power plant Kostolac (EPS), on air pollution and their impact on human health, plant and animal world. Besides sulfur dioxide, the table presents measurement results for other harmful substances emitted by power plants, such as CO_2, CO, Nox, and microparticles of soot and ash.

Keywords: pollution, pollutants , power plants, environment.

ITRODUCTION

Most of the atmosphere gases are concentrated at the earth's surface, in a thin layer of about 12 km height (troposphere). This layer, containing about 80% of the total mass of the atmosphere, makes life on Earth possible. The layer of the atmosphere, which height is about 200 km, is very diluted, but regardless that it represents only very small part of the total atmosphere mass, it powerfully protects life on the Earth from the solar radiation and high energy particulars that constantly penetrate into the atmosphere. In this layer of diluted gases, chemical reactions happen during which electromagnetic radiations of high energy are absorbed (of wavelength over 300nm). The radiations of higher wavelengths penetrate into the troposphere, which main components (nitrogen, oxygen, carbon dioxide and aerated water) don`t absorb them. However, some of the components that are present in very small quantities absorb part of the radiation. During this process photochemical reactions are happening, which main products are the biggest air polluters. The quantity of these substances can be locally increased due to human activities and then they represent the danger for human health and material goods. The main sources of air pollution are residential heating, industrial activities and traffic, (Nikolic, Sokolovic, 2005;, Nikolic, 2008; Report EPS, 2008).

POWER PLANTS AND AIR PROTECTION

During the work of the power plants and mines of the „Electric power industry of Serbia“ (EPS), the emission of harmful substances into the environment occures. In recent years, EPS has started the modernization of existing measures for air protection in power plants, by adjusting the functioning of electrical filters to requirements of EU legislation for emission reduction, replacement of the transport technology and disposal of ashes to landfill.

Among all plants and facilities of the EPS, power plants are the biggest polluters of air, because they use lignite from open pits as primary fuel. Power plant flue gases are discharged into the atmosphere through chimneys, and they contain SO2, NOx, CO2, CO and ash particles.

In aligning work of these objects with the requirements of the legislation, the priority is given to the decrease of particles emmision by the oldest blocks and reducing work of electrical filters (EF) to EU requirements (50 mg/m3).

The condition of electrical filters influences the particle air pollution in the vicinity of these blocks, that are near settlements. Therefore, it is expected that the reconstruction of this EF will have special effect on improving air quality, (Prvulovic et al., 2007).

The second phase in introducing protective measures ie. introducing desulphurization plants to reduce emissions of sulfur oxides into air, are planned at these facilities after 2009.

The concentration of sulfur oxides in the air in the vicinity of power plants is within the allowed values (GVE) due to dilution effect because of high chimneys.

Electrial filters

Electrical filters installed on the objects which construction started before 1970, had efficiency of ash separation from 98% to 98,5%, while filters installed on objects built afterwards had efficiency from 99% to 99,83%. Since 2004, aligning EF functioning with the requirements of the legislation has started and today, after EF reconstructions done, we have 6 blocks whose particles emissions meet the legal standard of 50 mg/m^3.

The concentration of particles in flue gases in case of not aligned electrical filters is within:

– For older units .... from 800 to 1500 mg/m^3
– For newer units .... from 80 to 400 mg/m^3

Emission of harmful substances from POWER PLANTS EPS-a

Emission of pollutants into the air is mainly done by the power plants. In Table 1, there are data on the total quantity of harmful substances from power plants except public company Kosovo.

Table 1:The amount of harmful substances emitted by power plants

Thermal Power TPP	t / years			
	particles	SO_2	NO_x	CO_2x10^3
TPP Nikola Tesla	15,125	140,253	32,555	21,042
TPP Kostolac	4,097	88,188	8,336	4,968
TPP Panonske	159	1,354	527	256
Total	19,381	229,795	41,418	26,266

The results of measuring the concentration of sulfur, nitrogen oxides and carbon monoxide in the flue gases of tested boilers (reduced to 6% O2), are shown in Table 2.

Table 2:The results of measuring harmful substances on boilers

TPP Kolubara – Kolubara processing				
Emissions the object HEATING PLANT				
Cauldron	Probe number	SO_2 mg/m^3	NO_x mg/m^3	CO mg/m^3
1	1	1802	390	228
	2	1843	425	209
	3	1850	434	163
2	1	2271	319	137
	2	1151	265	388
	3	1502	262	100

GVE Emissions by Regulations (Sl. Gl. RS. br. 30/97)	1450	800	250

Monitoring and influence on the environment

Characteristics of measuring emission of harmful substances from chimneys are given for each PP separately and based on measurements results carried out by authorized institutions within the program of periodic testing of measuring emissions of harmful substances into the air. In Table 3, the results of measuring air emissions by blocks of PP *(Power plant)* Nikola Tesla.

Figure 1: Power plant Nikola Tesla A

Table 3:Emission of harmful substances – periodical measurements

TPP Nikola Tesla									
Emissions of harmful substances - periodic measurements									
A branch of the company / Object	TPP Nikola Tesla A						TPP Nikola Tesla B		GVE
Blocks	A1	A2	A3	A4	A5	A6	B1	B2	
	(mg/m^3)								
SO_2	1.282	1.800	1.577	1.346	1.374	1.539	2.031	2.200	650
NO_x	345	360	387	378	390	443	445	440	450
CO	47	130	87	88	81	76	26	220	250
Powdery substance	73	50	70	92	42	340	50	32	50
TPP Kolubara A				TPP Morava					
Blocks	A1-A4	ELV	A5	A	GVE				
	(mg/m^3)								
SO_2	1.370-2.055	1.450	2.032	2.059	650				
NO_x	395-495	800	530	389	450				
CO	22-65	250	77	41	250				
Powdery substance	850-1400	100	259	793	50				

Based on the presented measurement results, it can be concluded:

- Emission of SO2 on all TE blocks is above GVE
- Emission of NOx is within GVE, except in case of block A5 Te Kolubara A
- Emission of CO is within GVE

- Emission of powdery substances is significantly above GVE except for blocks A2 and A5 of the PP Nikola Tesla A and blocks B1 and B2 of the Nikola Tesla B

Continuous measurements of harmful substances

In accordance with the requirements of the Regulations on emission limit values, methods and timeframe for measuring and recording measurement data, installation of the equipment for measuring the emission of harmful substances in flue gases is continued at certain blocks in addition to already installed equipment with embedded calibration of particle analyzer.

Table 4 gives an overview of annual particle emissions of SO2, NOx, CO and CO2

Table 4: Annual emission of harmful substances

TPP Nikola Tesla					
Emissions of harmful substances on an annual basis					
A branch of the company / Object	*Particles*	SO_2	t/year NO_x	CO	CO_2x10^3
TPP Nikola Tesla A					
Block A1	2,502	2,876	659	206	571
Block A2	335	8,796	1,762	872	1,213
Block A3	455	10,037	2,515	567	1,962
Block A4	758	11,115	3,129	720	1,848
Block A5	332	12,446	3,535	734	2,031
Block A6	2,340	10,513	3,025	521	1,924
Total	6,227	55,783	14,624	3,622	9,549
TPP Nikola Tesla B					
Block B1	829	33,306	7,295	422	4,442
Block B2	496	35,135	7,038	3,943	4,320
Total	1,324	68,441	14,333	4,365	8,762
TPP Kolubara A					
Block A1	2,202	2,614	173	203	
Block A2	1,256	1,799	311	133	
Block A3	518	831	241	19	1,875
Block A4	550	1,139	269	10	
Block A5	702	5,584	1,457	212	
TPP Kolubara B – *building under construction*					
Total	5,227	11,966	2,452	577	1,857
TPP Morava					
Block A1	2,346	1,861	1,147	121	778
Total	2,346	1,861	1,147	121	778
Total	15,125	142,253	32,555	8,685	20,946* 21,042*

In the vicinity of the Kostolac basin, measuring concentrations of air pollutants: soot, SO2, CO, CO2, NOx, suspended particles and sediment matter is conducted. Measurements were done according to the Regulations on limit values, emission measurement methods, criteria for the establishment of measuring points and data collecting (Sl.gl.Rs.br.54/92) on five stationary places (Cirikovac, Klenovnik, Prim, Drmno and Bradarac). Measurements are done quarterly, spring, summer, autumn, winter,(Steiner et al., 2003; Tolmac et al., 2005).

Daily average concentration of sulfur dioxide does not exceed the GVI on any measurement point.

On the MM-1 (Cirikovac), the average monthly concentration of sulfur dioxide is <5µg/m3, while the maximum measured average daily concentration of sulfur dioxide was 4.5 ĩg/m3.

On the MM-2 (Klenovnik), the average monthly concentration of sulfur dioxide is 7,7 µg/m^{3,} while the maximum measured average daily concentration of sulfur dioxide was 21,8 µg/m^3.

On the MM-3 (Prim), the average monthly concentration of sulfur dioxide is 10,5 µg/m^{3,} while the maximum measured average daily concentration of sulfur dioxide was 19,6 µg/m^3 .

On the MM-4 (Drmno), the average monthly concentration of sulfur dioxide is 12,2 µg/m^{3,} while the maximum measured average daily concentration of sulfur dioxide was 22,0 µg/m^3 .

On the MM-5 (Bradarac), the average monthly concentration of sulfur dioxide is 15,9 µg/m^{3,} while the maximum measured average daily concentration of sulfur dioxide was 25,8 µg/m^3 .

Periodic measuring emissions of harmful substances

Characteristics of emissions from the chimneys are given based on the results of periodic tests conducted in power plants annually by authorized institutions. Table 5 present the results of measuring emissions of harmful substances for the blocks B1 and B2, and the results of measuring particles for block A2, which were conducted within the performance tests for electrical filters.

Figure 2. Power plant Kostolac B

Table 5:Emission of harmful substances – PP(Power plant)Kostolac

TPP Kostolac					
Emissions of harmful substances					
A branch of the company	TPP Kostolac A		TPP Kostolac B		
Parameters	A1	A2	B1	B2	GVE
		mg/m^3			
SO_2		6.061	4.381	4.259	650
NO_x	*Block is not working*	370	449	440	450
CO		88	89	41	250
Powdery substance		35	184	81	50

From the presented measurement results it can be concluded that:

- Emission of SO2 on all TE blocks is above GVE

- Emissions of Nox are within GVE
- Emission of CO is within GVE
- Emission of powderysubstances is above GVE

Continuous measurements of harmful substances

In accordance with the requirements of the Regulations on emission limit values, methods and timeframe for measuring and recording measurement data , measuring emission of harmful substances in flue gases is conducted on block B2 PP*(Power plant)* Kostolac B, measuring SO2, Nox, CO, CO2 and other particles.

Table 6 gives an overview of annual emissions of mentioned particles.

Table 6:Annual emission of harmful substances in PP Kostolac

TPP KOSTOLAC					
Emissions of harmful substances on an annual basis					
A branch of the company	*Particles*	SO_2	t/year NO_x	CO	CO_2x10^3
TPP Kostolac A					
Block A1	0	0	0	0	0
Block A2	1,962	18,359	1,157	274	941
Total	1,962	18,359	1,157	274	941
TPP Kostolac					
Block B1	1,487	35,656	3,653	740	1,993
Block B2	648	34,172	3,525	333	2,013
Total	2,135	69,829	7,179	1,073	4,006
TPP Kostolac Total	4,097	88,188	8,336	1,347	4,947* 4,968*

In 2006, work on preparing the documentation and applying methods for flue gas desulphurization in TE Kostolac started, that would have the influence on reducing the presence of sulfur dioxide in the air.

CONCLUSION

Based on the measurement results and the conducted analysis, it can be concluded that emissions of CO2 and other harmful substances from power plants that use lignite coal as fuel, have a major impact on environmental pollution besides other pollutants. For this reason, in accordance with the laws and regulations of the European Union, activities that will reduce emissions of harmful gases from power plants into the atmosphere are being conducted, that include installation of new and more modern electric filters on chimneys, as well as desulphurisation of flue gases from the power plants chimneys.

REFERENCES

Nikolic, V. Education and Environment, Andrejevic Foundation, Belgrade, 2003.

Nikolic, V., Sokolovic, D. The functions of knowledge management for the Environment, Proceedings, Environmental and working environment in the system of national and European education, the Faculty of Occupational Safety, Niš, 2005.

Prvulovic, S., Tolmač, D., Blagojevic, Z. Efficiency of thermal power systems, Energy Technology, Vol. 4, No. 1, p. (36-38), Association for Solar Energy - Solar Serbia, Zrenjanin, 2007. Report on the environmental JP. EPS, 2008.

Steiner, A., Martonakova H, Butt, Z. A guide to good management of environmental, Belgrade, 2003. Tolmač, D., Prvulovic, S., Blagojevic, Z. : Thermal power systems and efficiency, Energy Technology, Vol.2, No.3, p.. (30-31), Association for Solar Energy - Solar Serbia, Zrenjanin, 2005.

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PROPERTIES OF SUSPENDED PARTICLES

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ABSTRACT

Suspended particles have a big influence on people's health and bring to pollution of the environment. Their concentration in the environment depends on where they come from,asictance of industry, adsorption of gases in the air like SO2 or NO2 into the solid particles existing in the air their physical and chemical criteria.

Key words: PM10 1, BS –smoke 2,TSP-total suspended particles 3.

BASIC FEATURES

In the atmosphere there are a number of suspended particles(solid and liquid), which occur in many different shapes, sizes and chemical composition. They are constantly circulating in the air, controlair currents and gravity. These particles are known collectively as aerosols.

Aerosols, their formation and reactions involving strongly associated with gases present in trace amounts in the atmosphere with their homogeneous and heterogeneous reactions.

The origin of the particles may be from natural or man made. Table 1 [1]. Provides estimates of quantities of particles with a diameter of less than 2 x 10-5m, which is emitted into the atmosphere annually.

Table 1: Annual quantity emitted or formed particles in the atmosphere

From The amount of particles	106 tons / year
natural:	
The remains of rock and soil	100-500
Forest Fires	3-150
Sea salt	300-900
Volcanic activity	25-150
Emissions:	
Sulfates from H2S	130-200
NH4 + NH3 salt from	80-270
Nitrate NOx from	60-430
Hydrocarbons from plants	75-200
Total natural emissions	773-2800
Anthropogenic sources:	
Direct emissions, smoke and so on	10-90
Sulfates from SO2	130-200
Nitrates from NOx	30-35
hydrocarbons	15-90
Anthropogenic sources total	185-415
Total particulate	958-3215

SOURCE OF AEROSOLS

The primary sources of aerosols are: forest fires, who can be a great source of very fine particles (0.05um), with several tons of material per hectare.

Another major source are volcanic eruptions, which can insert into the stratosphere large amounts of very fine particles who are retaing the in the atmosphere about five years before precipitate Earth's surface.

Sulfated aerosols are certainly the most important component of the population representation and visual effects that are attributed to many fields aerosols. Sulphate component is30-50% finer (from 0.1 to 1 microns) aerosols. By some measurements, in rural areas the total suspended particles finds concentration of 27.9 mg / m 3, of which the particles are less than 10 um represented with 22 mg / m3ili 79% and fine particles (<1UG) from 15.9 μg/m3 of which about 50% Another important component of the finer particles of organic carbon,which is the main source of combustion of fossil fuels, which makesan average of about 8% of the total aerosol mass, although in some places may be significantly higher .

Table 2: The composition of the particles on the three measuring points in rural areas

Composition	μg/m3	μg/m3	μg/m3
Organic C	3,7	3,6	2,9
Elementary C	1,6	1,6	1,4
Sulfur as (NH4) 2SO4	9,7	10,0	7,9
Aerosols	28,8	27,8	20,4

It is estimated that about 70% of particles that enter the atmosphere is calm again, the direct deposition under the influence of gravitational forces or the rain, washing out the atmosphere or incorporated into droplets as condensation centers. Aerosol deposition rate largely depends on their physical characteristics (mass, shape). Division of aerosols on the basis of these characteristics is given in Table 3.

Table 3: Physical distribution of aerosols

Title Features	criteria
Ejected particle	diameter of particles smaller than 0.1microns
Large particles	particle diameter between 0.1 to 1 microns
Giant particle	particles having a diameter greater than 1 microns
Dus	particles that fall from the solid material and air are you start
Fog	solid or liquid substance withdrawn money condensing
Products of combustion	smoke ejected from the chimney

Mechanism of stratospheric aerosols

Mechanism of stratospheric aerosols is carried out by the reactions (1), (2) and (3).

$$SO2+OH+M\text{-----}HSO3+M \quad (1)$$

$$SO2+HO2\text{------}SO3+OH \quad (2)$$

$$SO3+H2O\text{------}H2SO4 \quad (3)$$

Bisulfital radical formed in reaction (1) is easily oxidized to sulfuric acid. Although reaction (2) and (3) shown as a homogeneous gas reactions, though they are faster as a heterogeneous place in the presence of moisture or metal oxide reaction (4).

$$HSO_3^- + H_2O_2 \xrightarrow{(Fe,Mn)} SO_4^- + H^+ \quad (4)$$

When SO2 is oxidized and dissolved in drops containing sodium chloride, evaporation from water drops of HCl loss and form particles of mixed composition NaSO4/Cl, which are often found near the sea coast.

Also: Hydroxyl radicals react with other biogenic sulfur compounds:

H2S+OH------HS+H2O (5)

Bisulfid-radical (HS) is further oxidized to SO2 in a series of reactions.

The reaction of OH radicals with CS2 intermediate is formed that stabilizes the collision. This is shown by a simple reaction speed with increasing total pressure, if the partial pressure of O2 held constant. In addition to speed of reaction increases with decreasing temperature. Among the reactions of identified products are carbonyl sulfide and sulfur dioxide.

OH+CS2+M------(CS2-OH)+M (6)

(CS2-OH)+O2------- products (COS,SO2) (7)

Sulfur dioxide absorbed in the UV range with a maximum absorption at 294 nm coefficient e=10 atm-1 cm-1, there is another very weak absorption band between 340 and 390 nm (l=374nm e=0.004 atm-1 cm-1). None of these areas has enough energy for photo dissociation SO2 molecules, because its energy dissociation 564kJ/ml corresponding wavelength of light of 218nm.

It is believed that absorption in 374nm translations molecule of sulfur dioxide in the lower triplets are 3SO2, and 294 leading to the first excited singlet state 1SO2 (k=103S-1). Triplet has a relatively long lifetime (about 103 seconds). It is believed that this has been most responsible for most of the homogeneous photochemical oxidation of SO2.

Humid atmosphere in which SO2 is quickly shows the effect of light scattering, indicating the creation of sulfuric acid and sulfate aerosols (3). In polluted atmosphere in the presence of particulate matter and NOx, SO2 photo oxidation is much faster, probably because in this case most catalyzed heterogeneous reactions:

3SO2+NO-----SO+NO2 (8)

NO2+SO2------SO3+NO (9)

These reactions do not happen between SO2 molecules in the basic singlet state and illustrate the importance of photochemical excitation, even without direct photodisotiation molecules.

CS2 can absorb UV radiation in the area from 290 to 320 nm,(ie in the stratosphere), but it is not accompanied by photolysis already excited molecule reacts with oxygen, giving COS andSO2.

CS2+hv(313nm)-----CS2* (10)

CS2*+3/2O2-----COS+SO2 (11)

There are many factors that control the rate of heterogeneous chemical reactions, but also a finite amount of data, so it is difficult to give a detailed interpretation of these reactions would be based on measurements in real conditions. Still most of the conclusions related to the heterogeneous chemical transformations of the data is based on laboratory results.

Experiments show that the simulated flue gas stream of plants (and other plants that burn coal and oil), in addition to gas is a large amount of soot particles and metal oxides. The total area of these particles is sufficient for a noticeable adsorption of gases (up to 200mg/g of solid phase) and measurable reducing their concentration in the gas phase. The degree of conversion from gas to solid phase depends on many factors, among which are the most important types and sizes of particles, the contact time and relative air humidity . Clearly noticed an increase in the degree of adsorption with increasing humidity. At low relative humidity in order of decreasing rate of adsorption of gases in the order: MgO> Fe2O3> CaO-TiO2> Al2O3> SiO2, and at high humidity is slightly changed: MgO> CaO> Fe2O3> Al2O3-SiO2-TiO2.Od these oxides TiO2 and Fe2O3 only show a higher velocity of SO2 adsorption in the presence of UV radiation.

Inhalation of particulate matter can enter the human body and deposit in the respiratory system. Entry and depositing particles in the human respiratory system depends on the particle size, the defense mechanism of the respiratory system and breathing patterns. In late 70th-and early 80th-of the results indicated that exposure to high concentrations of particulate matter can cause adverse health of man. Studies carried out in mid-80th's, have shown that long exposure to particulate matter increases the risk of disease respratornih roads, changes in work and lung function and other adverse health effects. Recent studies have focused on the health effects caused by short-term, acute exposures of particulate matter. Both types of studies show that both chronic and acute exposure to particulate matter result in significant negative effective on human health, although the toxicological mechanisms for these effects less well-known [2]. Study presentations suspended particles, based on daily variations in concentrations and various health effects, have shown that short-term variations in PM10 concentrations lead to short-term changes in acute diseases [3].

Health effects caused by short-term exposure include lung inflammatory reaction, respiratory-related symptoms, adverse effects on the cardiovascular system, increased medication, hospitalization and mortality.

Prolonged exposure to suspended particles has a greater impact on public health than short-term exposure. Exposure to PM2.5 particles shows a high correlation with mortality, so the increase in long-term PM2.5 concentrations by 10 μm/m3 indicated a 6% increase in risk of death when it comes to all causes [4], 12% for cardiovascular disease and 14% of lung cancer [5].

Prolonged exposure to high concentrations of suspended particles can lead to shortening life expectancy due to cardiovascular disease and lung disease.

The increased concentration caused by the reduction of lung function in children and adults obstructive pulmonary disease, and reduction of lung function.

INFLUENCING HEALTH

Research confirms that, in the domain of mortality, cardiovascular and pulmonary disease, fine particles (<2.5μm) is much more harmful than the large particles. In toxicology and human exposure studies found several physical, chemical and biological properties of particles that cause lung disease. Among the significant metal content, the presence of polychlorinated aromatic hydrocarbons (PAHs), other organic compounds, endotoxins, and particle size (small particles<2.5um and extremely small<100nm).

Toxic-features that are crucial for negative health effects are: particle size (ultra fine, fine and coarse particles), the size surface, the geometric shape and other physical characteristics.Also, a great impact on the health effects and composition of the insoluble and soluble components (metals, organic compounds, endotoxins, and residues of nitrate and sulfate). These properties have an equally strong impact on human health.

Particle size-Numerous studies have shown that suspended particles, regardless of size, cause adverse health effects.

Fine particles are responsible for inflammation, given the size of area that is available to interact with the respiratory tract and the absorption of biologically active substances (the smaller the particle is,the surface area for absorption of metal organic compounds, acids, higher). Large particles have a greater potential to cause inflammation due to variability of chemical composition. Experiments have shown that fine particles reach the bloodstream causing thrombosis [6,7,8].

Metals-An increasing number of studies that show that the metals responsible for the toxicity suspended particles [9,10]. Metals soluble in water, originating from the fly ash particle residues of petroleum origin, contribute to inflammatory lung [11]. Transition metals also form a component that contributes to the toxicity of suspended particles [12]. Metals that are considered to be relevant for this property are suspended particles: iron, vanadium, nickel, zinc, copper and to a lesser extent [13].

Organic compounds are common components of suspended particles resulting from the combustion process. Be sure that the particles from this source made up the largest share of all particles contained in the air. From the suspended particles can extract many organic substances, especially PAH's, which together with some of its nitrocontent show mutagenic and carcinogenic propertie[14].

DATA

The data (PM10, BS, TSP) in summer and winter,in the town of Zrenjanin are shown in Table 4. Seasonal variations (PM10, BS, TSP) μg/m3 [15].

Table 4: Seasonal variations (PM10, BS, TSP) μg/m3 [15]

	Summer season	Summer season	Summer season	Winter season	Winter season	Winter season
parameter	PM1O	BS	TSP	PM1O	BS	TSP
Number of measurements	411	329	49	263	403	28
Mean concentration	27,95	2,95	120	42,68	12,35	117,75
The minimum concentration	2,75	0	43,0	6,2	0	17,0
The maximum concentration	81,60	24,00	236	206,8	134,0	241,0
Number of measurements exceeds GV	31	0	25	75	11	12

BS-smoke, TSP total suspended particles.

All measurements of total suspended particle concentration shown in the work were carried out during 2005. During the period measurements of total suspended particles were recorded 35 days exceeding the GV of 120 mg /m3 of which 54% was recorded in winter. The mean concentration was 119,2 mg m-3.

CONCLUSION

It can be concluded based on these data, citing increasing concentrations in winter than in summer, this is a direct consequence of the configuration environment, the interaction of other pollutants to which the above was the word of SO_2, NO_x or metal oxides and climatic conditions in the observed region.

From these data we can see that the maximum recorded values for PM10 and smoke, which can be seen in Table 5 exceed the GV.

Table 5: maximum registered values (PM10, BS, TSP) GVμg/m3 over for summer and winter

	summer	winter
PM10ug/m3	81	206,8
BS ug/m3	-	134,0
TMS ug/m3	-	-

REFERENCES

Dragan S. Veselinovic, Ivan A. Grzetic, SimonA. Djarmati, Dragan A. Markovic, Stanja i procesi u zivotnoj sredini, Fakultet za fizicku hemiju Univerziteta u Beogradu 1995.

Thad Godish, Air Quality, 4th Edition, Lewis Publishers, New York 2003.

Anderson H. R., Atkinson W.R., Peacock L.J., Marston L., Konstantinou K. (2004). Meta-Analysis Of Time Series And Panel Studies Of Particulate Matter (PM) And Ozone (O3), Report of WHO Task Group, Copenhagen, WHO Regional Office For Europe; (www.euro.who.int/document/e82792.pdf).

Pope A. C. (2002). Lung Cancer, Cardiopulmonary Mortality And Long Term Exposure To Fine Prticulate Air Pollution. Journal of the American Medical Association, Volume 287, p.1132-1141.

WHO Air Quality Quidelines for Euope., 2nd Edition, Copenhagen, WHO Regionl Office Europe, 2000 (WHO regional Publications, European Series, No91).

Nemmar, A. (2002). Ultrafine Particles Into The Blood Circulation In Humans. Circulation, Volume 105, p. 411-414.

Nemmar, A. (2002). Ultrafine Particles Affect Experimental Thrombosis In An In Vivo Hamster Model. American Journal Of Respiratory And Critical Care Medicine, Volume 166, p.998-100.

Watkinson, W.P. (2001). Cardiovascularand Systematic Responses To Inhaled Pollutions In Rodents: Effects Od Ozone And Particulate Matter. Environmental Health Perspectives, Volume 109, p. 539-546.

Pritchard, R.J. (1996). Oxidant Generation And Lung Injury After Particulate Air Pollution Exposure Increase With The Concentrations Of Associated Metals. Inhalation Toxicology, Volume 8, p. 457-477.

Molinelli, A.R. (2002). Effect Of Metal Removal On The Toxity Of Airborne Particulate Matter From The Utah Valley, Inhalation Toxilogy, Volume 14, p.1069-108.

Costa, D. L., Dreher, K.L. (1997). Bioavailable Transition Metals In Particulate Matter Mediate Cardiopulmonary Injury In Healthy And Compromised Animal Models. Environmental Health Perspectives, Volume 105, p. 1053-1060.

Unated States EPA. Air Quality Criteria For Particulate Matter (Third External Review Draft), Environment Protection Agency, 600/P-99/002aB www.cfpub.epa.gov/ncea/cfm/partmatt.cfm?ActType=default.

Monn, C., Becher, S. (1999). Cytotoxity And Proinflammatory Cytokines From Human Monocytes Eposed To Fine (PM2.5) And Course Paticled (PM2.5-10) In Indoor And Outdoor Air. Toxilogy And Applied Pharmacology, Volume 155, p. 245.

Report on the air quality, AD “Bio-ecological center”, Zrenjanin, 2006 (in Serbian).

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TESTING THE IMMISSION AIR POLLUTION OF THE CITY OF ZRENJANIN

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ABSTRACT

The sources of air pollution in urban areas may be divided into:
- Mobile sources emission (traffic and agricultural treatment by aircrafts)
- Stationary source emission (industry, power plants, warming processes of individual premises).

The following are the dominant components of air pollution: soot, carbon monoxide, carbon dioxide, nitrogen compounds, sulfur compounds and ozone.
The paper shows the results of air pollution testing in the city of Zrenjanin at the measuring locality "Veljko Vlahović".

Key words: Air pollution, immission, city of Zrenjanin.

INTRODUCTION

By Constant releasing of huge amount of pollutants into the atmosphere, a man has notably changed the atmosphere composition above the most densely-populated territories in the world. Presence of the pollutants in the air has a number of direct and indirect impacts on the health of all living beings in biosphere as well as on the material goods. The presence of different types of pollutants in the air, makes their influence even more complex. Pollutants can pollute in the form in which they are emitted or the new compound can be created as a result of the physical-chemical process in the atmosphere. Local effects of the air pollution are in most cases manifested as a change in the microclimate of the area.

Air pollution sources can be divided into three groups:
- Central heating
- Industrial activities
- Traffic

Measuring point VeljkoVlahovic Boulevard is situated in the main thoroughfare Zrenjanin-Novi Sad and it is the transit for Romania, Kikinda, Vrsac and the other towns around the city. The population of this part of the city is around 30000 people, and more than a half live in blocks of flats. The influence on the air pollution of the FSK , which is 8 km far from the spot, cannot be ignored.

AIR POLLUTION SOURCES

Pollutants can be emitted through:
- emission
- imission

Emission is a process of air pollution by releasing and emitting pollutants into the atmosphere out of the natural or artifical sources. Emission can be general and special. General emission presents a process of releasing pollutants out of all sources on Earth. Special emission presents a process of polluting of certain area from one or more single sources (Nikolić, 1992, Ramzin, 1996).

Imission, as a term opposite to emission, presents process of reception of pollutants into the atmosphere and also can be divided into general and special. General imission presents reception of all pollutants into the atmosphere, while the special one refers to reception of pollutants from single sources.

General imissiom is propotional to general emission and is constantly increasing due to increase of industraliazation, urbanization and traffic. Finding solution to the problem of air pollution comes to reduction of the amount and the harmfulness of emission, which can be achieved by the choice of fuel, raw materials, better technological processes and improvement of the processes of waste gas purification.

POLLUTANTS

All air pollutants can be in the can be in the form of liquid droplets (aerosol) and particular matters, depending on the size and chemical composition (Nikolić, 1992, Ramzin, 1996, http://www.zdravlje.org.rs/ekoatlas/indexsa.htm,26.04.2010.)

Composition of the pure air is presented in the table 1.

Tabel 1: Composition of the pure air

GASS	Mass %	Volume %
Oxygen	23.01	20.93
Nitrogen	75.51	78.10
Argon	1.286	0.935
Carbondioxide	0.04	0.03
Hydrogen	0.001	0.01
Neon	0.0012	0.0018
Helium	0.00007	0.0005
Krypton	0.0003	0.0001
Xenon	0.00004	-

In certain areas and weather conditions there is a certain amount of Ozone (from 0.003-0.1 mg/m^3). Problems occur when the given parameters become disrupted by release of pollutants into the air.

Air pollutants can be classified into:

- Basic pollutants come from many different sources of pollution.
- Specific pollutants which come as a consequence of different types of human activities, are in most cases of industrial origin and have a local influence on the environment.

Basic pollutants

Sulphur compounds

There are series of sulphur compounds in the atmosphere starting with the pure sulphur, through with its oxides (SO_2 i SO_3), their compounds with aereted water of sulphurous and sulfuric acid,as well as their sulphite and sulfate. In the environment it is often found as sulphur hydride H_2S.

Sulphur oxides stay in the atmospehere for two days and can be transported by wind up to the 100 km distance. The most important way of removing sulphur compounds from the atmosphere is precipitation which causes acid rains.

Nitrogen compounds

In the atmosphere, Nitrogen occurs in the form of oxides, acids and their salts, as well as in the form of ammonia. Major source of Nitrogen oxides are motor vehicles which use liquid fuel. Nitrogen compounds can be removed from the atmosphere as acid rain (oxides) and salts (ammonia).

Carbon monoxide

Carbon monoxide is produced from the partial oxidation of fuels. The largest source of this pollutant are motor vehicles, and its concentration depends on traffic frequency and regualtion as well as on the speed and wind direction..

Carbon dioxide

The largest source of carbon dioxide are processes of combustion and decay of organic matters. Human beings and animals produce Carbon dioxide through the process of metabolism which is emitted into the atmosphere as exiled air. Increased concentration of Carbon dioxide created the phenomenon called greenhouse effect whose consequence is a treperature rise and snow and ice melt on the poles as well as drought periods on Earth.

Ozone

Ozone, as an allotrope of oxygen is present in higher layers of atmosphere and has an ability to absorb large amounts of UV rays.Ozone at the ground level is produced in small concetracion in certain areas and weather conditions and contributes to the freshness of the air.

Soot

Ash is produced in the process of fuel combustion of inorganic parts, while the combustion of organic parts produces soot. Soot has an ability to condense with sulphur and nitrogen compounds as well as with vapour producing toxic fog-smog.

Particulate matter

Particulate matters are pollutants which occur in the air in the form of aerosol. The largest source of particulate matters are solid and liquid fuel furnaces.

MATERIAL AND METHODS

Labaratory researches were held in the air of the measurng point *VeljkoVlahovic* in accordance with the standard air analysis methods (JUS ISO 4219, 1997; ISO 9835, 1993; Nitric oxid and nitrogen dioxide method, 1994; Regulation, 1992).

RESULTS AND DISCUSSION

Measurements were performed in February at the measuring point Boulevard Veljko Vlahovic, which belongs to the city of Zrenjanin. Concentrations of sulphur (IV) oxide, soot, Nitrogen (IV)oxide and ground level ozone were tracked. Results of the research are given in the table 2.

Table 2: Research results

Day in a month	SO_2 (µg/m^3)	Soot(µg/m^3)	NO_2(µg/m^3)	Particulate. Matter.(µg/m^3)	Ground level Ozone(µg/m^3)
1	24	6	22		2
2	22	5	17	136	1
3	37	7	13	132	1
4	32	20	16	198	2
5	20	24	27	213	3
6	26	8	24	275	1
7	16	13	19	-	3
8	33	5	19	-	1
9	28	10	25	101	1
10	19	20	26	147	2
11	15	9	16	136	2
12	14	9	15	61	3
13	3	8	14	72	2
14	4	10	11	-	3
15	14	8	10	-	2
16	14	12	15	-	2
17	16	19	21	-	4
18	28	8	13	85	3
19	13	9	2	73	3
20	21	23	19	210	2
21	29	16	14	138	1
22	15	27	18	292	1
23	38	23	22	-	1
24	14	23	26	-	3
25	21	26	24	-	3
26	8	25	28	-	7
27	22	10	10	-	4
28	15	15	16	-	1
Max.meas.time	38	27	28	292	7
Min.meas.time	3	5	2	61	1
GVI	150	50	85	120	85

Concentration of sulphur(IV)oxide (fig.1) did not exceed GVI, daily maximum was 38µg. The concentration of soot did not exceed GVI (fig. 2). Maximal measured value was 27µg.

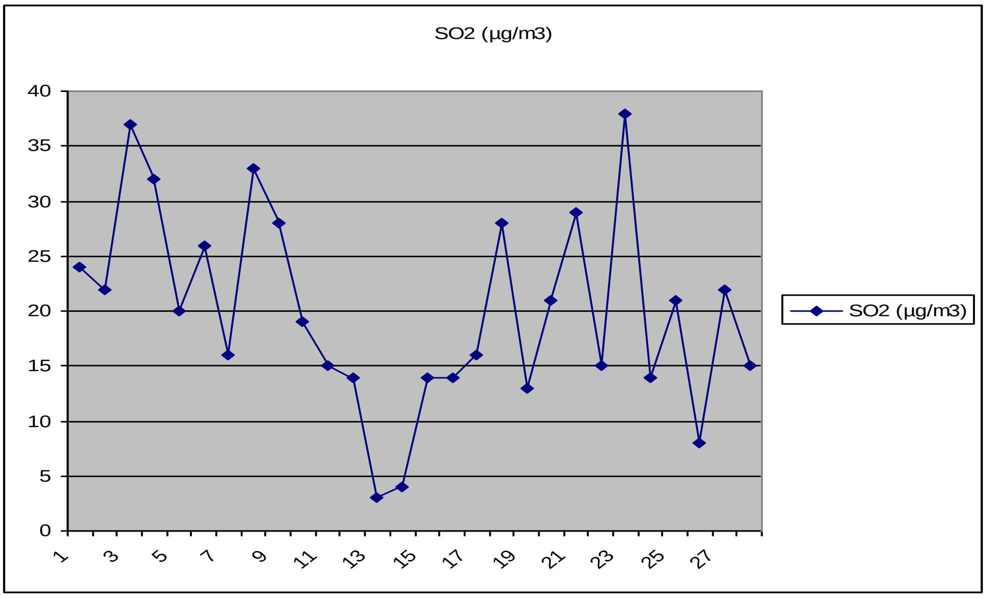

Figure 1. Level of SO_2

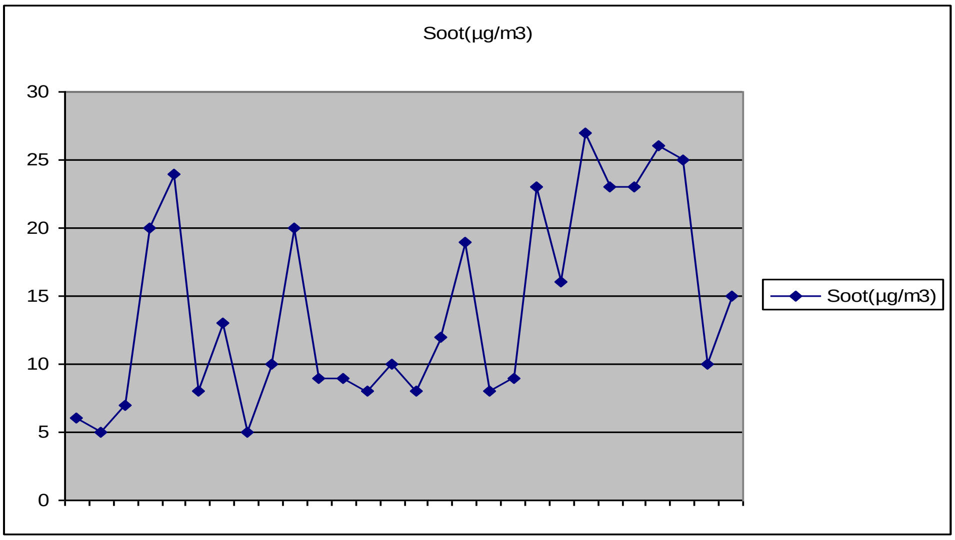

Figure 2.Level of soot

The concentration of nitrogen(IV)oxide did not exceed GVI (fig.3). The level of particulate matters exceeded GVI during ten days. Maximal measured value was 292µg (fig. 4). The concentration did not exceed GVI. Maximal measured value was 7µg (fig.5).

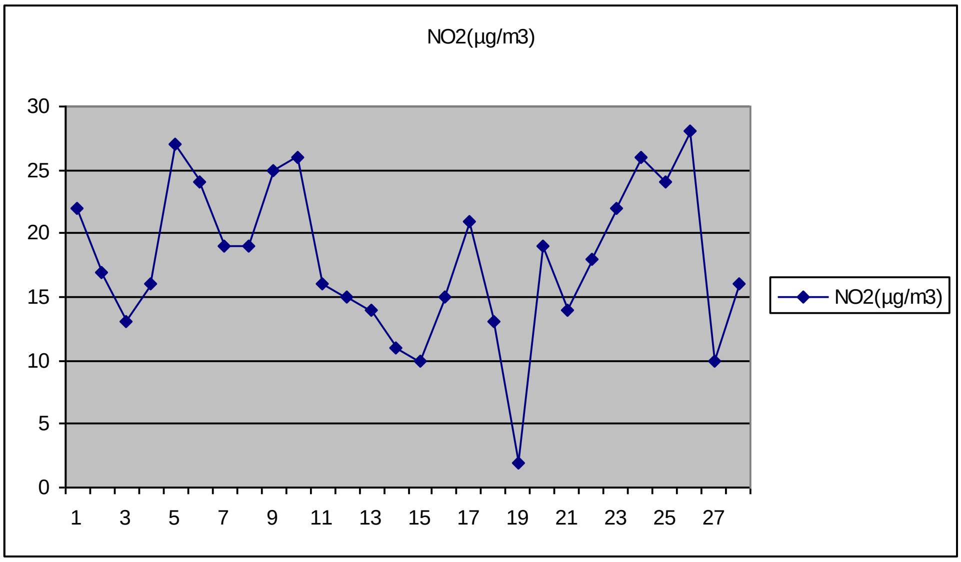

Figure 3. Level of Nitrogen(IV)oxide

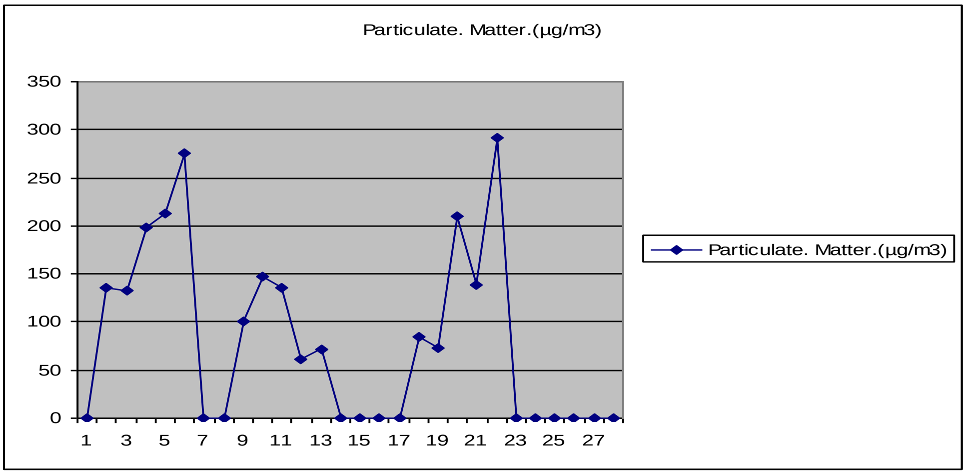

Figure 4. Level of particulate matters

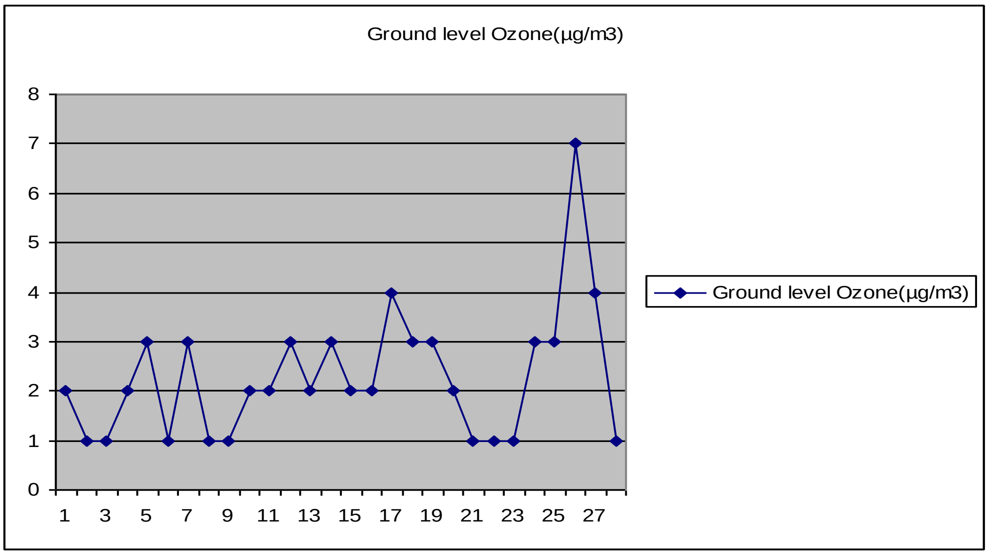

Figure 5. Level of ground level Ozone

CONCLUSION

In the work are presented methods and results of the analysis of the concentration of the air pollutants in the open space.Results of the research showed that the concentration of acidic pollutants as SO_2 did not exceed GVI. Maximal value was measured on 23 February and was 38µg. Soot concentration was within the GVI limits. Maximum value was measured on 22 February was 27µg. Contretation of nitrogen oxides did not exceed GVI. Maximum measured value was 28µg recorded on 28 February. Content of particulate matters had value higher than GVI in the period of 10 days, and the measurements were obtained 15 days. Maximal measured value was 2.5 times higher than GVI. Concentration of gound level Ozone was within GVI levels.

In the conclusion, it can be said that air pollution on the measuring point Boulevard Veljko Vlahovic, is periodical and depends on winds and increased level of traffic on the highway. Solving problem of air pollution is based on reduction of fuel consumption, usage of better techological procedures or improvement of the existing ones by adding appropriate elements for waste gas cleansing. Urban development measures are also very important and include appropriate planning and zoning settlement as well as providing enough of green space which are the key elements in forming the micro climate and the protection of air pollution.

REFERENCES

http://www.zdravlje.org.rs/ekoatlas/indexsa.htm,26.04.2010.
JUS ISO 4219, 1997, Određivanje sadržaja gasovitih jedinjenja sumpora u vazduhu,1997.
Nikolić M.: Higijena i medicinska ekologija-praktikum, Beograd,1992.
Nitric oxid and nitrogen dioxide method, Niosh manual of Analitical Methods,1994.
Pravilnik o graničnim vrednostima, metodama merenja imisije, kriterijuma za uspostavljanje mernih mesta i evidenciji podataka, Službeni glasnik RS 54/92.
Ramzin S.: Priručnik za komunalnu higijenu,1996.

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TECHNOLOGY MEASUREMENTS OF AIR QUALITY IN URBAN AREAS

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ABSTRACT

Atmospheric pollution is a major problem facing all nations of the world. Rapid urban and industrial growth has resulted in vast quantities of potentially harmful waste products being released into the atmosphere. The atmosphere is the largest imaginable chemical reactor in which pollutants may be converted into more harmful or harmless substances. The four major groups of gaseous air pollutants by historical importance, concentration, and overall effects on plants and animals (including people), are sulphur dioxide (SO2), oxides of nitrogen (NOx: NO, NO2), Carbon dioxide (CO2) and ozone (O3). Sulphur dioxide and nitric oxide (NO) are primary pollutants – they are emitted directly from sources. This paper describes these technologies for measuring air quality parameters.

Key words: Air quality, Atmospheric pollution, Technology measurements.

INTRODUCTION

Atmospheric pollution is a major problem facing all nations of the world. Rapid urban and industrial growth has resulted in vast quantities of potentially harmful waste products being released into the atmosphere. The atmosphere is the largest imaginable chemical reactor in which pollutants may be converted into more harmful or harmless substances. Societies have been reluctant to accept, or have simply failed to recognise the limitations of the cleaning properties of the atmosphere and self-adaptation of the ecosystem Planet, with no remnant damages or preventing a non-equilibrium status. The consequences has been that air pollution has affected the health and wellbeing of people, has caused widespread damage to vegetation, crops, wildlife, materials, buildings and climate, and has resulted in depletion of the scarce natural resources needed for long-term economic development.

The chemical pollution of the atmosphere is a consequence of the chemical compounds input, over the natural air constituents and is of natural and artificial origin. However, the natural chemical pollution sources like volcanoes eruption, natural decomposition of organic substances or fire (naturally occurred) are not of major concern as they are part of natural environment equilibrium. However, the anthropogenic chemical pollution is of major concern as their sources are increasing in number and concentration with the increase of global human population and our continuously increase of energy demand.

The anthropogenic chemical pollution has no borders and no matter where the pollutants are released into the atmosphere will have an impact over global environment. The most relevant sources are the incineration of fossil fuels to produce energy (heat and electricity), major industrial processes (like metallurgy industry or cement/construction industry) and transportation. We will classify the anthropogenic chemical pollution sources into two major groups: stationary and mobile sources.

The four major groups of gaseous air pollutants by historical importance, concentration, and overall effects on plants and animals (including people), are sulphur dioxide (SO2), oxides of nitrogen (NOx: NO, NO2), Carbon dioxide (CO2) and ozone (O3). Sulphur dioxide and nitric oxide (NO) are primary pollutants – they are emitted directly from sources. We shall start by looking at the main sources of these and other primary gases, and also consider some of the methods of control that can be used to reduce emissions and concentrations when required. The most important groups of anthropogenic air pollution sources are defined by industrial processed, residential heating systems, transportation (terrestrial, naval and aerial) and agricultural systems. The majority of the pollutants are the direct result of the combustion process in large power plants and piston engines so that the first steps to reduce the pollutants concentration from atmosphere is to control and reduce the emissions from those source groups.

In a figure 1. Is shown short and simplified relation between fuel, combustion, combustion products (pollutants) and air quality is given.

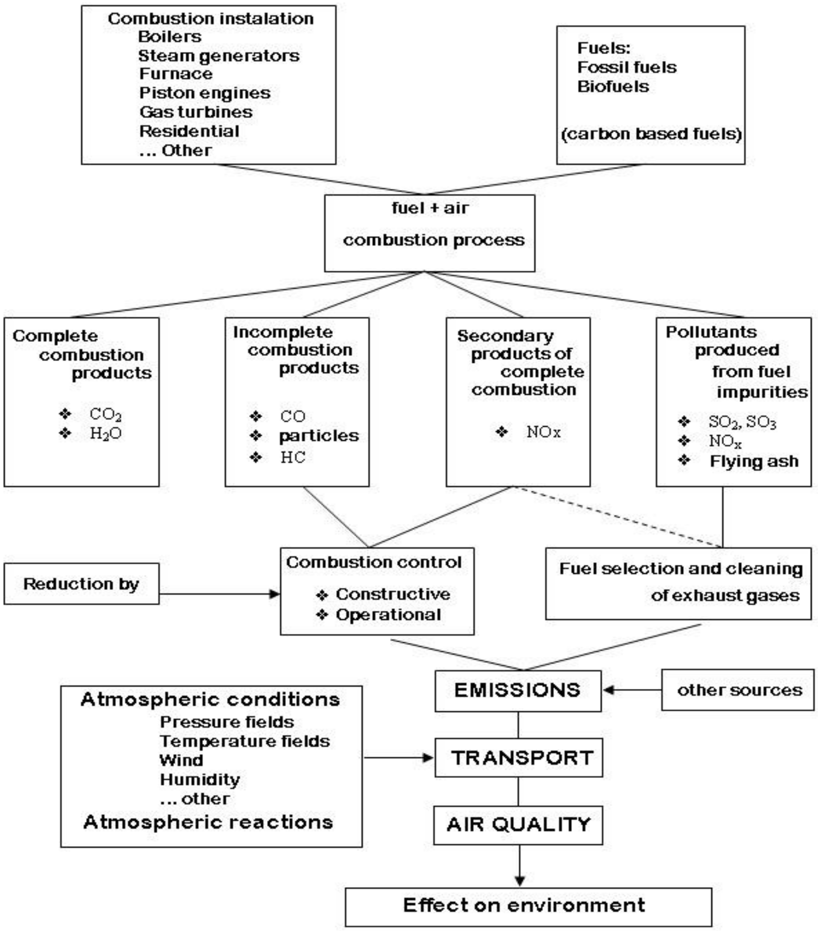

Figure. 1. Sources and products of anthropogenic pollution

CHOISE OF MEASURING METHOD

For a given pollutant, there may be a number of measurement methods, each having its own advantages or disadvantages in terms of performance, reliability and cost-effectiveness. Broad classification can be made into direct-reading (usually automatic) methods and indirect (usually manual) methods. Direct measurement techniques are those where the air is sampled and the quantification stage of the pollutant analysis is performed *in-situ* virtually instantaneously. Most direct-reading analyzers provide a continuous readout of the pollutant concentration or have a relatively short sample time-average period. Indirect measurement techniques are those where the air is sampled for a fixed time and the pollutant is captured, by for example evacuated flask, cryogenic trapping, absorption in a liquid or adsorption onto a solid resin. The analysis is then carried out on the pollutant in this form or after further pretreatment of the sample.

Table 1: Common direct-reading measurement methods for gases

Method	CO	SO_2	NO_x	O_3	Organics
NDIR	•				
NDUV		•			
UV fluorescence		•			
Chemiluminescence			•		
Flame photometric		•			
FID, PID					•
DOAS		•	•	•	•
DIAL		•	•	•	•
FTIR					•
UV absorption				•	

SAMPLING LINE

An important part of the measurement container is the sampling line. The way how to suck the sample into the container (to the analysers) can already influence the measurement. Therefore national standards have been developed for the sampling of gaseous samples and particulate matter. The intake line has to be designed in a way that rain or snow can not enter the sampling system and sedimentation does not take part. Chemical reactions and deposition on the walls have to be avoided. This requires short tubes, the time between inlet and analyser must not exceed 10s. The whole manifold system has to be built using chemically inert materials (i.e. Borosilicate glass or Polytetrafluorethen (PTFE)).

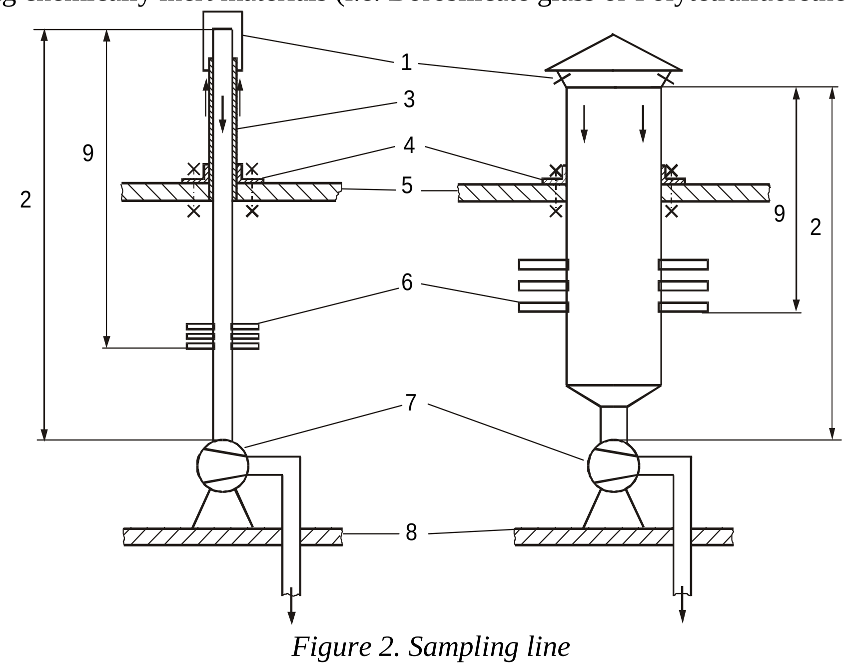

Figure 2. Sampling line

1. Intake head
2. Hollow tube
3. Tube to protect the intake line
4. Fixing
5. Roof of the container
6. Connection to analysers
7. Fan or pump
8. Floor of container

CO MONITORING IN AMBIANT AIR. REFERENCE METHOD

The reference measurement method for CO in ambient air is Non-Dispersive Infra Red detection method.
Reference standard: EN 14626:2005

NDIR instruments are primarily used for emission measurements; analyzers are mainly suitable for the determination of the gases CO, CO2, NO, SO_2, H_2O, CH4, C_2H_6, and many other hydrocarbons.

For CO and CO_2, NDIR photometry is the most commonly used measuring technique, which is also unrivalled in its application for the measurement of these gases in the ambient air range.

As it is shown in the Fig. 3, the instruments for CO measurements uses the modulation effect that occurs with infrared absorption of sample gas itself when sample gas and zero gas are alternately sent to its cell at a certain flow rate using a solenoid valve which is actuated at a frequency of 1 Hz. Unless the gas concentration of the measured component is changed in the cell, the output from the detector essentially becomes zero, therefore, the zero drift dose not occur. Since the instrument also uses the AS-type detector, extremely high-accuracy results are obtained without any effect of the interference component.

The radiation source is an infrared radiation emitter. The radiation - modulated by a chopper - passes a chamber containing the probe and in parallels a chamber containing a reference gas. To reduce the influence of interfering gases optical filters are used. The content of the measurement cell receives periodically infrared radiation with different strength, which results in different temperature and pressure effects. The pressure effects are hence transferred to electrical signals by a sensor, and this signal correlates to the measured CO concentration. Some systems use the pressure waves for detection, while others use directly the IR receiving an optical detector to measure the CO concentration.

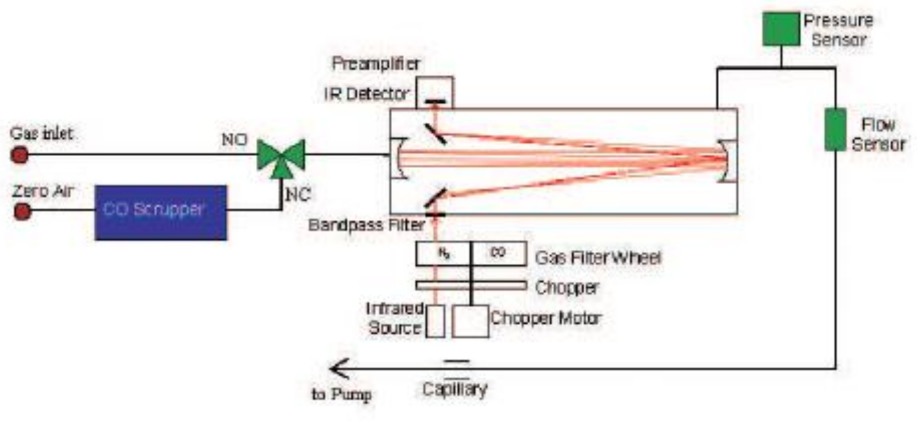

Figure 3. Flow diagram of CO module

SO2 MONITORING IN AMBIENT AIR. REFERENCE METHOD

The reference measurement method for SO2 in ambient air is UV Fluorescence detection method. Reference standard: EN 14212:2005

UV fluorescence is a measuring technique related to photometry. The measuring gas is also exposed to radiation. However, it is not the radiation absorption which is measured but a luminous phenomenon (fluorescence) which is caused by the excitation of molecules through UV radiation of a certain wavelength. The measuring principle is, e.g., applied in SO_2 ambient air measurement, presented in Fig 4.

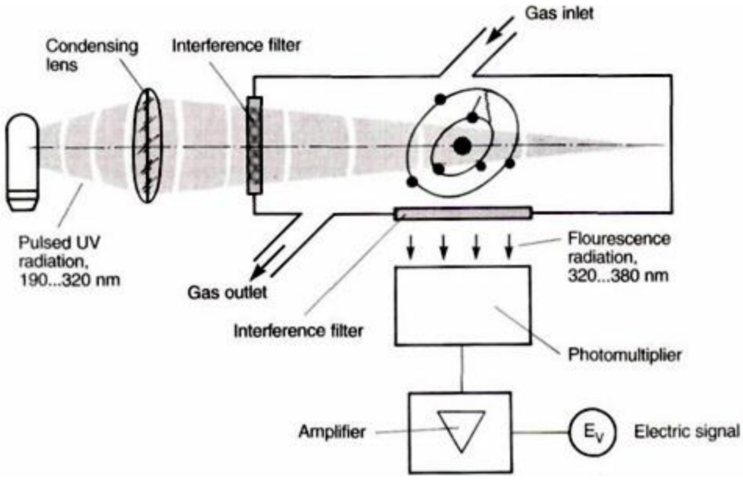

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Figure 4. Principle of UV fluorescence measurement (Zolner, 1984)

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The air sample is exposed to UV radiation in the wavelength range of 190-320 nm. If present, SO_2 gives off a fluorescence radiation of 320-380 nm. Due to an interference filter only a radiation of this wavelength is recorded by the detector (photomultiplier); thus, the measuring principle is strictly selective.

When a sample is irradiated with ultraviolet ray (215 nm), $S0_2$ emits the light of a different wavelength (peak: 320 nm, range: 240 nm to 420 nm) from that irradiated. The former, irradiated light is referred to as excitation light, and the later, emitted light is referred to as fluorescence. The method to obtain sample concentrations by measuring the fluorescence intensity is called the fluorescence method. In the fluorescence method, fluorescence, which radiates in all directions, is usually detected at the right angles to the excitation light in order to' prevent interference by the excitation light.

When excitation light is irradiated and absorbed following processes take place:

Process 1: $S0_2 + hv_1 \rightarrow S0_2{}^*$

There are three ways by which the $S0_2{}^*$ loses its excitation energy.

Process 2: Fluorescence process: Excitation energy is emitted as fluorescence.

$$SO_2{}^* \xrightarrow{kf} SO_2 + Kv_2$$

Process 3: Dissociation process: Excitation energy is used for dissociation.

$$SO_2{}^* \xrightarrow{kd} SO + O$$

Process 4: Quenching process: Excitation energy is lost by collision with surrounding molecules, M.

$$SO_2^* + M \xrightarrow{kq} SO_2 + M$$

Practically, the excitation energy is lost resulting from the confluence of these three processes.

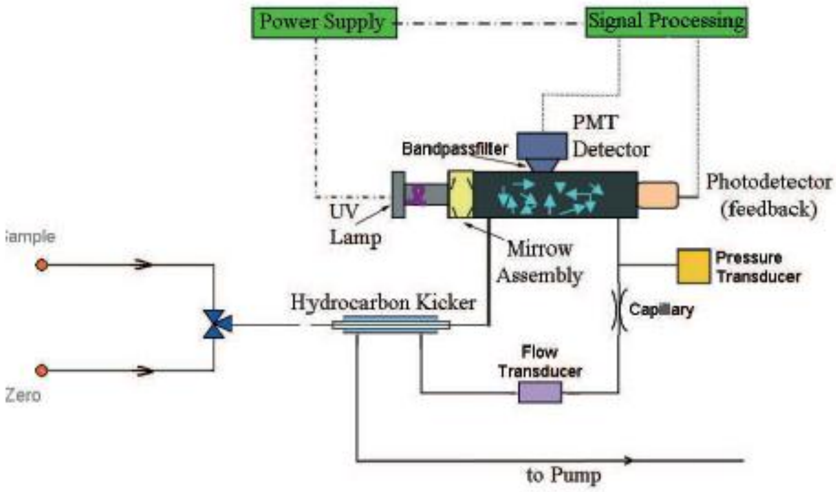

Figure 5. Flow diagram of CO module

NO, NO2, NOx MONITORING IN AMBIENT AIR. REFERENCE METHOD

The reference measurement method for NO and NO2 in ambient air is Chemiluminiscence detection method.
Reference standard: EN 14211:2005

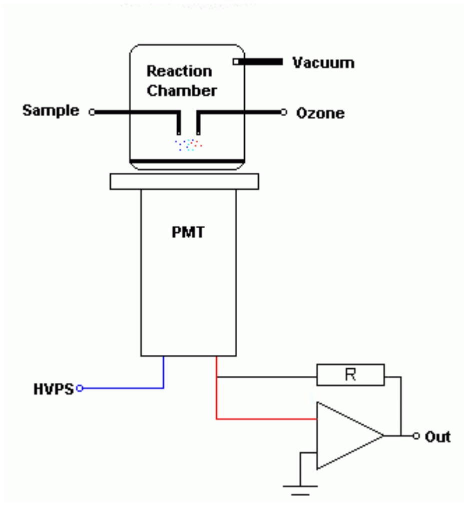

Figure 6. Flow diagram of NO_x module

Chemiluminescence is related to UV fluorescence. The difference between the two is that in chemiluminescence molecules are not excited by UV radiation, but are excited by a chemical reaction. Thus, the measuring principle is a chemo-physical one. The intensity of the radiation created is a measure for the concentration of the reacting gas in a mixture of gases, if the external conditions (pressure, temperature and volume flow of the measuring gas) are kept constant. Just as is the case in UV fluorescence, the radiation created is recorded by a photomultiplier acting as radiation detector and is transformed into an electric signal. This method is used mainly for measuring NO, $NO+NO_2$ (i.e., NO_x) and O_3.

The instrument must provide continuous and unattended monitoring of NO, NO_2 and NO_x with individual determinations and high reliability and accuracy. An internal NO_2 to NO converter permit

NO_x analysis and an integral ozone supply system which puts filtered, dehumidified ambient air through an ozonator to generate the ozone necessary for reaction with NO to give chemiluminescence’s reaction. The instrument must have a flow-chopping modulation system to give continuous NOx and NO analysis. With this system, the sample gas is divided into two separate lines. One sample gas line passes through the NO_2 to NO converter, while the other leads directly to the detector. Also a permeation tube in which only moisture is passed through is used for the sample line is needed. This tube functions so that an influence from the moisture is reduced by minimizing difference of moisture concentration between sample gas and reference gas.

Inside the reaction chamber NO reacts with ozone to form NO_2. The $N0_2$ is excited to a higher electronic state. This chemiluminescence’s is measured through an optical filter by a photodiode. The modulated hybrid signal from the detector is demodulated to give continuous NO_x and NO signals at the same time. The NO_2 concentration is given by subtraction of NO from NO_x.

$$NO + O_3 \rightarrow NO_2^* + O_2$$
$$NO_2^* \rightarrow NO_2 + h\nu$$

Filtered sample gas is divided into lines 1 and 2. In line 1, the sample gas flows through an integral converter which reduces NO_2 to NO. In line 2, the sample gas remains as it is. The sample gas is switched to NOx line, reference line, NO line and to reference line again by the solenoid valve with 0.5 sec interval. Then it is introduced into respective reaction chamber. Luminescence due to reaction of the sample and O_3 occurred in the chamber is detected by a photodiode. By electrically processing the output of photodiode, it is possible to take out continuous signal in NOx line and NO line respectively. Flow to the detector unit is controlled by capillaries. Ozone is supplied to the reaction chamber at a constant rate by an internal ozonator which uses dehumidified ambient air as feed gas. The dryer unit has two dryer cylinders. When one cylinder is under operation, the other is regenerated.

CH4, NMHC AND THC MONITORING IN AMBIENT AIR. REFERENCE METHOD

The reference measurement method for CH4, NMHC and THC in ambient air is Flame ionisation detection method (FID).Reference standard: EN 12619:2002 and EN 13526:2002

The so-called flame-ionization detector (FID) was originally developed for gas chromatography. Nowadays, it is also used as the most important measuring device for the continuous recording of organic substances in exhaust gases or in ambient air.

The measuring principle of the FID is classic and will be summarized here with the help of Fig 7.

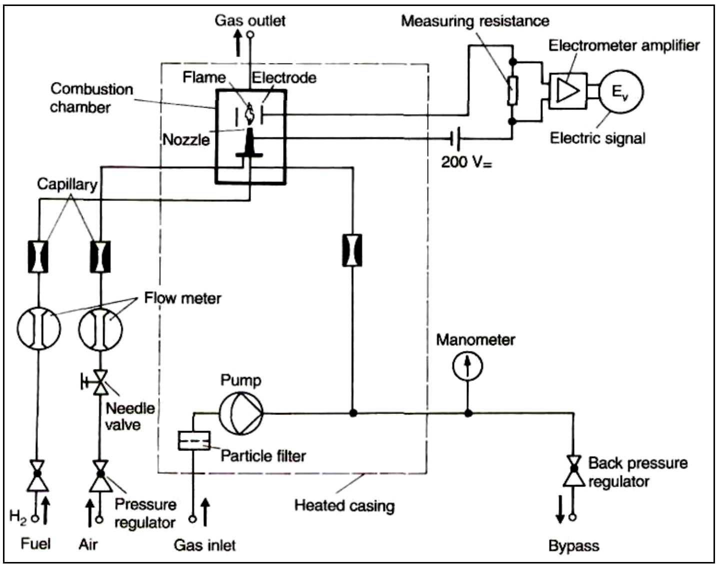

Figure 7. Diagram of a flame ionization detector (FID) (Kaiser, 1965)

The hydrogen flame burns out of a metal nozzle which simultaneously represents the negative electrode of an ionization chamber. The positive counter-electrode is fixed above the flame, e.g., as a ring. Between the two electrodes direct voltage is applied.

The ion current is measured as a voltage drop above the resistor W. The measuring gas is added to the burning gas shortly before entering the burner nozzle. The air required for combustion flows in through a ring slot around the burner nozzle.

For stable measuring conditions it is essential that all gases - combustion gas, combustion air and measuring gas - are conducted into the flame in constant volume flows. For this, all gas flows are conducted via capillaries. Constant pressures before the capillaries ensure a constant flow. Sensitive pressure regulators for combustion gas and combustion air are used to achieve this fine-tuning. The measuring gas is pumped past the capillary in the bypass in a great volume flow. Pressure is kept constant by the back pressure regulator, so that a constant partial flow reaches the flame via the capillary. Most FID’s operate with overpressure, i.e., the measuring gas pump is located before the capillary. To avoid condensation of the hydrocarbons to be measured almost all instruments can be heated to 150-200 °C. Heating includes the particle filter and the measuring gas pump; in most cases, particularly with warm exhaust gases, a heated sampling line is also used from measuring gas sampling to the measuring instrument.

TSP, PM10 AND/OR PM 2.5 MONITORING IN AMBIENT AIR. REFERENCE METHODS EN12341

Suspended particulate matter (SPM) in air generally is considered to be all airborne solid and low vapor pressure liquid particles. Suspended particulate matter in ambient air is a complex, multi-phase system consisting of a spectrum of aerodynamic particle sizes ranging from below 0.01 μm to 100 μm and larger. (US-EPA).

Respirable particles are attributed to growth of particles from the gas phase and subsequent agglomeration; most coarse particle (sizes 2.5-10 μm) are made of mechanically abraded or ground particles. Particles that have grown from the gas phase, either because of condensation, transformation, or combustion, occur initially as very fine nuclei (0.05 μm).

These particles tend to grow rapidly to accumulation mode particles around 0.5 μm which are relatively stable in the air. Coarse particles, on the other hand, are mainly produced by mechanical forces, such as crushing and abrasion.

These coarse particles therefore normally consist of finely divided minerals, soil, or dust that result from entrainment by the motion of air or from other mechanical action within their area. Since the mass of these particles is normally >3 μm, their retention time in the air parcel is shorter than that of the fine particle fraction. These smaller particles penetrate deeply into the lung, where the potential for health effects is the greatest. In addition, the smaller particles typically are man-made. TSP typically has a bimodal distribution, with naturally occurring particles centered at about 10 μm and man-made particles centered at about 0.4 μm (US-EPA).

Sampling options for PM10 compliance monitoring fall into two categories: "reference" methods and "equivalent" methods. In this moment the gravimetric method is the reference method and there are 3 “equivalent” methods accepted by regulations: Beta-radiation attenuation,oscillating pendulum and light scattering.

The beta attenuation monitor samples at ambient temperatures, relative humilities, and gas concentrations to minimize particle volatilization biases. These monitors operate at a low-volume flow rate (nominally 16.7 liters/minute [L/min]) using either a virtual impact or cyclonic flow operating principal to determine the 50% cut-point. For beta attenuation monitors, low-energy beta rays (i.e., 0.01-0.1 MeV electrons) are focused on deposits on a filter tape and attenuated according to the approximate exponential function of particulate mass (i.e., Beer's Law). These automated samples employ a continuous filter tape. Typically, the attenuation through an unexposed portion of the filter tape is measured, and the tape is then exposed to the ambient sample flow where a deposit is accumulated. The beta attenuation is repeated, and the difference in attenuation between the blank filter and the deposit is a measure of the accumulated concentration.

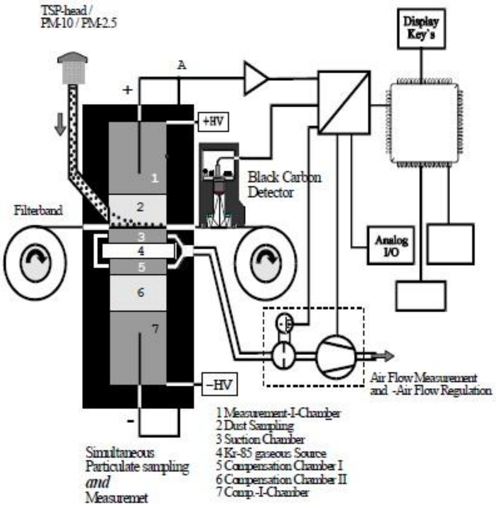

Figure 8. Flow diagram of PM module

The reference method monitors are so called “LSV”, Low Volume Samplers and are used for PM10 and PM2.5 measurements indoor and outdoor. The particles retained on the quartz or glass filters can be analyzed gravimetric but also chemical, in the laboratory, to analyze the content of the deposited particles. The working principle of the LCV is: the sample air is aspirated with a vacuum pump (maximum flow is 3 m^3/h). The glass or teflon/quarz filter is stored inside the inlet. The inlet is build so that only particle below the given aerodynamic diameter (2.5 μm or 10 μm) will be deposited on the filter. The air will be exhausted through a paper filter in order to retain the particles that could be generated by the vacuum pump.

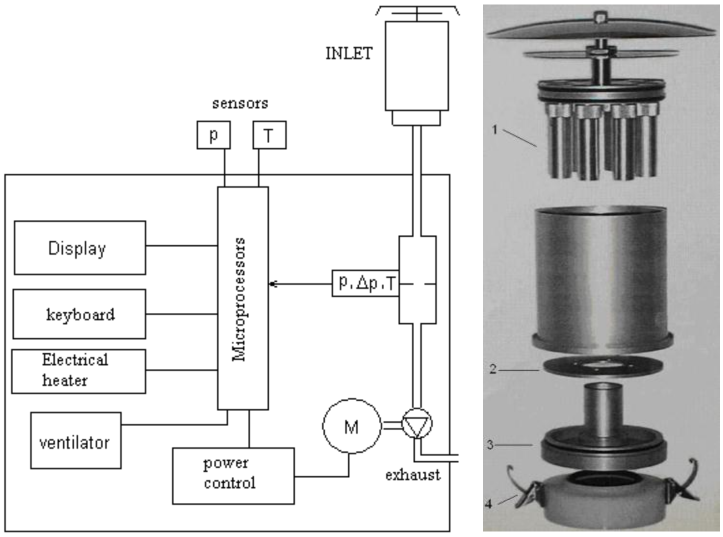

Figure 9. Flow diagram of PM10,PM2,5 module

SET-UP OF AN AIR QUALITY MONITORING STATION

The next figure shows a scheme of a set-up of such a measuring station. The measuring gas suction hoods and different meteorological measuring instruments are installed on a 10 m high altitude. The management and working methods are respecting the international standards SR EN ISO/CEI

17025:2005 (General features and competences), according to the fundamentals and definitions imposed by SR EN ISO 9000:2006. In addition to the instruments for the specific measurement of pollutants there are numerous other instruments for the recording of meteorological parameters such as wind direction and wind speed, temperatures, global radiation, duration of rain and bedewing, amount of rain etc., as well as an electronic controlled computer, to record, calculate and memorise the values.

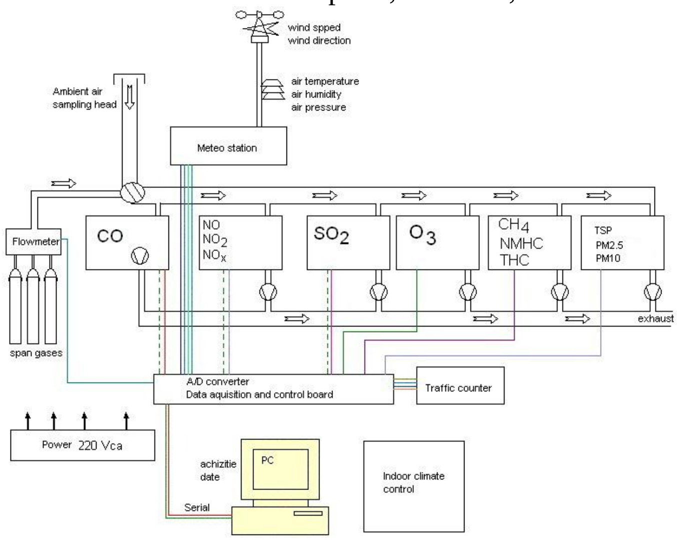

Figure 10. Set-up of the sampling system of an air quality station with air suction through tubes and with calibration gas switching

REFERENCES

I. Ionel, S. Ionel, F. Popescu, G. Padure, L.I. Dungan, D. Bisorca, *Method for determination of an emission factor for a surface source*, Optoelectronics and Advance Materials – Rapid Communication Journal, Vol 2 (12), 851–854, ISSN 1842-6573, 2008.

Quellen: WHO Regional Publications, European Series, No. 91, "‘Air quality guidelines for Europe"’, 2nd edition, 2000;

CONTINUOUS MEASUREMENT OF PM10 SUSPENDED PARTICULATE MATTER (SPM) IN AMBIENT AIR, Center for Environmental Research Information Office of Research and Development U.S. Environmental Protection Agency, June 1999, pp. 1-4.

Munn, R.E.: The Design of Air Quality Monitoring Networks. Macmillan Publishers, London 1981.

Dieter Eickelpasch, Georg Eickelpasch, Determination and Evaluation of Ambient Air Quality, ISSN ISSN 0722-186X, pp 26 -30

GESTIS Stoffdatenbank (http://www.hvbg.de/d/bia/fac/stoffdb/index.html); U.S. Environmental Protection Agency (www.epa.gov)

http://www.umweltdaten.de/publikationen/fpdf-l/2702.pdf

http://www.umweltbundesamt.de/luft/messeinrichtungen/5Appendix3.pdf

http://whqlibdoc.who.int/offset/WHO_OFFSET_24.pdf

http://ec.europa.eu/environment/air/quality/legislation/assessment.htm

http://www.epa.gov/ttnamti1/files/ambient/inorganic/overvw1.pdf

http://www.env.go.jp/earth/coop/coop/document/01-apctme/contents.html

http://www.epa.gov/radiation/marssim/docs/revision1_August_2002corrections/chapter6.pdf

http://ec.europa.eu/environment/air/pdf/air.pdf

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THE TRAFFIC IMPACT ON AMBIENT AIR QUALITY IN SEVERALS CITIES IN APV

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ABSTRACT

Over the years, in terms of character and intensity, the level of air pollution has been changed. Prior to the Second World War, sulfur dioxide and soot were reported like the most important pollutants in urban areas. The origins of these two pollutants were linked to the use of fossil fuels in different industry branches, mostly in the production of energy for heating. The problem was partially solved by using of "cleaner" fuels, increasing the height of the chimney for the discharge of waste gases, and installation of the exhaust gas cleaning systems. During the following years, in urban areas, increase in the number of vehicles, resulted in higher concentrations of nitrogen oxides, volatile organic compounds and suspended particles. The aim of this paper is to show ambient air quality, as well as the traffic impact on the air quality. Detailed analysis and the dynamics of concentration levels of the suspended particles, with a diameter smaller than 10 microns (PM10), will be shown for the several cities in APV.

Key words: Air Quality, Traffic, Suspended particles (PM10).

INTRODUCTION

Since the mid-twentieth century to the present, world has seen a dramatic CHANGES. The world s population is currently growing approximately 75 million a year ''The combination of population growth, greater per capita income and economic activity, and urbanization is beginning to place intolerable stress on both the earth s own natural resources carrying capacity and our own manufactured physical and social infrastructure''(Matthew J. Kiernan 2009) .

Air pollution is one of the most serious environmental threats in the global world. 71% of the world s cities nitrogen dioxide emissions, often associated with automobile use exceeded WHO maximums. (World Bank, World Development Indicators 2003)

Although air quality has improved in the industrialized world in relation to the concentration of sulfur dioxide and soot, problems with the concentrations of nitrogen dioxide, volatile organic compounds and suspended particles, originating from traffic, are increasing (Fenger, 2009)].

Air pollution is creating increasingly serious health problems in both the developed and developing worlds at a cost of hundreds of billions dollars each year. In the United States, estimates of the annual human health costs of outdoor air pollution range from $14 billion to $55 billion annually (Ostro et al., 1997).

NETWORK

Serbia made tremandous efforts to fulfill all requirements on path to join European Union. In the filed of environemntal protection many activities are complited. One of these requirements is to harmonize legislation with the EU directives and standards. Conserning air protection, a great progress in harmonisation was made. Low on air protection and majority of baylows are adopted.

According to the Low on air protection there is obligation for establishing national and local air monitoring network. There are 18 automatic stations for air quality monitoring in Vojvodina, and more than 40 sites where manual measurements are performed. Withn the the automatic stations network there are 11 stations on local level and 7 stations on national level.

The automatic stations for air quality monitoring are situated in major industry centers such as: Kikinda, Novi Sad, Subotica, Sombor, Zrenjanin, Pancevo, Beocin, Sremska Mitrovica. Two stations are situated in protected areas (Obedska bara and Deliblatska peščara) where all activities, which could led to the air pollution, are forbidden (Regulation on protection of Special Nature Reserve "Obedska Bara", Regulation on protection of Special Nature Reserve "Deliblatska pescara")

Each of these stations are classified according to European standards (EoI Directive), so there are 6 air quality atomatic station clasifies as straffic, 3 industrial an 9 basic stations.

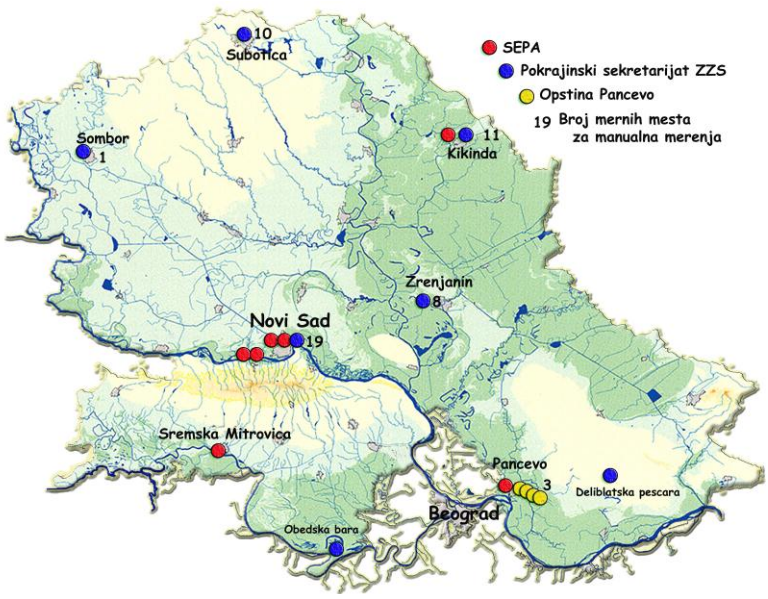


Figure 1. Air Quality Monitoring network in AP Vojvodina

METHODOLOGY

Results obtained from the diferent periods, including 2008 and 2009 for Subotica and Sombor (www.eko.vojvodina.gov.sr), and 2009-2011. for Novi Sad (www.sepa.gov.rs), have been used in this paper.

Sampling system for suspended particles in Subotica and Sombor: TEOM - filter papers placed on the oscillating microbalance. The decrease in the oscillation frequency caused by particle settling is directly proportional to the mass of the sample. Measurement principle: Filter sampling, direct measurements of the mass, continuous automatic measurement. Precision:± 5μg m-3 for 10-minute mean; ± 1.5μg/m3 for 1- hour mean Measurement range: 0–5000μ μg m-3 (Manual for TEOM 1400A)

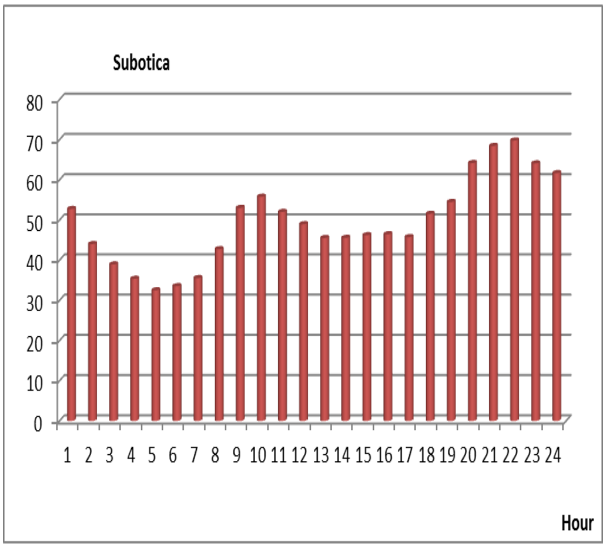
Sampling system for suspended particles in Novi Sad- is in accordance to the bylaw which regulates all requirements concerning air quality monitoring: The reference method for the sampling and measurement of PM_{10} is that described in EN 12341:1999 'Air Quality —Determination of the PM_{10}

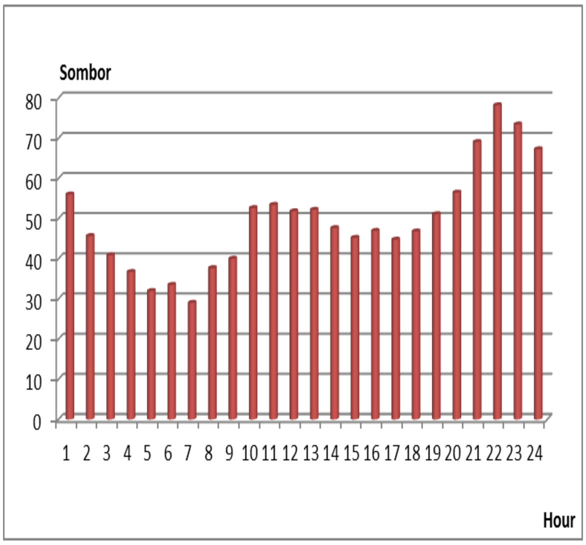
fraction of suspended particulate matter — Reference method and field test procedure to demonstrate reference equivalence of measurement methods' (Bylow on air quality monitoring requirements).

RESULTS

The dynamics of concentration levels of PM_{10}

Daily variations of the PM_{10} concentration – A detailed analysis of the data showed that the PM_{10} concentration varies during a day. An increase in the concentration is characteristic of the morning hours (morning peak) from 7 to 10 h, followed by the stagnation from 11th hour and a mild decrease, but with still high concentrations registered to 18 h, when another increase is observed to 22 h in all tree cities. The mean concentrations in the interval from 18 and 22h were above the maximal tolerable daily value of 50 μgm-3 in Subotica and Sombor. During the night, the PM_{10} decreases to the early morning hours, when a new cycle begins (Figure 2).





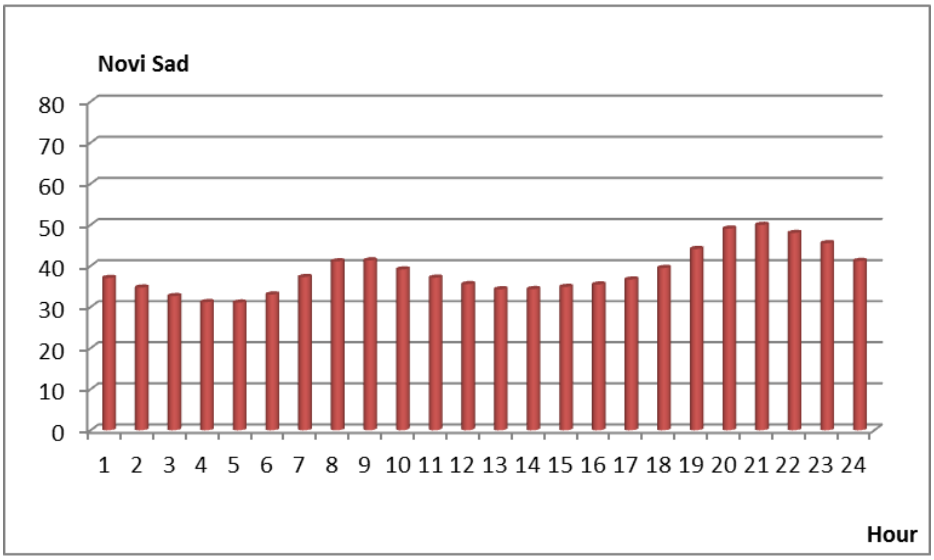


Figure 2. Average PM10 concentracion (ug/m3) during the day

It is important to point out that the distribution of certain PM_{10} concentrations varies during a day. Statistical treatment of the available data leads to the conclusion that during 24 h the percentages of particular PM_{10} concentrations show daily variations. During the early morning hours (from 1 to 7 h) the highest percentage makes the concentration of PM_{10} up to 30 μgm-3, during the major part of the day (from 7 to 18 h) the highest concentrations are of the particles of 30-50 μgm-3, whereas later (after 18 h), an increase is observed in the percentage of high PM_{10} concentrations (Figure 3).

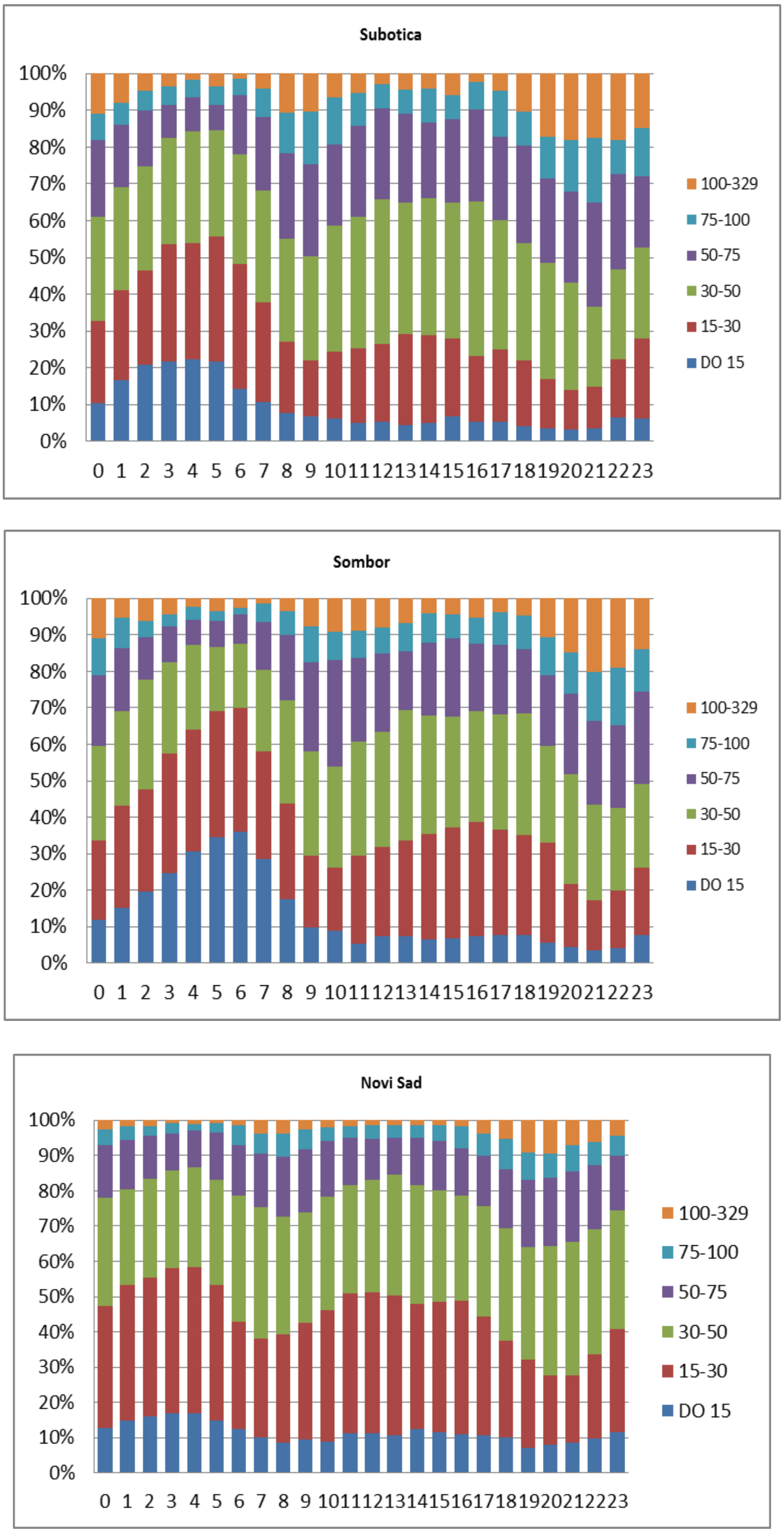


Figure 3. The distribution of PM_{10} concentrations expressed as a percentage during the day

Weekly variation of PM_{10} concentrations. In addition to the observed dynamics of daily PM_{10} concentrations, there is a certain difference in concentration during the week. Namely, the average daily concentrations during weekdays (Monday-Friday) are close or slightly below the limit value. During the weekend (Saturday and Sunday), the average daily concentration decreased and are below the limit value (Figure 4).

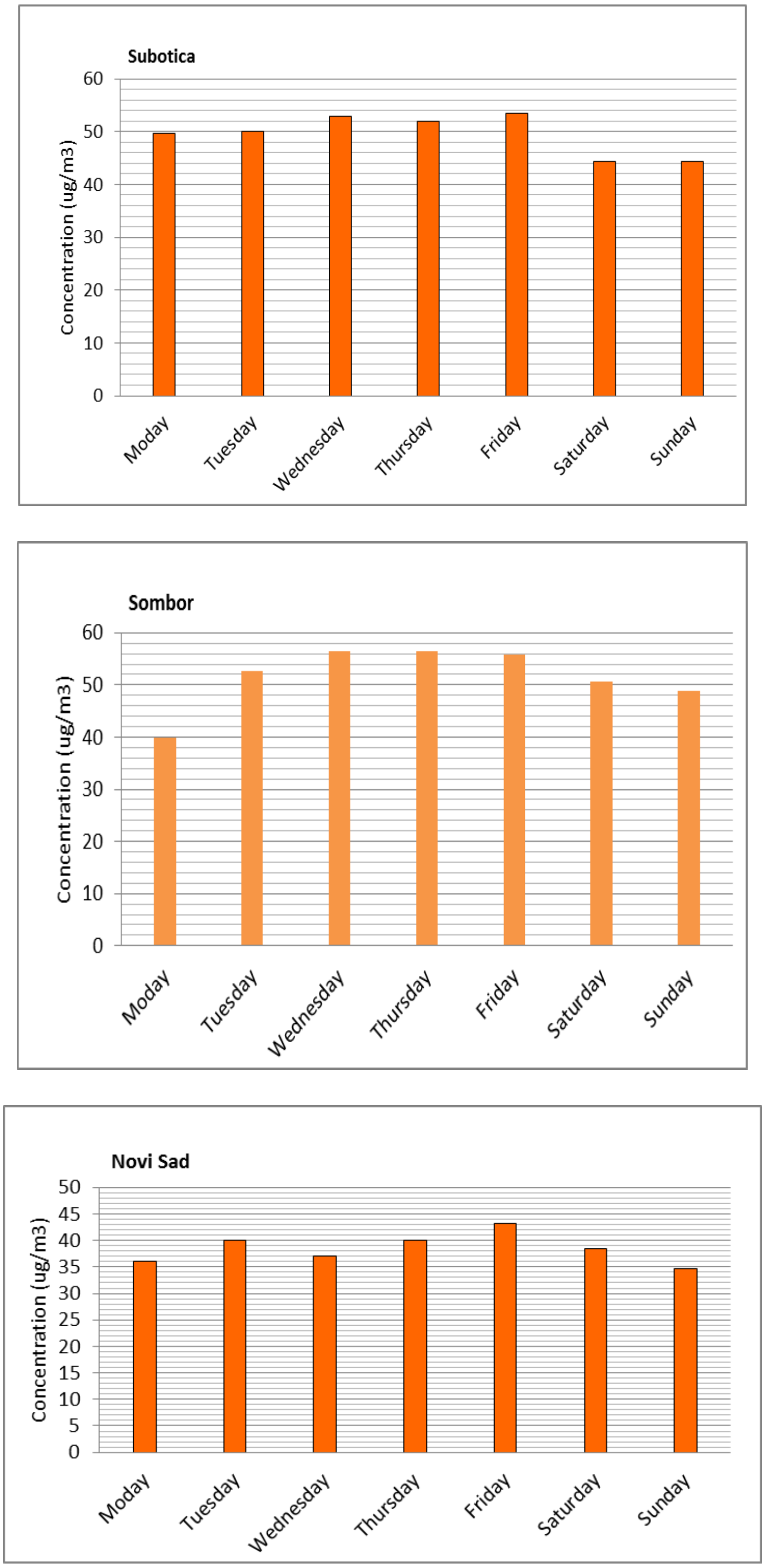


Figure 4.- Average PM10 concentration (µg/m3) during the week

CONCLUSION

Air pollution is recognized as one of the most important among major sustainability challenges. Man can live without food for days, without water for hours, but only few minutes without air. In average, man inhales about 15,000 liters of air daily. Although, the air is essential for life, exposure to air pollution can cause significant health problems. Pollutants present in the air inevitably affect the respiratory tract, since all air is filtered through the alveoli with the total area between 70 and 100 m^2.

This paper provides an analysis of concentration levels of suspended particles with a diameter smaller than 10 µm. Detailed analysis clearly shows significant impact of human activities on the concentration of PM_{10}.

For more extensive and comprehensive analysis of the traffic impact on ambient air quality, at a given micro locations, it is necessary to include next steps:

1. Performing correction factor for suspended particles concentration measured by different methods
2. Taking in consideration other parameters originating from traffic (NO_x) with significant contribution to air quality
3. Traffic Quantification and qualification
4. Analyzing of meteorological parameters which have an important role in air pollution distribution.

Information on air pollution originating from traffic, either the data that are obtained by measurements or modeling, as well as information about the propagation of this pollution are important starting point for planning effective measures to improve air quality in urban areas. That kind of information can be used by certain institutions in the urban planning, the traffic regime planning, and for forming warning system of the high pollution concentrations impact on public health.

REFERENCES

Bylow on air quality monitoring requirements (Official Gazette RS No11/10)

Fenger, J. (2009). Air pollution In The Last 50 Years – From Local To Global. *Atmospheric Environment,* Volume 43, Issue 1, p. 13-22

Low on air protection (Official Gazette RS No, 36/09)

Manual for TEOM analyser 1400A

Matthew J. Kiernan (2009). Book Investing in sustainable world: why GREEN is the new color of money on Wall Street/2009/AMACOM USA.

EIO Directive (97/101/EC) - Council Decision establishing a reciprocal exchange of information and data from networks and individula stations measuring ambient air pollution within the Member States

Ostro B., Chestnut, L. (March 1997). Assessing the Health Benefits of Reducing Particulate Metter Air Pollution in the United States. Office of Environmental Health hazard Assessment, California Environmental Protection Agency, Berkeley, California

Regulation on protection of Special Nature Reserve “Obedska Bara” (Official Gazette of RS, No.56/94, 81/08),

Regulation on protection of Special Nature Reserve “Deliblatska pescara” (Official Gazette of RS, No, 3/02)

World Bank, World Development Indicators 2003) (Washington, DC: 2003), same World watch calculation based on data. Pages 168-169.

www.eko.vojvodina.gov.sr

www.sepa.gov.rs

www.eea.europa.eu/soer: (EEA (2010) The European State and Outlook of the Environment Report 2010 - SOER 2010

MANAGEMENT OF SOLID URBAN WASTE

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„ECOLOGY OF URBAN AREAS“ 2011

A CITY AS URBAN TAXON OF THE BIOSPHERE AND PROBLEM OF “GARBAGE”

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ABSTRACT

A number of the environmental characteristics of the city as the special biospheric urbanized taxon, including important issues of inventory collection, recycling and the development of closed technological systems were analysed in this article.

Key words: biosphere, city, energy, garbage, man, nutritional, trace elements, urbanized taxon, wastes.

INTRODUCTION

Formation of a town as enclosed (alienated territory) to developed crafts known since antiquity. Under profitable conditions (the availability of adequate sources of food and energy) increased area of the city, absorbing the areas of land suitable for development. Currently, the city can be seen as urbanized taxon biosphere that consumes enormous amounts of water, food and energy (Fig. 1) and tending to a relative autonomy. The city as an ecosystem is significantly different from natural ecosystems [6, 12].

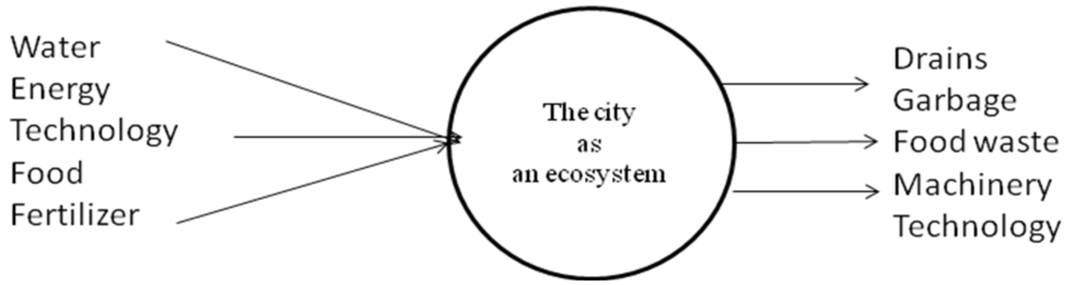

Figure 1. Incoming and outgoing flows of matter, energy and information to the city as urboecosystem

However, dependence of town on suppliers of energy and food is great. The desire of the city for independent functioning is relative, but it exists in relation to the presence of food processing. A city can have chicken farms, greenhouses, but this is insufficient to ensure urban food. As a megalopolis city often suffers from a lack of quality of air, water, greenery, and a modern fleet of personal use of the scale aggravates the ecological situation of the city. In addition, the manifestation of the epidemic in this metropolitan area is associated with greater risk for its inhabitants [1].

PROBLEM “HERBAGE” AND WASTE PRODUCTS

Functioning of the biosphere is always accompanied by processes of formation of detritus - excrement, dying and decay products of organisms that are best used in biogeochemical cycles. However, during the period of man-made transformation of the biosphere people establish and implement a habitat a lot of substances that negatively affect not only humans, but also on other organisms, accompanied by a decline of biodiversity and the blocking of some biosphere functions (Fig. 2). Basic kinds of pollution:

fertilizers, use of carbon and oil, use of atomic energy, the modern technologies of preparing food, wide application of detergents, dust or debris, biological and other waste, products of Industry and metallurgy, building materials, drugs.
This list is quite large, but in concentrated form, is primarily a production and consumption waste. Common questions technological evolution of the biosphere is closely related global problem of “garbage”, which is solved by the international community slowly.

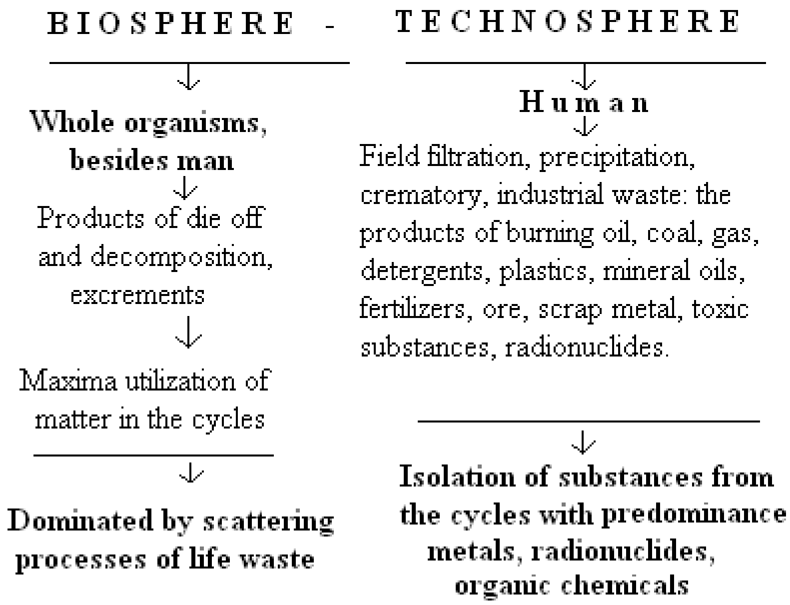

Figure 2. Some signs of urban and natural ecosystems

Waste production can be divided into: radioactive, medical, biological, construction, waste transport sector, industrial.

With regard to the identification, assessment and remediation of the ore and mining companies, there are numerous technology recycling dumps, heaps, tailings content, quarries, etc. At this stage, such local area in need of localization, accounting, periodic monitoring and transformation. It is necessary to identify the main types of waste and guidelines for their disposal.

THE PROBLEM OF POLLUTION AND ITS SOLUTIONS

By the early 1990’s, in Russia, there had been disposed about 70 % of the total amount of toxic industrial wastes of the Soviet Union, including all types of largest-volume wastes (used forming mixtures, slate processing wastes, oil slimes, galvanic slimes, oil wastes etc.). At that, over 1.6 billion tons of toxic industrial wastes had accumulated in Russia. Every year, this amount increased by 50 million tons, and only 20 % of it was recycled. Today, about 80 thousand types of chemical wastes are produced in the world at a total rate of about 300 million tons per year [14, 19].

New Yorkers throw away in the day, a total of about 24,000 tons of material. This mixture, consisting mainly of various junk, contain valuable metals, glass containers, suitable for further use, as well as waste paper, plastic and food waste, which are essential for fertilization. But along with them in this mixture contains an even greater number of hazardous waste: batteries, mercury, phosphorus, carbonates of fluorescent bulbs and toxic chemicals from household solvents, paints and fuses wood. A growing amount of waste and lack of recycling is typical of many cities.

Military actions make considerable contribution to the process of environmental pollution. As a result of World War II, thousands of tons of metals were piled on battlefields. The comparatively small-scale military action of NATO in Yugoslavia in 1999 resulted in the growth of consumption of such toxic elements as lead (Pb), cadmium (Cd), arsenic (As), mercury (Hg) and uranium (U) caused by air, water and soil pollution in Serbia, and by improper quality of imported foodstuffs or products supplied as humanitarian aid [3, 12, 13].

According to assessments of the RF State Commission for Ecology (Goskomekologia), the integral impact of military forces on the environment in peaceful time is comparable to the effects of one medium-size industry (about 4 % of the total effluent discharge and 1.2 % of atmospheric emissions). In the opinion of the Directorate for Ecology and Special Protection Facilities of the RF Ministry of Defense, actual emission and discharges of military sites (garrisons) are comparable to those of small and medium enterprises [19].

Particular concerns among civilization-related changes to the environment are caused by its pollution by industrial and household wastes. As has been mentioned above, the greatest risk is posed by different-type toxic substances.

In our opinion, a pollutant is a substance or a mixture of substances of technogenic or natural origin, which disturbs the cycles of migration of chemical elements and energy conversion and interferes with the functioning of ecosystems in general.

Pollution is a process of inflow and integration in the ecosystems of technogenic or natural substances in amounts toxic for the ecosystems or promoting formation of new dangerous compounds.

They can be classified according to the chemical structure, source, type of production, mechanism of affecting organisms, migration and transformation features.

In order to prevent environmental (soil, ground, water) contamination from taking an irreversible and catastrophic form, one needs to revise the strategy of nature utilization, and eliminate ways and sources of further pollution of the geological environment, on the one hand, and to develop and implement methods and technologies to suppress toxicity and clean up different constituents of the geological environment from such pollutants, on the other [15, 16].

Cleanup technologies are an intermediate step on the way of technosphere-to-noosphere transformation. These will be used until the mankind does not develop environmentally clean closed technologies.

One of the key tasks in this area is to develop recycling technologies. Disposal of toxic wastes is a forced practice of limited use. This potentially hazardous tradition should be replaced with waste reprocessing technologies, concentration, inactivation with secondary utilization in closed cycles. Wastes of different productions (effluent, tailings, slimes, non-utilizable waste, sewage tanks etc.) are products of imperfect technologies that need to be rejected as soon as possible and replaced with improved ones, including closed cycles [13-15, 18].

According to V.A.Korolev [14], three major methodical approaches can be used for preventing pollution. The first is to clean soils by direct removal of hazardous components through their withdrawal from an object, by cleaning or by other methods. The pollutants thus removed from the soil body need to be recycled outside the soil body. The second approach rests upon in situ detoxication, instead of removal, of a pollutant, directly in the soil body, for example, by its neutralization, decomposition (destruction), binding etc. The third approach is based on the construction around an anomaly of a shield to prevent further propagation of contamination (the Chernobyl’ “sarcophagus”) [16].

One also makes use of natural self-purification mechanisms. This approach rests upon the processes of abiotic and biotic transformation of chemical pollutants.

The following in situ processes can be used as applied to pollutants incorporated in solid-state rock (soil) or absorbed by it: 1) chemical neutralization + leaching (or dilution) + removing products together with solution; 2) treatment with desorbents (physical and chemical processes) + biodegradation + removing products together with solution; 3) in situ chemical or physical (thermal) hardening + biodegradation + constructing a shield; 4) thermal destruction + leaching + removing products together with solution, containing the polluted area and removing earth [10, 14, 15, 22, 23, 26].

The following chelation processes can be used, if a pollutant is in the liquid phase of the rock body: 1) evacuation (probably, with thinning) + water purification on the surface; 2) electrotreatment + evacuation + water purification on the surface; 3) chemical or physical and chemical neutralization (precipitation) + biodegradation + shield (or removing products with solution); 4) thermal destruction + biodegradation + shield (or removing products with solution).

If a pollutant is in the gas phase or it is an absorbed gas, then the following in situ processes can be used: 1) thermal treatment + vacuum extraction + shield; 2) biodegradation + evacuation + purging; 3) chemical or physical and chemical neutralization + purging (or evacuation) [14, 24]. In addition to the above purification processes, one needs to mention electrokinetics, which is widely used for purifying soils, phytostabilization and phytoextraction. As applied to soils, the inflow of heavy metals is corrected by means of appropriate fertilizers and additives [4, 10, 15, 24, 26].

A special and quite an independent problem is what should be done next with the pollutant. That is, the matter concerns recycling of final purification products or disposal of toxic substances withdrawn from the environment. They should not be simply stored in landfills, because this leads to secondary pollution of the environment. They should undergo industrial reprocessing, recycling or final decomposition into non-toxic compounds.

Thermal decomposition (incineration or pyrolisis as methods of recycling – reusing of resources).

First of all, there is a problem of “garbage”, or household wastes. Apparently, two principles need to be kept in mind at developing strategies for struggling against pollutants: 1) not to establish productions that disturb relatively natural biogeochemical cycles of chemical elements, 2) give preference to technologies with closed cycle and minimum interference with natural processes. In both cases, one should stay within the known migration cycles of substances, which maintain comfortable life of organisms and normal functioning of ecosystems.

The whole established system of commercial production needs to be restructured in order to make it non-waste or low-waste based on comprehensive recycling and to ensure environmentally safe and adequate level of waste disposal [17].

The volume of solid waste (MSW) in Moscow is made up of two streams: from housing and from public and commercial organizations and agencies (table 1). In quantitative terms, flows up from the housing stock - 1.9 million tons /year (60% of collected MSW), from public and commercial organizations and institutions - 1.2 million tons / year (40% of collected MSW).

Sanitation of the city of MSW is currently based on the following proposals: improving the system for collecting and transporting solid waste, the transition to two-stage removal of solid waste through the construction of garbage-processing plant, the introduction of industrial methods of processing solid waste based on the construction new garbage and incinerators factories and reconstruction of existing, the commissioning of new and restoration of existing solid waste landfills in accordance with modern environmental requirements [11].

Among the technologies used to correct microelementoses in humans, there should be mentioned development and application of numerous food additives. Unfortunately, in most cases, they are administered irrespective of daily consumption of macro- and microelements and without assessing their environmental status, which may lead to undesirable effects. In animal husbandry and veterinary, correction of mineral metabolism is more efficient, because the composition of fodder is known in most cases. Metal compounds, radionuclides and toxic substances are detoxicated by means of sodium thiosulfate, derivatives of pyrrolidone, humic acids, zeolites, pectines and various antidotes [5, 13, 14, 21]. However, in order to make timely decision on prescribing prophylactic or treatment procedures, special diagnosis techniques are needed, for example, diagnosis of microelementoses based on the chemical elemental composition of hair [9].

AREAS OF ENVIRONMENTAL STRESS

Areas of environmental stress or areas with special conditions of nature utilization and economic activity were designated formally because of actual technogenic transformation in the most part of Russia.

Table 1: Disposal of waste products of Moscow (according to the Department of Natural Resources and Environment) [11]

No	Name of the waste type, and company-processor	Adapted / adopted, t / year		
		1999	2000	2001
Total industrial waste recycled, including: - processed - handed over for processing outside of Moscow - buried at the landfill, “Salarevo”		1926707 301619(15%) 385088(20%) 1240000(65%)	1 601 888 337222(21%) 408666(25%) 856000(54%)	1 896 719 570922(30%) 80738(25%) 845059(45%)
1	Electroplating waste	306.75	357.64	514.41
2	Spent fluids and electrolytes	375.35	375.19	836.10
3	Mercury-containing waste	1297.13	1700.00	2005.00
4	Precipitate treatment facilities	6869.76	3182.20	8295.87
5	Petroleum waste	4328.50	5977.66	8751.06
6	Liquid organic wastes, including coolant	1899.05	1798.80	1615.00
7	Chlorinated wastes including perhloretilen	14.40	113.46	109.40
8	Sludge and paint waste	616.10	649.26	827.65
9	Oily rags, sawdust, paper and filters	841.95	1096.00	1230.90
10	Spent lead-acid battery battery ¬ nye	4000.00	6000.00	6465.54
11	Waste polyethylene	973.00	756.05	1384.32
12	Medications, medical waste, chemicals, cosmetics	120.11	179.30	212.92
13	Biological waste	3282.00	1911.00	340.80
14	Proven avtorezina and rubber products	6889.70	9063.00	9632.10
15	Window	21600.00	32850.00	35728.00
16	Fotowaste	325.10	756.72	985.60

17	Construction waste	226728.00	251600.00	465530.00
18	Wood waste	5640.00	1881.00	1036.00
19	Black metal?	15543.00	20046.00	25129.00
20	Colorful Scrap		1227.80	266.30
21	Metal-containing sludge and dust			25129.00

Disturbance of natural balance in most of Russia's territory, and, consequently, deterioration of health and living conditions of the population necessitated establishing a legal status of areas of environmental stress [19]. They differ in conditions and mechanism of origin, procedures of declaring their legal status, arrangement and practices for mitigating adverse effects of unfavorable conditions in the area. The ultimate aim of these practices is to ensure constitutional rights of every person for living in the ecologically safe favorable environment.

In compliance with the RF Law on Environmental Protection, parts of the territory of Russia, where economic and other activities cause stable negative changes in the environment that threaten human health, ecological systems and gene pool of plants and animals, are declared areas of environmental emergency (Article 58).

Territories with dramatic irreversible environmental changes that entailed considerable health deterioration, disturbance of natural equilibrium, damage to natural ecological systems, degradation of flora and fauna are declared areas of environmental disaster (Article 59).

According to the Water Code of the RF (Article 116), water bodies, their parts and drainage areas can be declared areas of environmental emergency and environmental disaster.

In compliance with the Forest Code (Article 46), assigning the above status to forest areas belongs to the jurisdiction of the RF.

Areas of environmental emergency are declared in accordance with governmental resolutions or decrees of the RF President based on statements of the state ecological inspection based on materials and data of area examination against environmental assessment criteria [1, 2, 19].

The Kuznetsk Basin in Kemerovo region and the cities of Nizhniy Tagil and Bratsk were declared areas of environmental emergency having passed the above state environmental assessment procedure, and a number of territories were included in the list of recovery and social and environmental rehabilitation [19].

Unfortunately, most part of a number of regions in Russia (northern territories, Eastern Siberia) proved to be insufficiently explored in terms of environmental safety, in spite of some radio-ecological and geochemical assessments made in some sea areas and continental taxons of the biosphere.

Environmental and health assessment is carried out according to the Criteria for Environmental Assessment of Territories to Reveal Areas of Environmental Emergency and Disaster [2].

Within the framework of the program "Environmental Safety of Russia", in 1993-1995, the Criteria were tested in Astrakhan, Irkutsk, Moscow, Perm' and Chelyabinsk regions, in the cities of Angarsk, Dzerzhinsk, Mednogorsk, Novocherkassk and Kirovo-Chepetsk, and in the republics of Sakha-Yakutia and Kalmykia. Relatively satisfactory, conflict, stressed, crisis and disaster territories with individual environmental problems (general water pollution, disturbed conditions, salinity etc.) were revealed [19]. Ranking the territories demonstrated the necessity of establishing through legislation, in addition to the areas of environmental crisis and disaster, of areas of environmental stress (areas of environmental threat), where adverse changes in the environment started to occur as a result of economic activity, and where prevention and prophylaxis actions need to be implemented. Taking this into account, the Law on Environmental Protection was correspondingly revised and supplemented.

Environmental threat is characterized by an integral value of risk: $R = p \times y$. Risk is determined as a product of the probability ‘p’ of adverse effects on the public, territory, population, objects of nature etc. caused by a source of environmental threat (polluted object of nature) and damage ‘y’ caused by these effects [19].

If necessary, one can determine the status of zones as follows: zones to be emptied or evacuated; zones where residents can stay, but have a right to leave, zones, where residents have social and economic privileges.

CONCLUSION

A new form of interaction between the society and nature is being established today; an involved legal, environmental and economic, and scientific and engineering problem arises: to ensure environmental safety. A new type of activity is emerging – protection of the population and territories from natural and technogenic emergencies.

The problem under consideration is closely related with the matters of Earth’s biosphere evolution. Development of the technosphere and increased amount of technogenesis products are finite, because they stimulate the development in the biosphere of a noosphere – the era of supremacy of intellect.

There is also a problem of disagreement between society and technology development. The higher level of technology development should correspond to a new stage of development of society and humans themselves in their interation with nature. Implementation of the noosphere concept does not remove the contradictions between the optimal level of society development and smart technologies. However, under the conditions of the noosphere, such contradictions will become predictable, they will be monitored and removed most promptly and with smallest energy and information expenses as against the conditions of the biosphere at the stage of early technogenesis.

Focusing attention on consequences of technogenesis, having negative impact on humans, one needs to mention positive aspects of the scientific and technical revolution. Making use of new energy sources, developing high-reproducibility breeds of animals and plants, getting into the space – these are results of man’s intellectual activity. Due to the scientific and technical revolution, many diseases in farm animals have been conquered and life expectancy of humans has increased [20].

To solve the problem of “garbage”and wastes should:

1. Conduct an inventory of waste, their systematization and environmental assessment.
2. In the environmental assessment of the territories occupied by industrial waste and its toxic components, use “The Criteria for assessing of the ecological status of territories”, developed under the National Russian Programme “Ecological Safety of Russia” [2]. Correct these criteria are in line with international approaches and provide the the Criteria by methodological guidance on their practical application.
3. To carry out quantitative evaluation of mineral components of waste production, including rare and dispersed chemical elements (rhenium, osmium, uranium, tantalum, niobium, cadmium, etc.).
4. Develop the technologies of detoxification of toxic waste, recycling and recovery of useful components.
5. In areas of storage of waste containing toxic concentrations of heavy metals, radioactive materials, pesticides and plastics, to conduct a comprehensive survey of the population and animals in order to diagnose possible pathologies and microelementoses, their prevention and treatment.
6. Actively promote a differentiated waste storage for recycling.

7. Develop technologies for processing waste and closed (“non-waste”) processes.
8. Improving the regulatory framework.

REFERENCES

Butorina M.V., Vorob’ev P.V., Dmitrieva A.P. et al. Engineering ecology and ecological management. M.: Logos, 2002. 528 ps. (in Russian).

Criteria of an assessment of ecological condition of territories for revealing zones of an extremal ecological situation or zones of ecological disaster. Moscow: Min. of ecol. and nat. res. of RF. 1992. 50 ps. (in Russian).

Djujic I., Djordjevic D., Djermanovic V.T., Djujic B.M. Dietary intakes of trace elements by residemts of Serbia two years after NATO operation "Merciful Angel" // Proceedings of 3rd International Symposium on trace elements in human: new perspectives. Athens, Greece, 2001, p. 263-280.

Dowson G., Mercer B. Rendering of toxiferous waste / translated by V.A. Ovcharenko. M.: Stroyizdat, 1996. 288 ps. (in Russian).

Ermakov V.V. Biological transformation of clororganic and mercury-containing pesticides: Abstract of diss. dr. biol. sciences. M., MVA, 1986. 34 ps. (in Russian).

Ermakov V.V. Technogenesis and biogeochemical evolution of taxons in the biosphere// Ecologica, 2005 .Vol. 9. No. 41. P. 3-12.

Ermakov V.V., Jovanovic L.N. Biodiversity and the biosphere technogenesis// Ecologica, 2010. Vol. 17, No 58. P. 77-85.

Ermakov V., Jovanovic L. Selenium deficiency as a consequence of human activity and its correction// Journal of Geochemical Explor., 2010. Vol. 107. P. 193-199.

Ermakov V.V., Tyutikov S.F. Geochemical ecology of animals. M: Nauka, 2008. 315 ps. (in Russian).

Hansen H.K., Ottosen L.M., Kleim B.K. et al. Electrodialytic remediation of soil polluted with heavy metals. Key parameters for optimization of the process // ICHEME Symposium Series. 1999, No. 145, p. 201-209.

Ishkov AG Implementation of the State Environmental Policy Waste Management in Moscow, Russia// Proceedings of the 4th Scientific-methodical seminar “Waste reduction program: the development and implementation”; on 24-25 February 2003.

Jovanovic L. Chemistry and Environmental Protection. Beograd, 2010. 315 ps.

Jovanovic L., Bajin D. Globalization of Environmental Problems// Ecologica, 2009. Vol. 54. P. 15-24.

Korolev V.A. Clearing of soils of pollutions. M: MAIK “Science/ Interperiodoka", 2001. 365 ps.(in Russian)

Korolev V.A., Ntkrasova M.A. Experimental researches of electrochemical migration of ions of metals in dispersed rocks// Geochemistry, 1998, № 12, p. 1277-1283 (in Russian).

Laverov N.P., Omel’yanenko B.I., Velichkin V.I. Geologic aspects of a problem of a burial of radioactive waste // Geoecology, 1994. № 6, p. 3-20 (in Russian).

Mayorov a E.I., Butuzov A.Ju. Ecology and environmental legislation of Moscow. M. UNITY. 2003.

Mukherjee A.B. Behavior of heavy metals and their remediation in metalloferous soils // Metals in the Environment (ed. by M.N.V. Prasad). Marcel Dekker, Inc., New Yourk-Basel, 2001, p. 433- 471.

Nikitin A.T., Stepanov C.A., Zabrodin Yu.M. et al. Ecology, nature protection and ecological safety (Ed. by V.I. Danilov-Danil’yan). M.: Publ. MNEPU, 1997. 744 ps.(in Russian).

Obukhova L.E.. Man and technological advance. M.: Nauka, 1977. 168 ps. (in Russian)

Riskulov A.K., Ermakov V.V. Veterinary-sanitarian aspects of a pollution of the environment by industrial lets // Control of the contents of pesticides and nitrates in soil, plants and in agricultural production. Frunze, 1989. P. 29-31 (in Russian).

Tyutyunova F.I. Hydrogeochemistry of technogeneses. M.:Nauka, 1987. 336 ps. (in Rusian).

Tomme M.F., Ksanfopulo O.I., Sementovskaya Y.M. A mineral composition of forages. M.: "Kolos", 1968. 350 ps. (in Russian).

24. Yeung A.T., Datla S. Fundamental formulation of electrokinetic extraction of contaminants from soil // Can. Geotech. J. 1995, Vol.32, No. 4, p. 569-583.

Zamana S.P., Ermakov V.V., Sokolov A.S.. Outlooks of usage of an element composition of a hair cover for diagnosticof microelementoses// Geochemical ecology and biogeochemical study of the taxons of the biosphere: Materials of 3rd Russian Biogeochemical School. Novosibirsk: Nauka, 2000. P. 153-154 (in Russian).

Zhinkin G.E. Electrochemical melioration of soils. M.: Nedra, 1963. 232 ps. (in Russian).

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TESTING THE FEATURES OF FLOATING ASH AND ITS POSSIBILE APPLICATION IN THE SYNTESIS OF A ZEOLITE TIPE 4A

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ABSTRACT

This paper will show results of surveys of floating ash and its use as raw material for obtaining the type 4A zeolite. Because of its characteristic pores in terms of size, and their active surface, zeolites represent a very useful material with a wide range of their application, and ion exchangers. Given that zeolite have great application we decided to synthesize zeolite 4A type of waste material (ash floating) why it was found that zeolites zeolites is synthesized from pure substances and holds a large amount of the components SiO_2 and Al_2O_3.Will be received low temperature synthesis of zeolites, the product obtained will be carried out structural and thermal tests.

Key words: Floating ash, zeolite, application.

INTRODUCTION

The rapid development of industrial productivity, increasing world population and expressed more requirements of the modern man who lives more comfortable and better day by day more face humanity in need of different purposes. Man as a part of nature, with is activity works and influences the natural eco-system with historical dimensions. By destroying the natural biocenosis, by depleting non-renewable natural resources (coal, oil, etc.) that are generated by thousands of years, consciously or unconsciously has deeply transformed the natural environment. Coal as a (non-renewable) mineral resource will always be necessary essential to as man the industrial productivity of each country use it to produce electricity. Landfills (burning coal) or floating ash is a fertile ground for environmental problems. Each year in the world the thermal power plants produce large amounts of coal ash. The world total amount of coal ash is about 500 million tons annuals. And this amount is predicted to be greater. This large amount released can cover the bottom and degrade the environment with ecological consequences that are complex and interactive.The of waste material (coal ash) is a global problem and the question related to the environment is expected to gain importance worldwide, especially in small countries. The challenge to be focused on is to find the best solution and best technologies for recycling the coal ash. (Amrhein, 1996) previous attempts to use fly ash as a soil amendment have had limited success because of its low nutrient value, low cation exchange capacity (CEC), and elevated levels of toxic trace elements.

The technique for recycling coal ash could be used as the main raw material for the synthesis of zeolite 4A type that gets as much attention over the last decade and the present, according to physical properties waste materials (coal ash) represents a solid powder material whose color varies, but usually greyish due to impurities present. In terms of chemical composition due to the high content of components of SiO_2 and Al_2O_3 it represents suitable raw material for the synthesis of zeolite 4A. Because of its characteristic pores in terms of size, and their active surface, zeolite represent a very useful material with a wide range of their application as it is used as ion exchanger, as a molecular sieve, adsorbent of various gases and as a catalyst.

MATERIAL AND METHOD

Levitating solid powdery ash represents a material whose color varies, but usually is greyish due to present impurities.

Due to the high content of components of SiO_2 and Al_2O_3, it represents a suitable raw material for the synthesis of zeolite 4A. Zeolites geology is introduced for more than 250 years, but in practice it has been emerging as a new in the last 30 years. Regardless of this it quickly occupies an important place among other of practical materials. (Cekova,1983).

Natural zeolites are produced in response to volcanic ash layers of rocks with alkaline groundwater. Also zeolites crystallize in conditions of deposition in shallow water pools for the period of thousands or millions of years. Natural zeolites are usually dirty, i.e. they are contaminated to varying degrees by other minerals, metals, quartz or other zeolites, which mostly are not used for commercial purposes**.** (Dimitrievski, 2010).

Zeolites can be extracted by conventional mining methods from open pits. Dug ore is processed further by breaking, drying and milling (grinding) after they are classified according to the size of the grains (particles) and packing. Today, world annual production of natural zeolite is 4 million tons. The largest suppliers of natural zeolites are located in Asia, Australia and Europe. The first experimental work and knowledge of zeolites are made of natural minerals. By examining the properties of natural zeolites are concerned RM Barer and his associates, many of the works concerning the synthesis of zeolite (Barer, 1978).

The methods for the examination of the starting raw material **-** floating ash and the product obtained type of zeolite 4A applied chemical, structural and thermal methods. Laboratory studies were performed in the laboratory of the secondary school " Marie Sklodowska - Curie" Chemical analysis of levitating dust test medium was made up to 380 K. The amount of SiO_2 is determined by alkali fusion). Alkali oxides (NaOH) with certain flame photometry and volumetric method (Dimeski 1978).

Methods that are applied for testing: x-ray structural analysis and infra red spectroscopy. X-ray analysis is applied to identify the minerals based on the fact that every substance has a distinctive crystalline structure and gives a certain image of diffraction (standard) commercial type 4A zeolite product of the firm VEB COMBINAT BITERFELD of the test material which can determine the unknown mineral. Differential **-** thermal analysis provides an opportunity to determine the temperature intervals that occur during thermal reactions in the test material if continuous and gradually are heated to high temperatures, and also provides general character and intensity of these reactions. The same analysis is applied by (Znu, 2011) in his research.

The largest increase has noticed (Hedvall, 1966), where the reaction capability where a crossing has a modification in another.

The table no. 1 shows the analysis of raw material (floating ash) expressed in percentages.

Table. 1 Chemical composition of floating ash

Substance	Percentage (%)
SiO_2	52,36
Al_2O_3	23,92
Fe_2O_3	7,91
CaO	7,52
MgO	2,32
Na_2O	0,90
K_2O	1,80
SO_3	1,20
Loss of burning	1,90
Total	99,88

In its composition, the levitating dust contains quartz, mullit, feldspar, anhydrite and hematite. Diffraction listed minerals are characterized by appropriate reflexes corner in the appropriate area. Quartz is marked with Q, with Mullit E Feldspar with F, Anhydrite A, and with Hematite H. Figure 1.

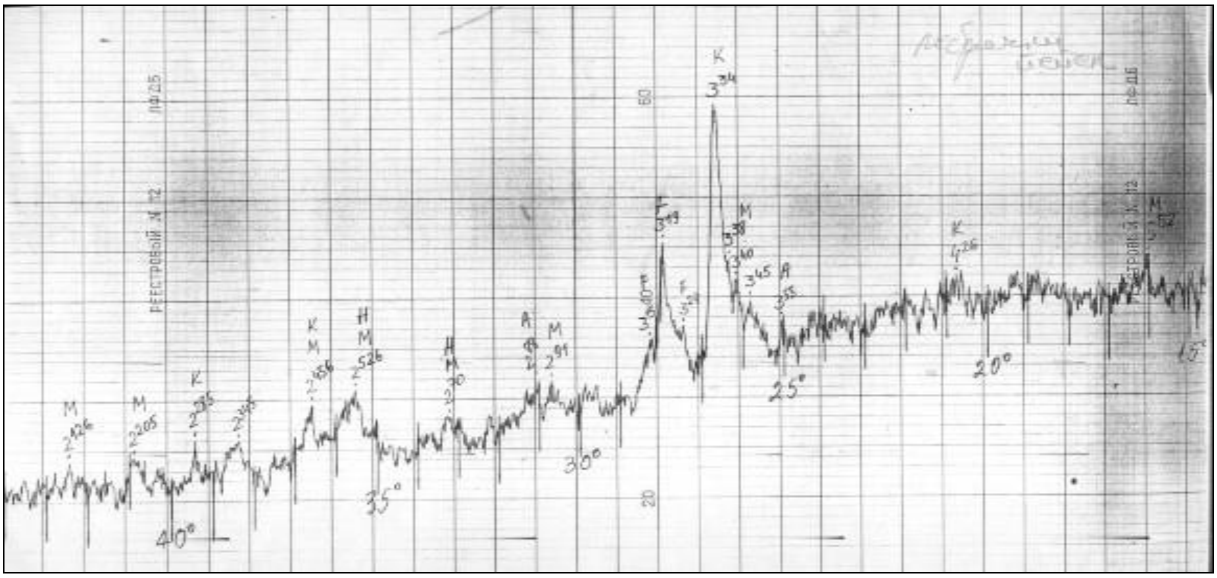

Figure 1. Diffraction of floating ash

The IR spectrum of flowing ash is characterized by similar strips from 1200 to 1000 sm -first The IR spectrum of floating ash phenomenal characteristic bands in the region 1200 to 1000 sm^{-1} so maximum 1000 sm^{-1} that is characteristic of Si (Al) - O connection in the region 3500-3400 sm^{-1} . The hidrooksility tapes come from groups that contain components flowing into ashes.

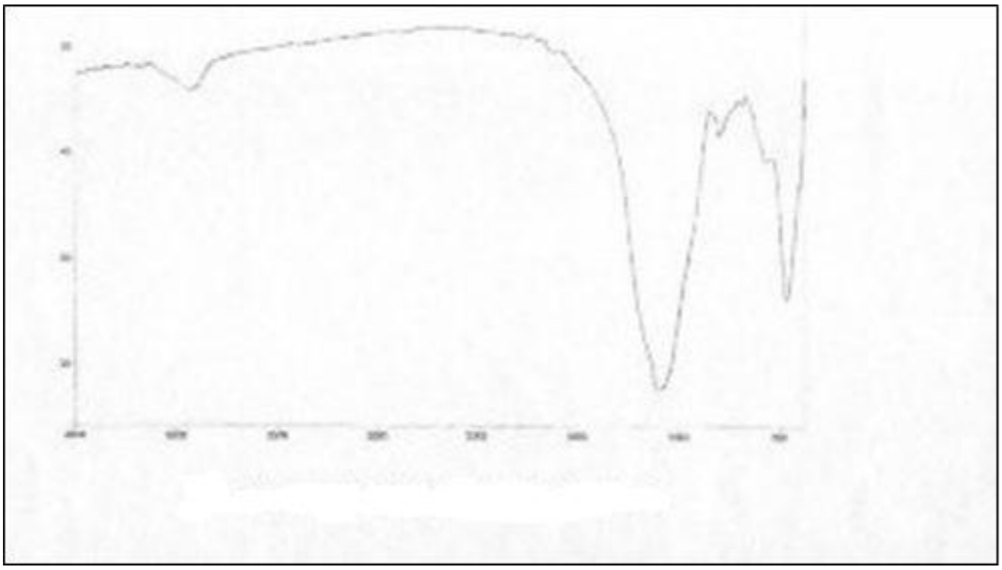

Figure 2. IR spectrum of floating ash

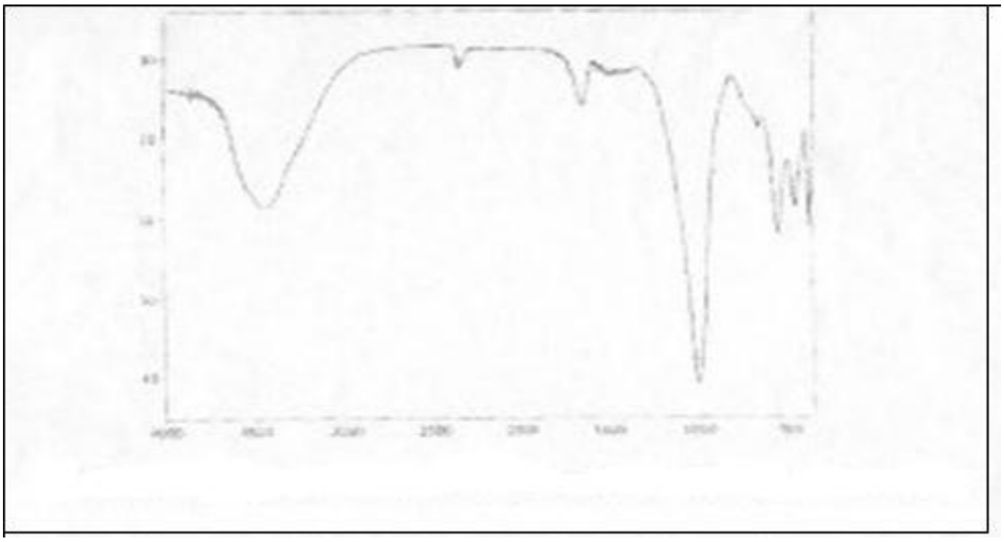

Figure 3. IR spectrum of zeolite obtained from the floating ash

In general, the synthesis of zeolites consists of preparing aluminosilicate part (hydrogel), crystallization of the hydrogel, washing and separation of the crystals and drying. The most difficulty task in the synthesis of zeolites is obtaining homogeneous crystals. Mon composition in structure and size. Successful resolution of this task depends on the conduct and strict adherence conditions for synthesis. For performing the synthesis at low temperature, we need the following materials: Components of floating ash SiO_2, Al_2O_3 Components sodium aluminates ($NaAlO_2$) floating ash Components metal cation sodium hydroxide (NaOH) floating ash component hydratation water. Low temperature synthesis of molecular sieves type 4A is performed in water suspension; glass reactor equipped with stirrer and a thermostat fan. Components are taken in such a relationship to provide moll relationship zeolite type 4A. The calculated amounts of sodium aluminates, sodium hydroxide and water, and the rest as a starting raw material for the synthesis of zeolite type 4A mixed vigorously about 1 minute, then the mixtures are left to age 24 hours at room temperature. The process of crystallization is performed in the same reactor thermostat with temperature deviations ± 2 K. Crystallization temperature ranged of 368 K to 370 K.

Crystallizations are performed during 6 hours. After the crystallization reaction mixture is filtered hot under vacuum pump and evaporated with distilled water to pH 9^{th}.

The final products are dry at a temperature of 393 K. The obtained products under defined conditions of synthesis have been identified by structural analysis. Laboratory equipment needed necessary for or product zeolites, is similar to machines and appliances be used in industry for the synthesis of zeolite from waste material (ash floating). We need the following accessories: reactor (a glass flask with round bottom or Erlenmeyer), reverse fan, magnetic stirrer with heater, funnel, filter paper and dryer. There are many ways for the synthesis of zeolite 4A. Which method for the synthesis of zeolites will be applied depends on the type and composition of the starting components. The most commonly applied methods in the synthesis of zeolite 4A are: Treatment of natural or synthetic and glass material with a solution of alkaline hydroxide. Treatment of solid materials that contain SiO_2 aluminums with alkaline solutions. Crystallization of the gels obtained by the interaction of silicate solutions or aluminatni. The synthesis of zeolite 4A from floating ash as a carrier of the major components (SiO2 and Al203) apply the second way TS treatment of solid materials that contain SiO_2 aluminatni with alkaline solutions.

DISCUSSION

The synthesis of zeolites needs strict adherence to operating parameters and conditions to obtain desired material. Any derogation from the set parameters and conditions can affect the quality of the zeolite. That s why after the synthesis, tests on chemical composition and structures of the resulting material are done. Sufficient quality for analysis provides two reliable and accurate methods. In this case examination of the type 4A zeolite, synthesized from waste material (ash floating) applies two comparative methods: IR - spectroscopy and X-ray diffraction.

Comparison is made between the IR spectrum diffracts gram the synthesized zeolite 4A and diffracts gram IR spectrum of commercial zeolite 4A from "Halle" (Germany) which takes in 100 % zeolite. Obtained crystal product is compared with the commercial product. Cristal is calculated using the method whereby X-ray calculated surface sun reflex the characteristic distance d - that the type of zeolite 4A are: (1,226 nm); (0,866); (0,707); (0,582); (0,427); (0,367) ; (0,369); (0,339); (0,327); (0,298); (0,290); (0,274); (0,268); (0,262 nm). The results are compared with data given in the literature thus obtained assigning diffracts gram the product of the type 4A zeolite.

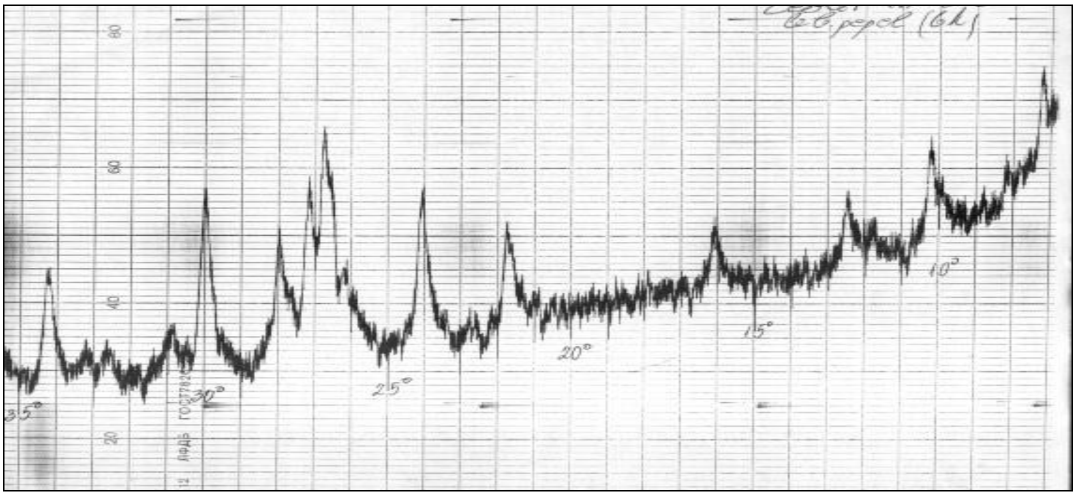

Figure 4. Diffracts gram of zeolite 4A from the floating ash

Bar manifested in the IR spectrum region from 3600-3400 sm-1 with a maximum of over 3500 is result from to vibrations of OH groups from water, and 1655 cm 3 e result of molecular water. In the area of 1300 to 400 sm3 appear vibrations of Si (Al) O features at 1000 cm zeolite -1 e manifested asymmetric, and valence vibration, of 670 and 555 cm-1 appear valence vibrations that result from dual 4 Article ring (D4 R) deformational and vibration to 464 cm -1 of Si (Al) O.

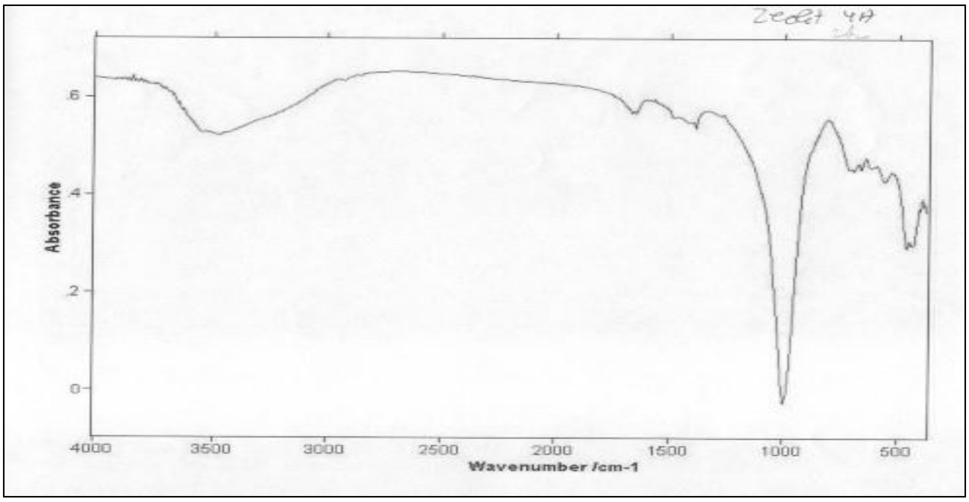

Figure 5. Infrared (IR) spectrum of products obtained from 2 hours

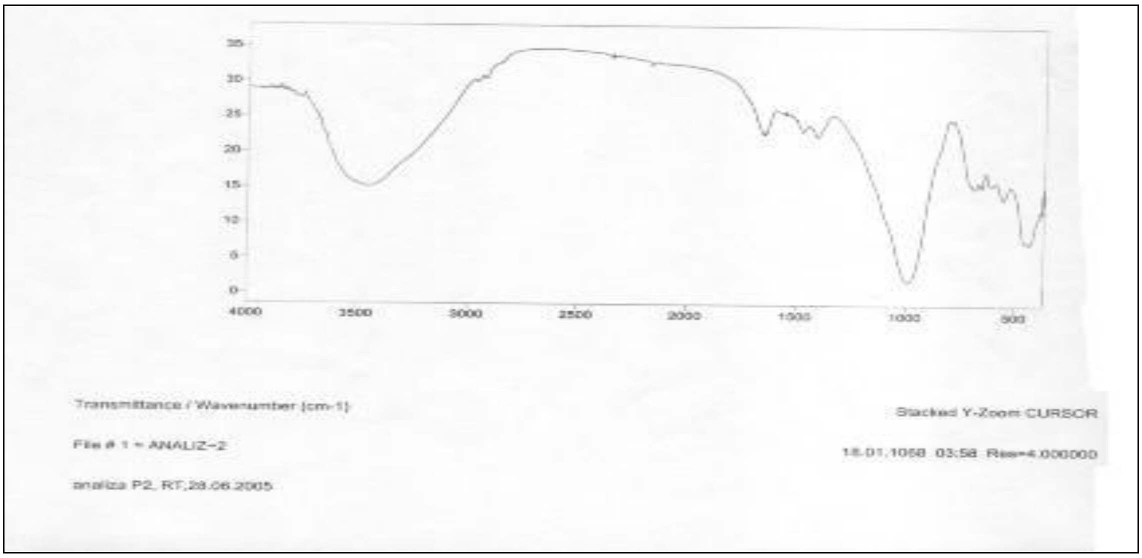

Figure 6. IR spectrum obtained from the floating ash zeolite, after 4 hours

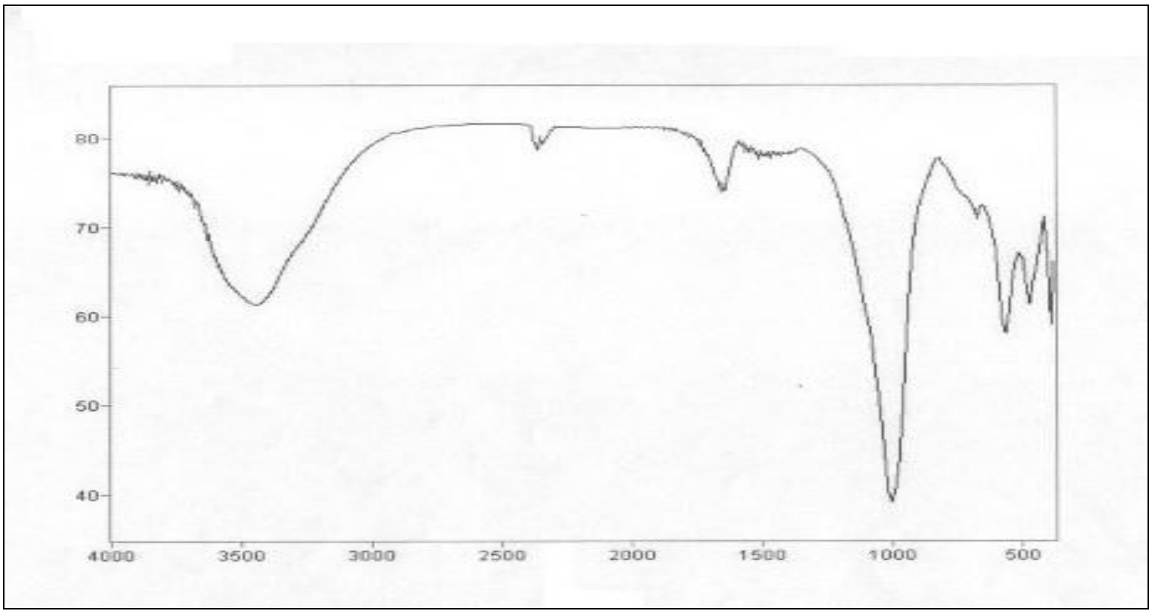

Figure 7. IR spectrum of zeolite obtained from the floating ash after 6 hours

CONCLUSION

Based on the tests and results, it can be concluded that, the object of study is the synthesis of zeolite type 4A from waste material - floating ash and examination of its features: Coal (levitating) ash physical properties presented by powder solid material whose color varies, but usually greyish due to impurities present. In terms of chemical composition due to the high content of components of SiO_2 and Al_2O_3 it represents a suitable raw material for the synthesis of zeolite 4A. Synthesis from zeolites of waste materials contributes to reducing the waste generated by industry, which uses as raw solid fuels, which avoids the use of natural resources. To produce these aluminosilicate while preserving the environment and increasing economic viability and profitability of the technological process.

REFERENCES

Amrhein, C., Haghnia, G.H., Haghnia, G.H., Kim, T.S., Mosher, P.A., Gagajena, R.C., Amanios, T., De La Torre, L. (1996): Environmental Science and Technology, 30 (3), pp. 735-742.

Barer, R.M. (1978): Zeolites and Clay Minerals as Sorbent and Molecular Sieves, Academic Press, New York.

Dimitrievski, D. (2010): Removal of nickel with absorption of natural and synthesized zeolites from waters of different origin. University of Cyril and Methodius in Skopje. Doctoral dissertation. pp. 1-103.

Dimeski, M. (1978): Practukum po kvantitativna nemiska analiza (Gravimetrija –volumetrija), Skopje.

Цекова, Б. (1983): Синтеза на зеолит од тип 4А поаѓаќи од остатоците по лужење на алунит од алунитисан туф. Универзитет Св. Кирил и Методиј во Скопје. Центар за математичко-технички науки Скопје. стр. 1-134.

Hedvall, J.A. (1966): Solidi state chemistry, whence where, writer, Elsevier publishing Co. Amsterdam, London, New York.

Znu, Y., Chang, Z., Pang, J., Xiong,C. (2011): Synthesis of Zeolite 4A from kaolin and bauxite by alkaline fusion at low temperature. Materials science forum. Volume 685, pages 298-306.

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WOOD BIOMASS' ANAEROBIC FERMENTATION, SOURCE FOR RENEWABLE AND SUSTAINABLE ENERGY

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ABSTRACT

Romania, as a European Union member state has a high biomass energy potential, estimated at some 7.594 million tons / year (318 PJ / year = 318 • 105 J / year), representing almost 19 % of the total consumption of primary resources in 2000. Potential reserves are wood waste, agricultural waste (animal and vegetable),and household waste and energy crops. This study proposes to highlight specific parameters for two varieties of woody biomass plant of origin, both in terms of determining some of their physicochemical characteristics and in terms of behaviour along the anaerobic fermentation process, which has as a result the obtaining of biogas.

The two varieties are linden sawdust and beech sawdust respectively, and the paper will highlight the main parameters of the process variation, meaning temperature, pH and the pressure values that are correlated with the parameters obtained previously during measurements conducted on a pilot plant that is located in the Multifunctional Laboratory of the Mechanical Engineering Faculty from „Politehnica" University of Timişoara (http://energieregen.mec.upt.ro/)

Key words: short rotation plantation (coppice) SRC, biomass residues, biogas, anaerobic fermentation

INTRODUCTION

The interest in using renewable energy resources increases more and more in the past decades. With exception of hydroelectricity and nuclear energy, the major part of all energy is produced from petroleum, charcoal and natural gas. However, these sources are limited, and will be exhausted by the end of this century (Popescu, 2009). Analyzing the existing estimates, it is noted that very short time remains until the exhaustion of existing resources, at least for oil and natural gas, which require the finding of immediate and efficient solutions to replace of energy witch is being produced (Cioabla, Ionel, 2010). Biomass is a renewable fuel that is discharged simultaneously by burning heat and delivers an amount of CO_2 equal to that consumed in its genesis. It is expected that biomass will play a major role in replacing fossil fuels contributing to a great extent at the use of renewable resources by the year 2010 (Demirel, Scherer, 2008).

Technically speaking, energy plantation (short rotation plantations or coppice) means growing select species of trees and shrubs which are harvestable in a comparably shorter time and are specifically meant for fuelling energy applications. The short rotation fuel wood may be used either directly in wood burning stoves and boilers or processed into methanol, ethanol and biogas. These plantations help provide wood either for cooking in homes or for industrial use, so as to satisfy local energy needs in a centralised or decentralised manner. The energy plantations provide almost inexhaustible renewable sources (with total time constant of 3-15 even 20 years only for each cycle) of energy which are essentially local and independent of unreliable and finite sources of fuel. The attractive features of energy plantations are: (a) heat content (low calorific value) of wood is similar to that of coal, even higher, when comparing to Romanian Lignite (b) wood is low in sulphur and not likely to pollute the atmosphere, (c) ash from burnt wood is a valuable fertiliser, (d) utilisation of erosion prone land for raising these plantations helps to reduce wind and water erosion, thereby minimising hazards from floods, siltation, and loss of nitrogen and minerals from soil and (e) help in rural employment generation - it is estimated that an hectare of energy plantation is estimated to provide employment for at least seven persons regularly. Selection of multipurpose species provides a number of by-products like oils, organic compounds, fruits, edible leaves, forage for livestock, etc. In view of getting maximum biomass, sustainable de-forestation and forest management systems will have to be developed. These must include social forestry, silviculture (short-rotation forestry) tree-use systems, coppicing system, drought, salt-, pollutant - resistant plantations and high density energy plantations (HDEP). HDEP is the practice of planting trees at close spacing. This leads to rapid growth of trees due to struggle for survival. It provides quick and high returns, and opportunities for permanent income and employment.

Silviculture energy farms employ techniques more similar to agriculture than forestry. The chief objective of energy plantation is to produce biomass from the selected trees and shrub species in the shortest possible time (generally 5-10 yrs) and at the minimal cost, so as to satisfy local energy needs in the decentralized manner. This would certainly relieve the pressure on the consumption of fossil fuel like kerosene and prevent the destruction of plant cover which is one of the primary components of the life support system (Khoshoo, 1988).

Therefore, annual plants should be grown to meet the demand of energy. Keeping in view the climatic factors, plantation of deciduous trees should be encouraged, as their growth is faster than the coniferous ones. The species to be planted should have the following characters: *(i)* fast growth, *(ii)* stress resistance, *(iii)* less palatable to cattle and other animals, *(iv)* early propagable, *(v)* high caloric value, *(vi)* absence of deleterious volatiles when smokes come out, *(vii)* high yield of biomass, and *(viii)* disease/pest resistant.

Biogas is the combustible gas produced by the anaerobic digestion of organic material, e.g. animal manure, human excreta, kitchen remains, straws and leaves through the action of micro-organisms. Biogas is primarily composed of methane (CH_4) and carbon dioxide (CO_2), with smaller amounts of carbon monoxide (CO), hydrogen sulphide (H_2S), ammonia (NH_3), nitrogen (N_2) and oxygen (O_2) (Mateescu, 2008).

In 1776, for the first time, the Italian Physicist, Volta, demonstrated methane in the marsh gas, generated from organic matter in bottom sediments of ponds and streams. Under anaerobic conditions, the organic materials are converted through microbiological reactions into gases (fuel) and organic fertilizer (sludge). The mixture of gases is composed of 63 % by volume methane, 30 % by volume CO_2. 4 % by volume nitrogen and 1 % by volume hydrogen sulphide and traces of hydrogen, oxygen and carbon monoxide. Methane is the main constituent of biogas. It is also referred to as bio fuels, sewerage gas, Klar gas, sludge gas, will-o-the wisp of marsh lands, fool's fire, *gobar* gas (cow dung gas), bio energy and fuel of the future (da Rosa, 2005). About 90 % of energy of substrate is retained in methane. Biogas is used for cooking and lighting purposes in rural sector. It is devoid of smell and burns with a blue flame without smoke. But promising technologies are supposed to use wood from short rotation plantations for controlled and centralised energy supply, such as cogeneration. The calorific value of biogas is equal to that of half litter of diesel oil (6 kWh/m^3_N).

Each year some 590-880 million tons of methane are released worldwide into the atmosphere through microbial activity. About 90 % of the emitted methane derives from biogenic sources, i.e. from the decomposition of biomass. The remainder is of fossil origin (e.g. petrochemical processes). In the northern hemisphere, the present tropospheric methane concentration amounts to about 1.65 ppm (parts per million).

Anaerobic digestion is also a key technology for the treatment of large volumes of bio-waste generated in industrialized countries (Bagi et. al, 2007).

By 2007, the German Greens (Grüne) commissioned a report on the potential of biogas in Europe. The Öko-Instituts and the Institute für Energetik in Leipzig carried out the study and came to some startling conclusions: Germany alone can produce more biogas by 2020 than all of the EU's current natural gas imports from Russia.

The growing interest in the gaseous bio fuel can be easily explained: it can be produced in a decentralised manner, it is highly efficient - yielding more than twice as much energy per hectare of energy crops than ethanol from similar crops - and it can be obtained in a straightforward way from a large variety of biomass resources (organic waste, manure, dedicated energy crops). What is more, the fuel has two highly efficient uses: as a gas for compressed natural gas (CNG) - capable vehicles (taking you twice around the world on a hectare's worth of biogas) as well as a fuel that can be used for the cogeneration of power and heat.

Related to obtaining biogas from waste biomass in Figure 1 is presented the biogas production in Europe, observing that most developed countries in this regard are France, Germany, Italy, Britain and Spain, while Denmark and Sweden do not put as much emphasis on the use of biogas, these countries using other types of renewable energy (wind, solar).

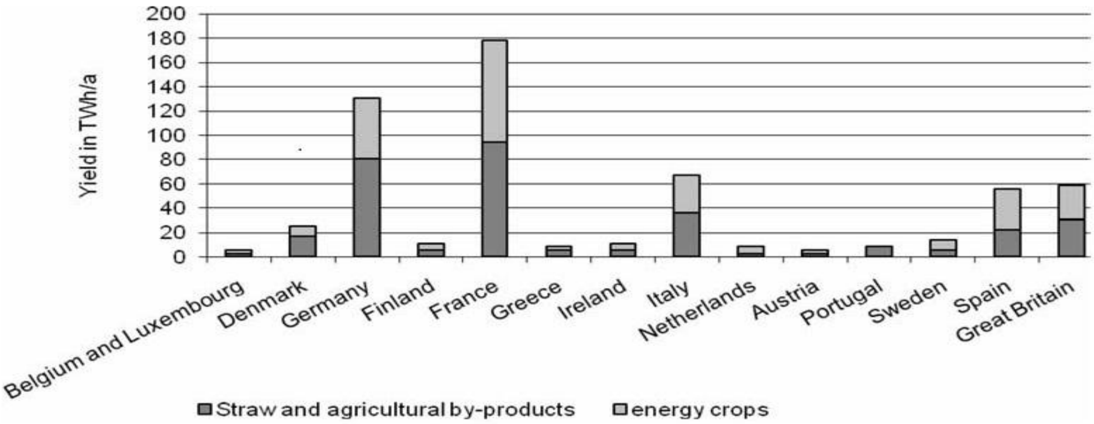

Figure 1. Biogas production across European countries (Deublein, Steinhauser, 2008)

In Romania there are not in use today any biogas plants for vegetable waste (cellulose) in the absence of technology, not the raw material that is available in considerable quantities. The amount of heat resulting from energy recovery of biomass in Romania has different weights in the balance of primary resources, depending on the type of waste used, or intended final consumption. Thus, 54% of heat generated from biomass is obtained from the combustion of forest residues. Also 89% of housing necessary heating and food preparation is considered to be the result of consumption of vegetal waste in rural areas (Deublein, Steinhauser, 2008). Related with the different types of vegetal biomass, agricultural waste is the second most common form of waste and includes waste from the raising of animals and the harvesting and processing of crops and trees (Ionel, 2010).

TECHNOLOGY

Anaerobic digestion of organic matter and production of methane is based on A-hydrolytic and fermentative bacteria; B-acetogenic bacteria (I-acetogcnic dehydrogenation by proton reducing acetogenic bacteria; II-acetogenic hydrogenation by acetogenic bacteria); C-methanogenesis by acetoclastic methanogens *(i.e.* acetate respiratory bacteria) (III), and hydrogen oxidizing methanogens (IV) (Figure 2)

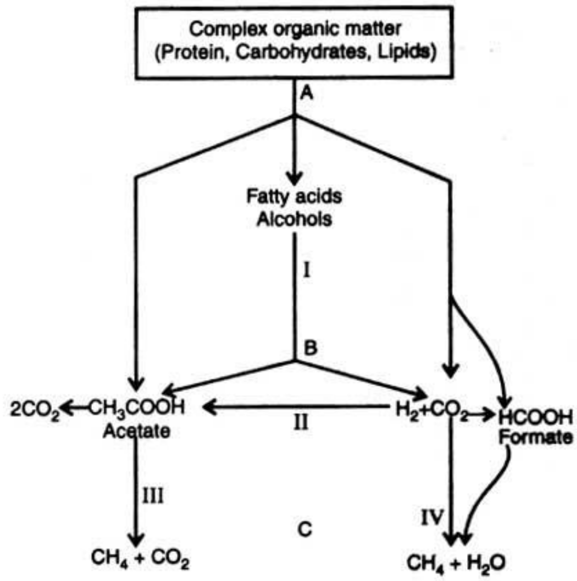

Figure 2. Production of biogas from complex organic matter

According to Ed Burton, the 'chunkettes', once dried (less than 10% moisture), are placed into Ed's homemade gasifier based on similar devices used in WWII to power cars. The gasifier is composed of two sections, The upper A section, (a modified garbage can) holds the dried wood 'chunkettes' and funnels them down the burn zone. The lower B section is divided in two. At the very bottom is a propane burner which is used to start the wood burning. There is also an access panel for ash removal. The upper B section features a recessed container cavity extending down into the burner space. The 'chunkettes' falling into the recessed container cavity are slowly “roasted” consuming all available oxygen in the process. Once oxygen has been consumed, the remaining gasses, rich in carbon monoxide, methane and hydrogen exit the furnace and conduct the produced gases to the 'bio-nox' gas cleanup box. Contrary to perception, smoke is not released from the open top of the furnace as you might imagine. In operation a vacuum draw is exerted by an engine, which keeps gasses flowing in one direction.

Biogas made from grass, straw, wood and leaves – this is currently only possible for very young grass and a degree of degradation of only slightly above 50% is currently achievable. On the other hand, wood and leaves are classified as not fermentable. Maxbiogas technology allows for a near complete fermentation of plant material. A comparison of biogas yields with und without (bp) maxbiogas technology is shown in the table 1.

Table 1: Comparison of biogas yields with und without (bp) maxbiogas technology [according Maxbiogas company]

Substrates for the bp	bp Nm³/t oTS	bp+LX-plant Nm³/t oTS	Substrates for the bp	bp Nm³/t oTS	bp+LX-plant Nm³/t oTS
Crop straw	250 - 370	~ 690	Maize (whole plant)	570 - 600	~ 880
Leaves	0 - 300	~ 700	Land conserva-tion grass	130	~ 650
Forrest wood residues	0	~ 600	Nawaro digestate	0	700

Maxbiogas technology is based on known processes from the paper industry. In this processes lignin is separated from cellulose (Figure 3). The main innovation of the maxbiogas process is based on the adaptation to the general thermal conditions of biogas plants as well as the recovery of the hemicelluloses. Processes which originally needed 150 bar and 200°C are now realised at 70°C and at normal pressure. This means that in the maxbiogas process no additional thermal energy is required beside the waste heat from power generation or from gas purification. The easiest application is the pre-treatment of biogas digestate. The solid parts of the digestate are mainly composed of cellulose und hemicelluloses which were not available for biogas production. The maxbiogas LX-plant pre-treats the digestate in such a way that it is transformed almost completely into biogas in the biogas plant fermenter. The energy used by the maxbiogas process is supplied by the power generation or by the gas purification of the biogas plant.

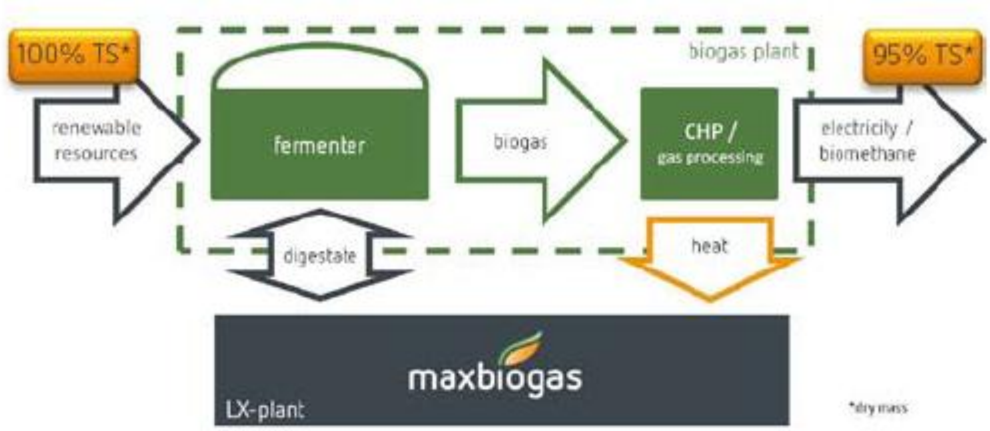

Figure 3. Schematics of the processes lignin separated from cellulose

Another pilot installation used for obtaining biogas from biomass (wood) through anaerobic fermentation which is built at the Unconventional Energies Laboratory at Politehnica University of Timisoara is presented in Figure 4.

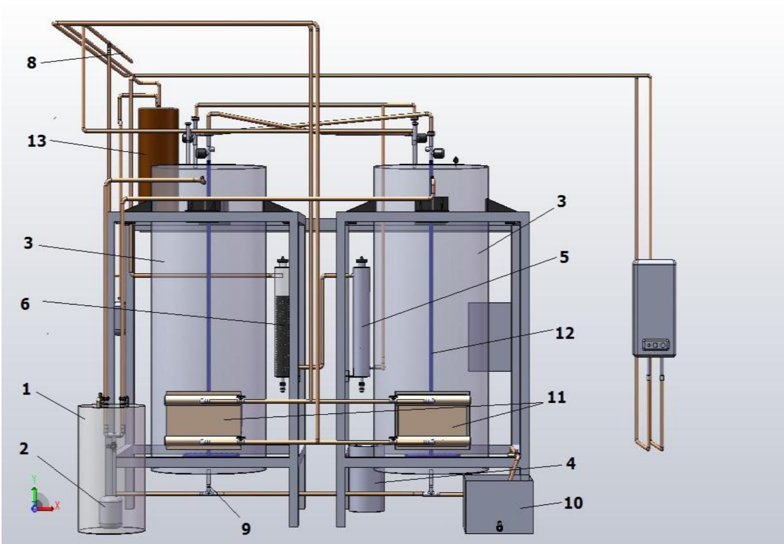

Figure 4. Principle scheme for the pilot installation used for obtaining biogas from biomass (Cioabla, 2009)

The Biogas pilot plant components presented by Figure 3 are: 1 – preparation tank, 2 – pump, 3 – fermentation reactors, 4 – correction agent tank, 5 - filter for retaining the H_2S, 6 - system used for retaining CO_2. 7 - adjacent system for CO_2 desorption and compression, 8 – consumer , 9 - gravimetric system, 10 – system for neutralizing the resulting liquid, 11 – heating system, 12 - bubbling system, 13 - small tank for biogas samples. Also, inside of each reservoir there is a bubbling system for assuring a good homogenization of the used material suspension.

From the biomass deposit, the used material is passed through a mill, and then it's sent to the tank where the preparation of the suspension of biomass is made (1). the biomass suspension is transported by means of the pump (2), and introduced into the fermentation reactors (3). the correction agent tank for the ph value assures, through the control system, the conditions for the process of anaerobic fermentation. the resulted biogas is passed through a filter for retaining the h_2s (5). passing through a desorbtion system the co_2 is retained up to 90 % by volume (6), thus the quality of the biogas is considerably improved. further, its compression in the adjacent system (7) occurs. finally the purified biogas is sent to a consumer (8) or evacuated in vessels or appropriate structure, as it is possible. the used material is discharged through the means of a gravimetric system (9), and the solid material is retained for being dried, using normally the natural drying. following it is sent to a compost deposit for being used as a soil fertilizer. the compost is also a very good combustion matter, subject to new energy recovery. a part of the resulting liquid is neutralized in same cases in the system (10) and sent to the sewerage network or, in other schemes, it is transported by the recirculation pump (2) from the suspension preparation tank (1). the fermentation reactors are heated with thermostatic control, by using energy delivered from the system (11). for the homogenization of the suspension one uses a bubbling system (12), realized from polypropylene pipes, in order to avoid the possible corrosion. also, for depositing small quantities of biogas of the purpose of analyzing, the installation is equipped with a small tank (13) positioned at the top of the reservoirs.

FINDINGS AND DISCUSSION

The determinations were made on batches containing beech dust and linden dust, as it can be seen in Figures 5 and 6.

Figure 5. Beech dust (Cioabla, 2009)

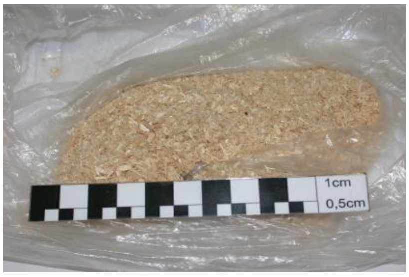

Figure 6. Linden dust (Cioabla, 2009)

In Table 2 are presented some of the general properties of the used sorts of biomass.

Table 2: General characteristics for the used biomass

No	Sample	Humidity [%]	Ash content [%]	High calor. value [kJ/kg]	Low calor. value [kJ/kg]
1	Beech dust	6.43	0,92	17751	16322
2	Linden dust	8.01	0,54	17705	16263

In the next figures (Figures 7-12) the variation of the main parameters, like temperature, pH and pressure inside the pilot installation during the two batches are presented.

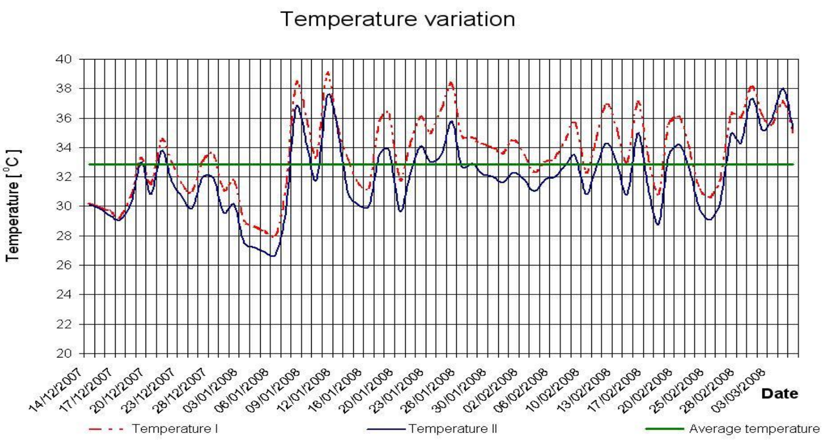

Figure 7. Temperature variation for beech dust batch (Cioabla, 2009)

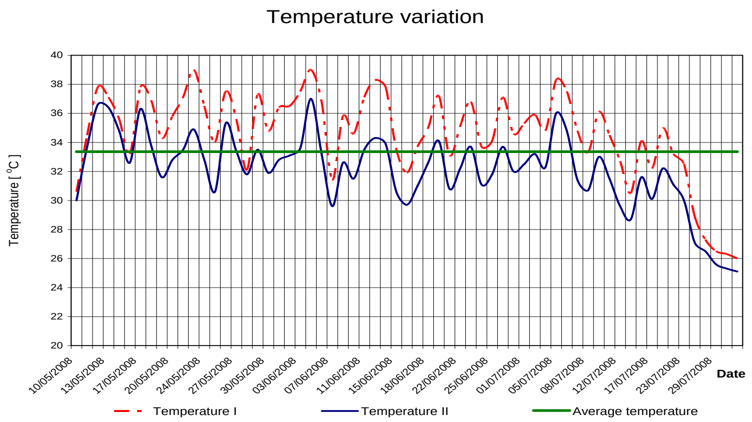

Figure 8. Temperature variation for linden dust batch (Cioabla, 2009)

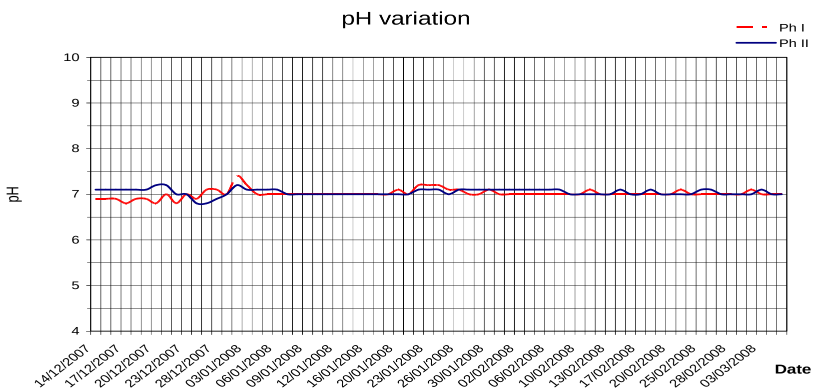

Figure 9. pH variation for beech dust batch (Cioabla, 2009)

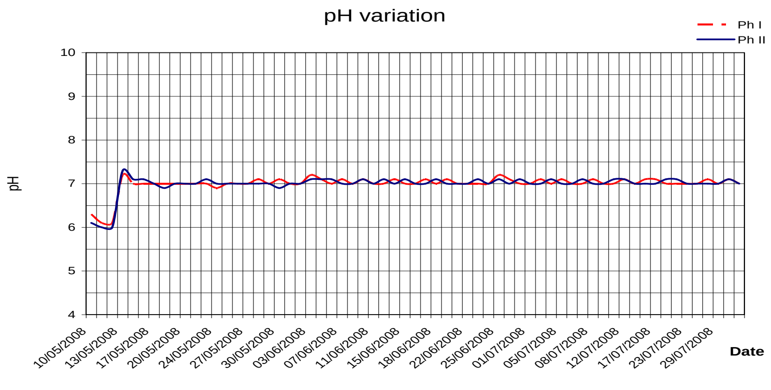

Figure 10. pH variation for linden dust batch (Cioabla, 2009)

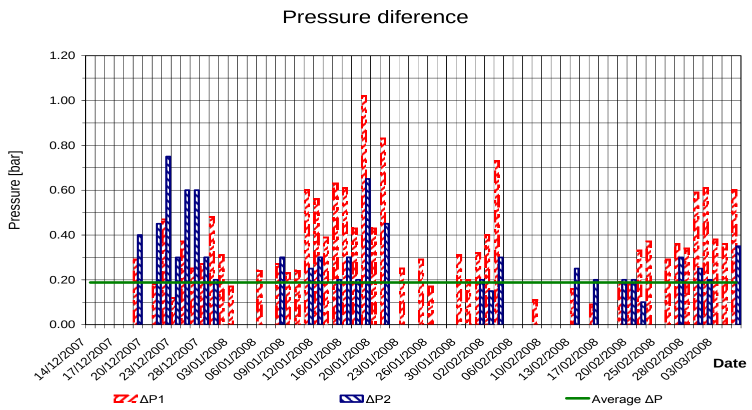

Figure 11. Pressure difference for beech dust batch (Cioabla 2009)

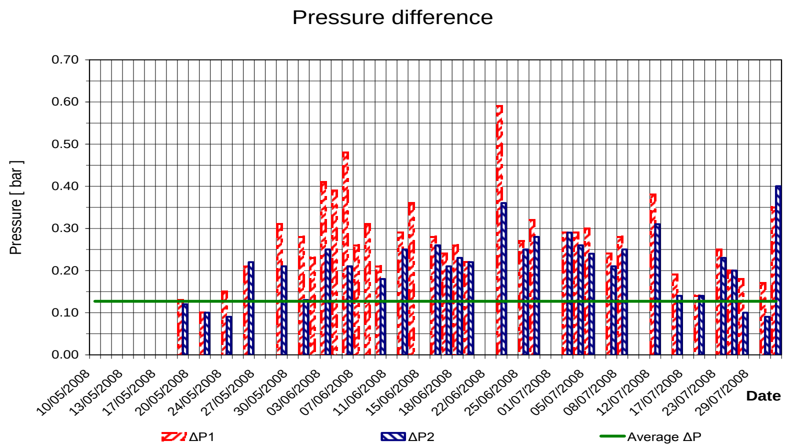

Figure 12. Pressure difference for linden dust batch (Cioabla 2009)

The temperature is measured at the level of each of the two reservoirs (temperature 1 for the first reservoir and temperature 2 for the second reservoir) and in correlation with it, there was studied the pH variation (pH 1 at the level of the first reservoir and pH 2 at the level of the second reservoir) and the pressure difference, which represents the biogas production on a daily basis for the entire installation, with an average value presented in each of the two batches. The reservoirs present the same characteristics, the heating conditions and the used material suspension are the same, but the constructive solution implies two reservoirs in order to use a portion of the produced biogas in each one of them on a daily basis to agitate the material inside the reservoirs with the help of a bubbling system made by polypropylene and which is found inside the reservoirs in order to have a proper homogenisation of the material. This aspect is important because in case there is not a good level of homogenisation inside the fermentation reservoirs, the biogas production will decrease and eventually stop. Even if the conditions for the two reservoirs were approximately the same, there can be observed differences between the temperature in the first and in the second reservoir, thus having an influence upon the production of biogas and, as a secondary effect, a small difference in pH variation of 0.1 – 0.2 units.

Table 3: Calorific values for the residual material after the anaerobic fermentation process (Cioabla 2009)

No.	Sample	High calorific value [kJ / kg]	Low calorific value [kJ / kg]
1	Beech dust residue	13195	11759
2	Linden dust residue	13254	11843

Also, because the used material is high in lingo-cellulose, the links were very hard to break, the biogas production was low, and the residues had the potential to be used in co-burning processes because of their calorific value which are presented in Table 3.

CONCLUSIONS

Biogas is a type of unconventional clean and green and CO_2 lean (even free) energy for the future, one way to produce energy and still tends to assume a growing impact in the present context related to reduce amounts of fossil fuels. It can be originated also in short rotation coppice, even the process is in turn to be optimised.

The paper brings some examples from biogas production on a pilot plant, by using different wooden species as origin. For the beech dust batch it can be observed from the graphics that there is a difference between the variations of temperature for the two reservoirs, but the domain remains established between 30 – 37° C. The pH values are between 6,5 – 7,5 and the small differences from one day to another are corrected with the help of dosing pumps. The average value for the pressure difference is approx. 0.2 bar / day; For the linden dust batch it can be observed that there is a similar variation in temperature between the two reservoirs like for the first batch, the pH values are around 7, and the correlation between the pressure difference and the biogas production is at a low value, of 0.12 bar, meaning a smaller quantity of produced biogas;

Using this kind of technology with application of all kinds of vegetable residues, it can improve the recovery of energy potential for materials that usually are not used for any kind of activities, while obtaining a clean fuel with no dangerous impact over the environment.

Unlike fossil fuel combustion, biogas production from biomass is considered CO_2 neutral and therefore does not emit additional Greenhouse Gases (GHG) into the atmosphere. However, if biogas is not recovered properly, it will contribute to a GHG effect 20 times worse than if methane is simply combusted. Therefore, there is a real incentive to transfer biogas combustion energy into heat and/or electricity. Finally, biogas production from anaerobic digester presents the additional advantage of treating organic waste and reducing the environmental impact of these wastes. It contributes to a better image of the farming community while reducing odour, pathogens and weeds from the manure and producing an enhance fertilizer easily assimilated by plants. Implementing a biogas system is in fact we are not just having FREE energy for ourselves, we also saving the environment and our earth to be cleaner and greener.

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REFERENCES

**** Burton, Ed., Bio-Mass to Bio-Gas. Wood "Chunkettes" to Produce a Hydrogen Rich Bio-Gas, http://www.clean-air.org/Ed%20Burton%20Story/wood_chips_to_bio.htm

***, Brochure developed at the company maxbiogas: The new biogas resources - straw, wood or leaves -for biogas plants

Bagi, Z., Acs, N., Kovacs, l. K., et. al, (2007). Biotechnological intensification of biogas production. *Appl Microbiol Biotechnol,* 76, 473 – 482.

Cioabla, A. E., (2009). *Theoretical and experimental contributions concerning biogas production from biomass residues.* PhD Thesis, Politehnica Publishing House, Timisoara.

Cioabla, A. E., Ionel, I., (2010). Biogas production through anaerobic fermentation, based on different waste biomass. *WSEAS Transactions on heat and mass transfer, 5 (3),* 153 – 164.

da Rosa, A., (2005), Fundamentals of Renewable Energy Processes, Elsevier Pub. House , 501-502.

Demirel, B., Scherer, P., (2008). The roles of acetotrophic and hydrogenotrophic methanogens during anaerobic conversion of biomass to methane: a review. *Reviews in Environmental Science and Biotechnology,* VII (2), 173 – 190.

Dieter, D., Angelika, S., (2008). *Biogas from waste and renewable resources, an introduction*. WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.

Ionel, I., (2010). Clean technology from waste management. *Advances in Waste Management, 4th WSEAS International Conference on Waste Management, Water Pollution, Air Pollution, Indoor climate (WWAI'10).* 155 – 171.

Khoshoo, T.N., (1988), *Environmental concerns and strategies*, Ashish Pub. House (New Delhi).

Mateescu C., (2008). Opportunities and barriers for development of biogas technologies in Romania. *Environmental Engineering and Management Journal,* VII (5), 603 – 607.

Popescu, F., (2009). Advantages in the use of Biodiesel in an urban fleet. Case study. Major crossroads in Timisoara City. *Journal of Environmental Protection and Ecology,* 10 (1), 182 – 191.

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SOME ASPECTS OF STRATEGIC PARTNERSHIP FOR INDUSTRIAL WASTE MANAGEMENT IN LUCANI MUNICIPALITY

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ABSTRACT

Industrial waste management in Serbia barely exists or it is at the level of individual attempts made by some industrial enterprises. The volume of the current and new industrial waste is worrying, even though the manner of waste treatment is defined by law. Problems arise within enterprises that are not ready or not sufficiently educated to organize particular activities and eliminate detected inconsistencies with legal regulations. This paper deals with a necessity of creating a strategic partnership between waste processors and the industrial sector as an imperative transition condition for treatment, recycling or export of waste until conditions are made for the full implementation of the Waste Treatment Law. The paper presents the results of one such collaboration between the enterprise MB-Namenska Lucani and the processor SZTR Neda-Plus Lucani and demonstrates how public/private cooperation can lead to successful waste management.

Key words: industrial waste, industrial landfills, recycling.

INTRODUCTION

Industrial waste includes all waste material produced during the industrial process. Industrial waste is divided into non-hazardous and hazardous, but although it is disposed to special industrial landfills, or so called sanitary fields, very often these two types of waste are not separated but they are mixed and thus become almost unusable and very polluting. U.S. industrial plants generate and accumulate around 7.6 billion tons of industrial solid waste every year. The data regarding the volume of generated industrial waste in the territory of Serbia are incomplete and inappropriate. According to the information provided by the Serbian Ministry for Environment,Mining and Spatial Planning (http://www.epa.gov), out of 1.8 million tons of industrial waste produced in Serbia annually, more than a third accounts for hazardous waste. The latest information says that there are 440 industrial landfills in Serbia, but this seems not to be the final number if we take into consideration that a number of industrial landfills has not been registered yet for the reason of postponing the reporting requirement of a polluter about the quantities and properties of non-hazardous and hazardous waste produced in industrial plants. The current treatment of industrial waste in Serbia is hindered by regulatory and economic restrictions, education and organization within the industrial waste generators. Most of the landfills were made haphazardly, with no clear plan about the final destiny of the waste and with no appropriate technical and technological preparation of the landfill. What is characteristic for such industrial landfills is that the land area is permanently occupied and degraded. Besides, they are a very dangerous source of environmental pollution. Due to inappropriate preparation of industrial landfills, many hazardous materials may penetrate into underground waters or be scattered by wind on the surface outside of the landfill and its surroundings. They can also generate methane gas (so called landfill gas) thus jeopardizing health of local population. For that reason it is very important to motivate generators of industrial waste to cooperate with certified waste processors, to make conditions for its appropriate disposal, separation and recycling, as well as conditions for the remediation and recultivation of current industrial landfills, a part of which has not been registered and has not met technical and technological conditions prescribed by law. Other more technologically advanced countries have the same problem. “Generation of tremendous amounts of solid wastes every day has been a major concern only to a very few people. Recycling of used materials is a good solution to this problem. Public awareness of recycling has not been very succesful in U.S. Recycling is yet to be popular among comon people. Initiative on the part of federal and state governments and several other federal agencies should increase. Parallel federal funding and spending should also increase in this area. Otherwise pressure will increase on landfill requirements. Other different problems with solid waste generation will also increase. Indidvidual participation in minimizing the waste and recycling should be initiated“. (Wukasch, R.)

This paper describes a strategic partnership between waste processor SZTR Neda-Plus Lucani and the industrial enterprise MB-Namenska Lucani and presents the results of waste tratment in the industrial landfill of the industrial partner. The goal is to demonstarate how public/private cooperation can lead to successful waste management.

ANALYSIS OF RESULTS OF WASTE TREATMENT IN INDUSTRIAL LANDFILL OF MB-NAMENSKA, LUCANI

The industrial landfill MB-Namenska, Lucani originated from the sixties of the last century and is situated within the plant's area. It used to be a sole industrial landfill for the whole chemical industry plant Milan Blagojevic, which was divided after privatization into a number of separate business entities that today have their own mini landfills. It covers the land area of around 3 hectares. A part of the landfill is separated and intended for the disposal of gypsum made in the process of waste water neutralization in the production process.

Figure 1. Map of Lucani

The cooperation between MB-Namenska and SZTR Neda-Plus Lucani started back in 1995. Within the project “ Action for the protection of air purity and environment 1997 “ (Society for the prevention of air pollution, Serbia) the chemical industry plant Milan Blagojevic Lucani was placed on a black list as one of seven largest polluters in the country, while the enterprise Neda-Trade was awarded a green list for the environment protection. It was then that the cooperation between the two enterprises become significant. Neda-Trade, predecessor of today Neda-Plus Lucani was officially the only enterprise that carried out exploitation and partial remediation of this industrial landfill until 2005. After many decades of inappropriate waste disposal, exploitation conditions were significantly harder while recycled raw materials were of much worse quality. As a result, economical and ecological benefit of this landfill exploitation was not higher. The change in properties and quality of waste raw materials after their mixing and inappropriate treatment is the fact that implies the necessity of separation of the industrial waste at its origination source. The division and privatization of some parts of HI Milan Blagojevic partially brought benefit to the process of collection and treatment of industrial waste, because the new enterprises have barely used this landfill, but they have disposed their waste directly to the processor Neda-Plus which carries out separation and further treatment and disposal of waste in an appropriate way. Although in the previous years such cooperation was only occasional and adding up the disposal of newly produced waste, the volume of waste has been significantly reduced after a decade of intensive exploitation of this landfill by Neda-Plus It is estimated that the volume of deposited industrial waste at this location is around 27,000 cubic meters. The following tables present the analysis of results of all waste raw materials treated by *SZTR Neda-Plus Lucani* in the previous 10 years (Table 1). In such volume of waste there is a portion of industrial waste of special industry *Milan Blagojevic Lucani* (Table 2).

Table 1: Total raw material waste treated by SZTR NEDA PLUS Lucani (1995-2005)

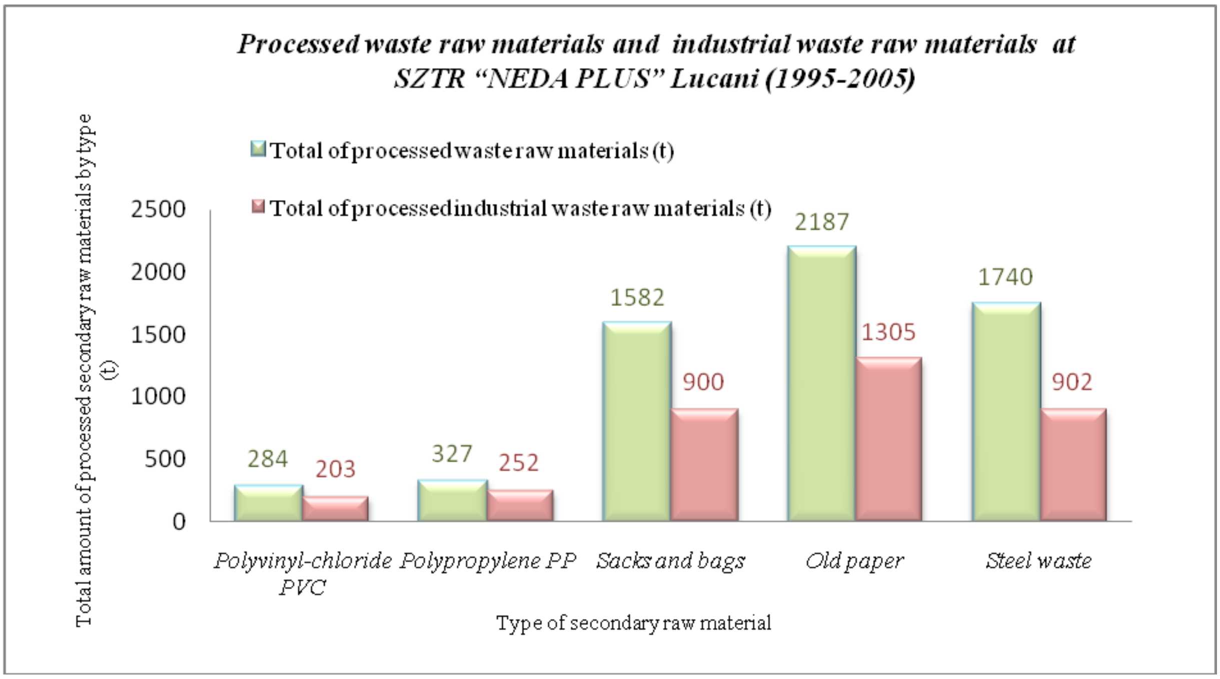
Type of secondary raw materials	Average treatment by year (t/year)	Years of treatment	Total treated secondary raw materials by type (t)
Accumulator	30	10	**300**
Polyvinyl chloride PVC	28,4	10	**284**
Polypropylene PP	32,7	10	**327**
Sacks and bags	158,5	10	**1 585**
Used paper	218,7	10	**2 187**
Steel waste	174	10	**1 740**
Total raw materials treated			**6 423**

Table 2: Non-hazardous industrial waste treated by SZTR NEDA PLUS Lucani (1995-2005)

Type of secondary raw materials	Average treatment by year (t/year)	Years of treatment	Total treated secondary raw materials by type (t)
Accumulator	20,3	10	**203**
Polyvinyl chloride PVC	25,2	10	**252**
Polypropylene PP	90	10	**900**
Sacks and bags	130,5	10	**1 305**
Used paper	90,2	10	**902**
Steel waste	20,3	10	**203**
Total treated industrial raw materials			**3 562**

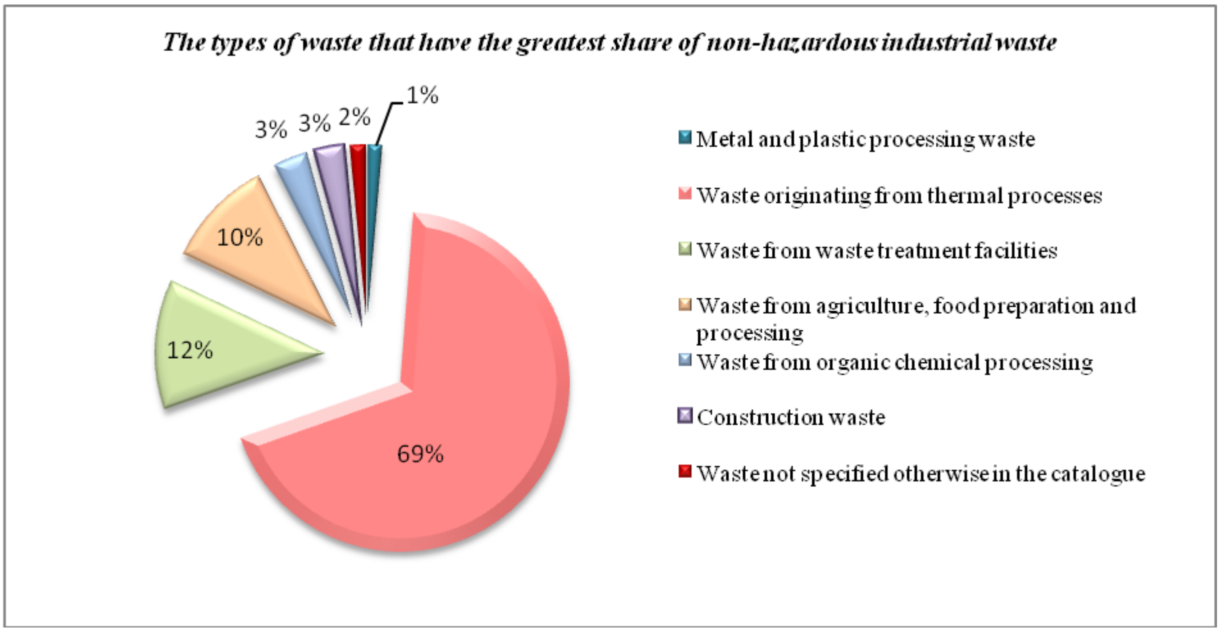
SZTR Neda- Plus Lucani collects and recycles around 10% of total waste generated at the level of Lucani Municipality which qualifies this municipality among the best in Serbia by the percentage of recycled waste raw materials. In Table 1 we see that in 10 years total of 6,423t of waste raw materials were treated, bearing in mind that it is the full capacity of this enterprise. Excluding the treatment of accumulator which is not included in the morphological composition of industrial waste in the quantity of 300t, total quantity of treated waste would be 6,123t. For the same period, Table 2 presents the overview by types and quantities of treated industrial waste for 10 years in total quantity of 3,562t. We may conclude that in this period more than a half of treated waste was industrial waste. The following graph illustrates this comparison.

Graph 1: Comparative analysis of total volume of treated waste and industrial waste in SZTR Neda-Plus Lucani



These data are very significant because apart from the quantities of treated industrial waste, they provide information about the composition of industrial non-hazardous waste at this landfill. We may assume that there are differences in the composition of industrial waste, depending on the industry type, so that in this case also we may identify some differences and inconsistencies with regard to the established composition of non-hazardous industrial waste in the territory of Serbia. (Project, no. 36/09 and 88/10).

Graph 2: The types of waste that have the greatest share of non-hazardous industrial waste



CONCLUSION

It is natural that long-standing processors have more experience in waste organization and management than polluters and waste generators. The Waste Treatment Law shall bind the waste generator to treat waste appropriately, but it will not bind it to manage waste by itself. It is more often today that solid industrial waste is managed by joint effort of two or more entities and by mixing public and private sector, through horizontal and vertical integrations. By analyzing the cooperation between *MB-Namenska* and *Neda-Plus Lučani* over decades, more than a third of the landfill has been remedied. If the cooperation had not been interrupted, the results would have been better. It is anticipated that a new ten-years' agreement for the remediation of this landfill concluded between these two enterprises will result in the complete remediation and recultivation of this land, while at the same time a new industrial landfill will be constructed in accordance with technical and technological conditions and the Waste Management Law. Measuring and monitoring of results will provide additional information regarding the requirements of the new landfill and progress management in order to meet the target of reducing waste. The results presented and historical data may often help us to plan the future and/or make strategic planning of initiatives with regard to the Principle of Waste Management Hierarchy (Waste Management Law, no. 36/09 and 88/10). This type of cooperation should be encouraged because even in hard working conditions results are significant. Until conditions are made in Serbia to build a number of facilities for industrial waste management (e.g. US Steel Smederevo that invested USD 22 million: http://www.ocistimosrbiju.rs), these types of strategic partnerships between the industrial waste generator and waste processor are the only practical transition solution.

REFERENCES

http://www.epa.gov/epawaste/nonhaz/industrial/guide/index.htm
Wukasch, R., F. Purdue University, School of Civil Engieneering
Project „Establishing composition of waste and assessment of its quality in order to define a strategy for managing secondary raw materials within the sustainable development of the Republic of Serbia“, Faculty of Technical Sciences in Novi Sad and Environmental Protection Agency
Waste Management Law (Official Herald of the Republic of Serbia”, no. 36/09 and 88/10)
Waste Management Strategy of the Republic of Serbia for the period 2010-2019 (Official Herald of the Republic of Serbia”, no. 29/10)
Nemerow, N. (2006). Industrial Waste Treatment Contemporary Practice and Vision for the Future.
Investment projects and documentation of the enterprise Neda Trade and SZTR Neda Plus Lucani in the period 1995-2010
Gottlieb, Robert, A Waste Management Crisis, in Solid Waste Management Planning
Basic Facts about Solid Waste. 2003, Environmental Protection Agency: Washington, DC.
http://www.ocistimosrbiju.rs/src/Izgradnja-postrojenja-za-upravljanje-industrijskim-otpadom-u-US-Steel-Serbia--914-c74-content.htm

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REVIEW POSSIBILITY OF ESTABLISHING AN INTEGRATED MUNICIPAL WASTE MANAGEMENT SYSTEM IN BOSNIA AND HERZEGOVINA

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ABSTRACT

Municipal waste management in Bosnia and Herzegovina, as in most countries in the region, is currently at a very low level. In such a situation in this area most affected social, economic and financial, political and cultural reasons. This paper reviews the current situation and considering the possibility of establishing an integrated solid waste management in Bosnia and Herzegovina. All the facts show that Bosnia and Herzegovina in the future is still a lot of effort to bring waste management at a satisfactory level. All structures of society must allocate significantly greater financial resources than ever and it is essential that in future we pay special attention to strengthening environmental awareness among citizens of all ages.

Key words: municipal waste, integrated system.

INTRODUCTION

Municipal waste management is a complex system that is globally focused on reducing the amount of disposed waste, increase in the percentage of recycled waste, the establishment of rational use of natural renewable resources and reduce the potential negative impacts on human health and the environment. Solid waste management system includes the implementation of mandatory measures for waste management in gathering, transportation, storage, treatment and disposal, including the supervision of these activities and taking care of waste management facilities after they are closed. Each procedure for the treatment of waste usually has its advantages and disadvantages. In the selection procedure is necessary to consider the extent to which the procedure provides for the protection of the environment and the possibilities for the practical application of the obtained products.

The problem of solid waste management is a complex and multidisciplinary, and developing appropriate strategies and its practical application can significantly contribute to preventing further degradation of human living and working environment. In the world in the application of different municipal waste management system, a different representation of the management system depending on the level achieved development, structure, quantity, and a global approach to solving this problem.

Like most countries in transition in Bosnia and Herzegovina municipal waste management lags far behind the industrialized countries. In Bosnia and Herzegovina municipal waste management was not adequately resolved until 1992., and the ravages of war are only further aggravated the situation in this area.

Reaching EU standards in terms of integrated solid waste management requires a relatively high financial investments and their implementation in Bosnia and Herzegovina is needed some time.

The European Commission and World Bank have actively participated to improve waste management, developed a system of environmental monitoring, in both entities and Brcko District agreed on legislation in the field of environmental protection.

This paper provides an overview of the current situation in Bosnia and Herzegovina in the field of solid waste management and is considering establishing an integrated system in this area.

CURRENT SITUATION IN BOSNIA AND HERZEGOVINA IN THE MANAGEMENT OF MUNICIPAL WASTE

In most countries of the region solid waste management systemand organized primary collection is no different in basic elements. In organizational terms the essence of the process is to involve as many citizens of waste collection system where the head, in most cases, the utility company owned by local governments.

Collection of waste from individual users throughout the territory of Bosnia and Herzegovina, at a low level of concern. Urban areas have a high percentage of the population coverage of organized waste collection, but the level of service unsatisfactory. Common to all issues is the lack of uniform containers for waste collection, the lack of recycling yards, obsolete fleet, insufficient training of workers and others., Resulting in, among other things, is very bad and low service charges for garbage and municipal waste disposal. In rural areas the problems are almost identical, with the additional burden that an urban disorder and complexity of housing which greatly complicates the process of organized municipal waste collection.

In Bosnia and Herzegovina in the system of organized collectionof municipal waste includes about 50% of the population. Moreself-defeating a information that only 30 to 40% of those involvedin organized system of collecting this waste, regularly pays compensation for his care. The financial resources obtained in this way are not sufficient to establish a basic system for waste disposal, let alone for construction management and waste treatment. This financial situation in the utilities does not optimistic that in the near future to mend the current situation in this area.

Collection system for collection and disposal of waste varies from municipality to municipality and in most cases is not sufficient for the financial viability of utilities. Inadequate payment systems, such as billing for collected bag waste, lead to absurd situations that municipalities with 10 thousand inhabitants covered by organized waste collection service, a monthly payment of only the realization of a thousand euros. According to the analysis that have been made for the strategy of environmental protection, every citizen of Bosnia and Herzegovina, on average, annually produces about 270 kg of municipal waste, whose disposal in principle and should pay.

Table 1 given waste composition and calorific value of the basic components that are found in the structure of municipal solid waste in Bosnia and Herzegovina in the last few years.

Table 1: Mass fraction and the calorific value of the basic components in the structure of solid municipal waste

No.	Component	Mass fraction, %	Lower calorific value, kJ/kg
1.	Paper and paperboard	20	13490
2.	Biowaste	40-60	9300
3.	Waste from food	40-60	7560
4.	Plastic	7	26980
5.	Wood	5	16050
6.	Rubber and leather	4	19538

Landfills in which utilities are currently disposed waste dumps mostly classical (dumps), or sites to which no pre-treatment of municipal waste disposed of nature.

The main reason for this low level of social and personal awareness regarding the proper disposal of waste. Failure to grasp the basic principles of environmental "polluter pays" and the impossibility of implementation across all strata of society, is increasingly becoming a major environmental problem.
In Bosnia and Herzegovina has 75 registered landfills for household waste. Municipal landfills are the most open and most often inadequate site for that purpose. The landfills do not have any systems to protect soil, air, surface and groundwater. Until recently, no one municipal dump was no quality control of leachate and gas. The biggest problems are created by an illegal landfill, which in Bosnia and Herzegovina has about 1100. With these landfills into the atmosphere without any controll and fill gas that emits green house gases include, in addition tothe flammable and explosive.

In Bosnia and Herzegovina in the last few years have built four relatively modern center for municipal waste disposal. These centers were built in Sarajevo, Zenica, Bijeljina and Banja Luka.

ESTABLISHING INTEGRATED MUNICIPAL WASTE MANAGEMENT SYSTEM INTO BOSNIA AND HERZEGOVINA

For disposal of waste is necessary to establish stable organizational, economic and legal framework, with a gradual attainment of the actual cost of waste management. This would encourage households and industry to carry out the selection of waste which would increase the share of recycling and reuse of waste. The funds that get financed in this way to introduce new technologies for treatment of specific waste components.

The most acceptable method of waste disposal in Bosnia andHerzegovina is a model that is based on the construction of centers for waste management would be performed where the separation of usable part of waste. However, in order to solve the problem of this type of municipal waste should first increase the percentage of population covered by organized waste collection. It is essentially a huge problem and a major responsibility of local communities. Should take into account the fact that four million people in Bosnia and Herzegovina, as many as two million of its waste is disposed in nature. Thus, in Bosnia and Herzegovina each year to the way that rejects about 500 thousand tons of municipal waste, ie. waste that ends up in river basins, river valleys, meadows, plains, abandoned mines and others. Currently, the existing system of solid waste management in Bosnia and Herzegovina dispose of over 500 thousand tons of waste.

Table 2 given the estimated progression of growth of municipal waste in Bosnia and Herzegovina until 2018. year.

Table 2: Estimated progression of growth in municipal wasteBosnia and Herzegovina

<table>
<tr><th>Year</th><th>Mass</th><th>Unit</th><th></th></tr>
<tr><td>2006.</td><td>1.125.450</td><td rowspan="5">t</td><td rowspan="2">Estimated value</td></tr>
<tr><td>2008.</td><td>1.166.477</td></tr>
<tr><td>2011.</td><td>1.236.704</td><td rowspan="3">Estimated progression of growth</td></tr>
<tr><td>2014.</td><td>1.324.512</td></tr>
<tr><td>2018.</td><td>1.465.110</td></tr>
</table>

In some countries, the system of granting concessions to companies engaged in the collection and disposal of municipal waste, which in practice proved to be extremely high quality solution. An example of such a solid waste management in Croatia, which is a relatively short period of time results that were achieved at the level of the European Union.

Today, they need significant funds to Bosnia and Herzegovina has established the primary process of collecting municipal waste and its final disposal. According to the basic principle of environmental "polluter pays" principle, bear the costs of this process, only citizens who are in this case and pollutants. Due to the different social structure of society, the percentage of collection and payment of these services is different from the middle to the middle and ranges from 15 to 60%. In most cases, fees for municipal waste collection in Bosnia and Herzegovina is not a commercial rather than social, so they can work hard to be a system that relies solely on economic performance. Another problem that arises in the management of municipal waste is to separate the useful from the useless part of the waste, ie. selection of waste. Today, the world's most represented in the system, selection of components contained in the structure of municipal solid waste.

The first system is a system of integrated solid waste management. Under this system, responsibility for products placed on the market is transferred to the burden of the manufacturer or retailer or importer. Manufacturers and retailers are organized into interest groups that have a priority task to fulfill the goal related to the amount of collected material (rubber, PET packaging, electrical and electronic waste, batteries, paper, cardboard, etc.). Relative to the amount of products placed on the market, set by local legislation or legislation of the European Union. This system has been implemented in most EU countries and from countries in the region in Austria, Hungary and Slovenia.
The second system, a system of deposit of waste management, accountability and cost of the procedure is transferred to the consumer as the ultimate pollutants through increased price of the products involved in the financing of this system. This system guarantees a very good result, but its function at the end becomes quite expensive because the price of a product packaged in containers increased to 30%, which directly affects the standard of living. The system has one serious drawback since it does not recognize other types of containers other than PET, glass and aluminum. This system is in Croatia gave good results. However, its establishment costs are high, so it was mainly implemented in industrialized countries.

The third system, the system of separating waste at the site of the primary delay for which the costs of municipal waste are transferred to the primary collectors to increase the cost of collecting the waste treatment funded with prior mechanical separation of the components. This system started operating in Turkey and has proven to be economically justified for this region. Asian part of Istanbul has a processing factory that day about a thousand tons of municipal solid waste. This system requires a relatively large initial investment through economic activity back in the long run.

To Bosnia and Herzegovina has established an integrated solid waste management system that meets the standards of the European Union must take into account the following factors:
- Cultural heritage of the population;
- Insufficient training of the population of all ages;
- Socio-economic condition of society as a whole;
- The state consists of two entities and Brcko District, which has the effect that each unit has its own legislation, ie. harmonized legislation in certain areas;
- Not performed consistently in practice the application of legislation;
- State and unstable economic entities;
- Utility companies have outdated facilities and equipment;
- Have passed laws and implemented for individual components of which are found in waste (eg. law on packaging and packaging waste);
- Few companies that can perform processing of individual components of waste in order to re-utilization for the same or similar purpose;
- A lot of "wild" dumpsites and landfills with the technological aspects do not meet the requirements for waste disposal;
- Does not respect the basic principles of environmental "polluter pays" principle, and others.

To establish an integrated municipal waste management system in Bosnia and Herzegovina requires significant financial resources and appropriate period of time. Establishing such a system requires the involvement of all citizens, local government, the two entities, joint state institutions, governmental and non governmental organizations. Of course, these activities require extensive support from the Fund for Environmental Protection in the European Union.

CONCLUSION

Municipal waste consists of various waste generated in households, waste resulting from the cleaning of public areasand waste that is in its properties similar to waste from households, which occurs in the economy, institutions, clubs, shopping malls and services.

Municipal waste management in the whole of Bosnia and Herzegovina is extremely low. To be in this area resulted incompliance with EU legislation is necessary in future to focusactivities on:
- Educating people of all ages;
- The acquisition and modernization of financial and technical resources for utilities (drums, containers, vehicles, loaders, etc..);
- Establishment of a strategic state-level or entity;
- Preparation of quality projects for EU pre-accession funds to ensure funding for the rehabilitation of existing dumpsites and security technologies for recycling and material utilization of individual components of the waste (paper, cardboard, PET, glass, etc..);
- The adoption of laws relating to the components contained in the structure of municipal waste (eg. law on packaging and packaging waste, etc..);
- Giving greater importance to this issue in print and electronic media, and others.

To waste management has led to a satisfactory level is necessary in the future in Bosnia and Herzegovina establish an integrated system that will be acceptable to all entities that generate waste.

REFERENCES

Herceg, N., Lukić, T.: Okolišnog odlaganja skoro da i nema, Fondeko svijet, Sarajevo, Broj 29 (2009), str. 28-29.

Herceg, N., Lukić, T.: Razvoj infrastrukture za cjelovit sustav gospodarenja komunalnim otpadom, Fondeko svijet, Sarajevo, Broj 29 (2009), str. 6-7.

Simić, S.: Tehnologije reciklaže otpada, Glas srpski-Grafika, Banjaluka, Mašinski fakultet, Istočno Sarajevo, 2010.

Simić, S., Džombić, D.: Upravljanje komunalnim otpadom u Republici Srpskoj, Četvrta regionalna konferencija o uzajamnosti zaštite životne sredine i efikasnosti energetskih sistema, ELECTRA IV, Tara, 11-15.09.2006.

Simić, S.: Dobijanje energije iz čvrstog komunalnog otpada, Reciklažne tehnologije i održivi razvoj, V SRTOR, Soko Banja, 12-15.09.2010., str. 36-41.

Simić, S.: Specifičnosti zakonodavstva BiH u oblasti zaštite životne sredine, Druga regionalna naučno-stručna konferencija, Pravo i zaštita životne sredine u privredi i praksi, EKO-JUSTUS II, Palić, 14-18.06.2010., str. 15-19.

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MOTOR VEHICLES AT THE END OF THE LIFE CYCLE AS A SOURCE OF IRON BASED METALS, AND ENVIROMENTAL IMPACT OF A SCHREDDER PLANT IN SERBIA

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ABSTRACT

At the end of the lifecycle, vehicles represent a potential threat to the environment, and can be an important resource of materials which can be reused. This paper gives a statistical review of the number of registered vehicles of national brand "Zastava" which presents one-third of passenger cars in Serbia. The amount of Fe – metals by vehicle dismantling, and the possibility of their recycling is shown. In this paper is also described the only shredder plant of that type and capacity in Serbia. The types of gases, water, liquid and solid waste which is generated in the production process and appropriate technologies which are applied in order to minimize pollution are listed.

Key words: End of Life Vehicle, Statistic data, Fe-metals, Recyclability, Shredder plant.

INTRODUCTION

The growth of the world's population has determined the need for faster, simpler and easier communication. Due to such communication, along with modern social - economic and industrial development, the number of vehicles has largely increased. In order to minimize the impact of vehicles disposal on the environment, the End-of-Life Vehicles Directive (2000/53/EC) aims to promote the collection, reuse and recycling of their components. Generally speaking, there are several problems if the vehicles are disposed and not recycled, like occupying the landfill space, potential leakages of fuel and motor oil into water recipient and soil, emissions of volatile compounds, and possible fires. Some of the components are classified as harmful or either hazardous to the environment. Those problems are still present in recycling operation, if the dismantling operations are not handled by regulations (Guidebook for the Vehicle Dismantling and Recycling Industry Environmental Planning Regulation, 2008; Pavlović et al., 2009).

AMOUNTS OF FE-METALS AND RECYCLING POTENTIONAL BY VEHICLE DISMANTLING

The car is a highly complex product that is produced using more than hundred different technologies, and that consists of about 15.000 parts. Car parts are produced from different materials. The total weight of the current passenger car is represented by iron and steel (Guidebook for the Vehicle Dismantling and Recycling Industry Environmental Planning Regulation, 200; Đorđević 2009).

Almost a third of passenger cars in Serbia are the brand "Zastava" (which is about 511.553 vehicles), which presents models "Koral", "Skala" and "Florida" by one-third (approximately 170.517 vehicles) (Đorđević, 2005; Pavlović, 2008/2009]

Potential for recycling Fe-metals from vehicles “Zastava” (see Table 1) is calculated by a formula, as follows:

$$\text{Number of vehicles from particular model “Zastava”} \times \text{vehicle weight}$$
$$\times \text{ percentage of Fe-metals in vehicle} \times \text{rate of recyclability (Djordjevic, 2005)}$$

Table 1: Recyclability potential of Fe-metals in "Zastava" vehicles (Đorđević, 2005; Zastava automobili – Institut za automobile 2004)

Model of Zastava car (Fiat Auto)	Number of vehicles	Vehicle weight [kg]	Percentage of Fe-metals [%]	Rate of recyclability [%]	Fe-Metals recyclability potential [t]
Koral	170.517	807	73.6	62.0	62.793
Skala	170.517	835	75.0	62.0	66.207
Florida	170.517	950	73.6	62.0	73.920
Total					**202.920**

In this analysis is shown the potential for recycling Fe-metals only from vehicles brand “Zastava”, which makes one third of the total number of registered passenger cars in Serbia (according to data for 2008. yr.). The remaining two thirds are foreign vehicle manufacturers with much greater potential for recycling, because they are more massive and have higher rate of recyclability. Serbia has significant capacity for processing Fe-metals, so vehicles for recycling are an important resource (Djordjevic, 2005; Pavlović, 2008/2009, Zastava automobili – Institut za automobile, 2004; Pavlović et al., 2009).

SHREDDER PLANT

Shredder plant consisting of equipment and installations used for the shredding of scrap metal. Maximum thickness of material that can be processed in the shredder is 2 mm for sheet metal, 5 mm for steel plates and 10 mm for round parts (Jody et al., 2006; Interni materijal - Analiza uticaja centra za reciklažu u Beogradu na životnu sredinu, 2003).

Shredder plant in one pass completely crushes car body (with engine, gearbox, axles, springs, wheels and seats). Shredding of motor vehicles must be done only when the following items are previously removed:

- glass,
- battery,
- electronics and electrical cables,
- tires,
- bumpers,
- gas tank,
- air conditioning,
- waste oil.

After that, the car body, in the original size or compressed to a smaller volume, is processed in Shredder. Shredder, whose impact on the environment is analyzed in this paper, is the German production, Metso Lindemann, 2.7 MW of installed power capacity of 35-45 cars per hour, or about 19 t/h of the final product (Interni materijal - Analiza uticaja centra za reciklažu u Beogradu na životnu sredinu, 2003).

TYPES OF GAS, WATER AND OTHER LIQUID AND SOLID SUBSTANCES THAT COULD BE GENERATED IN THE PROCESS OF SHREDDER PLANT

Air pollution

In the stationary work shredder plants as air pollution could be emitted:

- exhaust gases from the engine of machines that perform transport and handling operations,
- dust particles that occur during transport and manipulative operations,
- vapor liquid materials that remained insome parts,
- dust particles contained in the input raw materials, which are due to air in the process of grinding,
- particulate material in the process of milling fragmented to a size that allows them floating and scattering into the ambient air.

Production waste water

The shredder plant does not produce waste water because the water is not used in the production process. Conditionally, the production water may be considered as:

- waste water from the wet purification of air,
- water from fire fighting.

Atmospheric waste water

Atmospheric waste water is:

- atmospheric water that is deposited by washing of accumulated dirt from the car body,
- atmospheric water that is washing transport and handling plateaus,
- atmospheric water that had been in contact with the any material from the shredder plant.

Soil pollution

This shredder plant produces the following types of solid waste:

- unusable material (rubber, plastics, iron oxides, etc.),
- floating sludge from the scrubber,
- sludge from the scrubber,
- saturated coalescent filters,
- sludge from the oil separator,
- municipal solid waste.

This shredder plant produce the following types of liquid waste:

- oil from the hydraulic system of the plant,
- lubricating oil as a result of periodic oil change (Jody et al., 2006; Interni materijal - Analiza uticaja centra za reciklažu u Beogradu na životnu sredinu, 2003; Vujić et al. 2009).

TREATMENT OF AIR, WATER AND WASTE IN THE SHREDDER PLANT

Polluted air treatment

Treatment of air in Shredder facility is provided by system for treatment of polluted air which:

- possesses air and water cyclones which allow the light fractions to precipitate in shredder and to be ejected effectively through a tube with drum grid,

enables efficient treatment of exhaust gases, because it has a wet scrubber with a built-in Venturi nozzle in front, where the output exhaust gases are treated and when discharging into the atmosphere contain a maximum of 50 milligrams of dust per cubic meter, which is much lower than ELV prescribe by the regulations in this area.

Waste water treatment

Waste water treatment depends on place of origin.

- process water from scrubber – scrubber has closed circulation system. The only water losses are due to partial evaporation and the assembling of water and dust into mud, which is stored in barrels. Losses are compensated with pouring of fresh water. Needlessly for additional processing of process water.
- other process water – in waste water treatment facility (Tehnix separator type 25000) treated is:
  - waste water from atmosphere
  - process waste water from facility

Solid and liquid waste treatment

Unusable material (rubber, plastics, iron oxides, etc.) incurred in the process of crushing, as well as floating sludge and sludge from the scrubber, is delaying in rolling containers. The final disposition of solid industrial waste is city landfill.

Saturated coalescent filters from oil separators and sludge from the oil separator are disposed in facility landfill, located within the functional unit of the logistical support of complex.
Oil remain in the replacement process (hydraulic and reduction) is storaged in the steel barrels, each kind of oil in particular barrel. Barrels are disposed of in facility landfills located within the functional unit of logistical support of complex. Once collected, large quantities of used oil are disposed and treated in Belgrade Refinery. Municipal solid waste is disposed at municipal empty containers (Interni materijal, Analiza uticaja centra za reciklažu u Beogradu na životnu sredinu, 2003).

CONCLUSION

This work analyses the potential for recycling Fe-metals from vehicles brand "Zastava" and the largest shredder plant in Serbia, the types of gases, water and waste that are generated in the process and systems and technologies used for their treatment and care.

The analysis of shredder plant impact can be divided into three groups, environmental impact of shredder on air, water and land.

Environmental impact of shredder on air

Applied treatment of polluted air provides sufficient filtration efficiency of air, so there is no excess emission limit values of harmful and dangerous substances which are prescribed by ordinance.

1) Environmental impact of shredder on water

In operating shredder plant, there is no risk of pollution of groundwater and surface water. Sanitary-sewage water is discharged into the city sewer system and do not affect the quality of surface and groundwater at the site.

2) Environmental impact of shredder on soil

Direct pollution of the soil of this plant can only arise as a result of improper operation or neglect of employees working at the plant. Indirect contamination of land can occur only in case of failure at the plant for waste water treatment or in case of non-technological disciplines that can result in blockage of drainage canal which leads process water to the plant for waste water treatment.

Analyzing the impact of shredder plant, and with respect to the capacity of the plant and technology work, which meets high environmental and safety standards, it is easy to conclude that the existence of such a shredder plant is great benefit for the Serbia and certainly one of the most important link in the chain of the national project for the recycling of motor vehicles (Pavlović, 2008/2009; Interni materijal, Analiza uticaja centra za reciklažu u Beogradu na životnu sredinu, 2003).

REFERENCES

Djordjević M., (2005). Sistem za reciklažu iskorišćenih putničkih automobila, doktorska disertacija, *Mašinski fakultet*, Kragujevac.

Guidebook for the Vehicle Dismantling and Recycling Industry Environmental Planning Regulation, (2008). *British Columbia*.

Interni materijal - Analiza uticaja centra za reciklažu u Beogradu na životnu sredinu, (2003).

Jody, B.J., Daniels, E.J., (2006). End-of-Life Vehicle Recycling-The State of the Art of Resource Recovery from Shredder Residue, *Energy Systems Division, Argonne National Laboratory*, September, Argonne, IL

Pavlović, M., (2008/2009). Izveštaj sa Nacionalnog Projekta "Razvoj integrisanog i održivog sistema reciklaže motornih vozila na kraju životnog ciklusa u Srbiji".

Pavlović M., Karanović N., Čepić Z., Pavlović A., (2009). Quantity and recyclability of Fe - metals at the End-of-Life vehicles in republic of Serbia, *10th International Symposium "Interdisciplinary Regional Research" – ISIRR Hunedoara*, Romania.

Vujić G., Pavlović M., Stajić T., Karanović N., Čepić Z., (2009) Development of integrated and sustainable system in recycling of motor vehicles at the end of their life cycle in Serbia, *4th International Conference on Engineering Technologies - ICET 2009,* Novi Sad, Serbia.

Zastava automobili – Institut za automobile, (2004.), Kragujevac.

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SOME ASPECTS OF RECYCLING CARS

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ABSTRACT

Discussed in the framework of the issue of recycling of motor vehicles at the end of life cycle. In recent years, in Serbia there is a need to build a network of centers for the disassembly and recycling at the end of the life cycle (ELV). The reasons for this are the sustainability of industry, environmental protection, harmonization of legislation with the EU, and so on. In this situation it is necessary to define the dismantling of the centers have characteristics of flexibility and adaptability, ie. able to overcome the challenges of business during normal and emergency situations.

Recycling brings both economic gains, and gains in reducing pollution.Upotrebom recycled to save natural resources and saves energy. Recycling creates less air and water pollution than the primary production of raw materials. Recycling saves storage space, create new jobs in companies engaged in the collection, production and distribution of recyclable materials, saving considerable resources and the environment.

Keywords: recycling, automobiles, automobile tires.

INTRODUCTION

Recycling of vehicles at the end of the life cycle in developed countries is regulated by the process that led to the development of new industries. It has multiple effects related to environmental protection, sustainable use of natural resources, energy saving, labor intensive employment, improving economic performance and the realization of significant profits, as well as the realization of sustainable development of the entire automotive industry. Real situation of recycling of motor vehicles in Serbia is far from the situation in developed countries. To overcome this problem in the framework of technological development, we developed a model of integrated and sustainable ELV recycling system, which is defined by a network of centers for the collection and dismantling of ELVs, and the network of centers for recycling materials and substances that come from waste motor vehicles. This model is made in accordance with the requirements of EU directives relating to the ELV. In this way the model is expected to offer solutions for the recycling of ELV weight 95% from 2015. year and to provide significant employment growth in the recycling of motor vehicles (Pavlovic et al., 2011).

Also, the model defines the ELV recycling and the impact on the development of new motor vehicles, leading to the final goal in the coming decades: ELV recycling without rest and without any waste (Arsovski et al., 2010). Huge amounts of waste automobile today represent a major problem in all countries. With these problems facing our state.

It is estimated that in the Republic of Serbia is currently in use around 1.6 million cars, with an average age between 16 and 17 years. Serbia will soon face the problems and the amount of approximately 1.6 million tons of waste materials of various kinds, among which there are hazardous substances. Generation of automotive waste takes place successively, through the dynamic renewal of the fleet and of course generating waste in the exploitation of maintaining a car. In any case, it is a very large quantity of waste utilization of which would be the optimal way to plan.

In Serbia there are not enough system regulations, which create conditions for the development of recycling cars. The result is a weak development of the industry. World experience shows that material recycling is one of the most dynamic industries in developed countries (Milivojevic et al., 2010).

In order to ensure effective recycling of motor vehicles is necessary to create an appropriate legal framework and basic infrastructure requirements, which would undoubtedly contribute to its development by attracting investments and establishment of technological resources in accordance with the regulations. Also, the introduction of system solutions in the field of automobile recycling contributes to the renewal of the fleet and consequently reduce emissions of harmful substances, increase road safety and saving energentskih and raw material resources.

The current situation in Serbia can be characterized as a lack of organization in the field of recycling of metals with the exception of collecting and recycling its initial (selection, cutting and crushing). Unfortunately, all hazardous materials, plastic parts, rubber and other non-metal parts are not treated the same and are left to waste or green space (Milivojevic et al., 2008; 2009).

MATERIAL AND METHOD

Recycling industry as a whole is very diverse and includes a wide range of services and productive economic activities from those of processing and collecting, to those that provide reuse of used parts or provide new products from recycled materials, (Krstic et al., 2007; Milivojevic et al., 2009). Recently it was confirmed that the energy consumption for the production of secondary raw materials from the recycling process incurred significantly lower than those used to obtain materials from ore in the primary production (Ilic 2002; Guise et al., 2005).

Recycling of used motor vehicles (ELV) in high-income countries is very successful, especially after the introduction of Schreder in the recycling process of used cars. The rate of recycling in developed countries exceeds 90% of the total number of used motor vehicles. ELV recycling contributes to environmental protection (Hempfl 2002; Jovanovic et al., 2008).

ELV recycling reduces the exploitation of minerals from natural environments and makes the source material for production of new products derived from recycled materials (Kozic et al., 2005; Gareth et al., 2006).

Besides the economic benefits of recycling system of used motor vehicles, is an important contribution to protect the environment. Removal of environmentally harmful materials and parts, specialty oils, brake fluid, antifreeze, airbags, mercury, freon and the like-requires special treatment and expertise in areas such waste disassembly. In Germany, Centers for dismantling vehicles covered by a circle whose radius is 50 kilometers. In Serbia there are about 1.4 million passenger and light commercial vehicles. Estimated number of waste produced per year from 100.000 vehicles a year in Serbia, meaning that a larger number of operators equipped for recycling, (Afgan et al., 2009; Medic et al., 2011).

A new model of recycling vehicles at the end of the life cycle involves recycling along the entire lifecycle of the vehicle. In this way, is included in recycling of waste generated from production of raw materials to the recycling and waste materials from motor vehicles by the end of its life cycle. At the same time is a very important aspect of the model and design of new motor vehicles, which involves the use of environmental friendly material and recycling of their complete without the rest. Also, special attention is paid to energy intensity and energy efficiency as a motor vehicle, and the whole cycle of production, operation and recycling. Thus conceived model dramatically reduces the negative impact of motor vehicles on the environment, allows the use of clean and renewable energy sources, and ensures sustainable use of natural resources. Thus, this model of recycling directly positive effect on the environment and the use of energy, and indeed significantly improves the objective quality of life. On the other hand, by ensuring sustainable use of natural resources to secure a quality life for future generations, which is an essential condition for the existence of human society (Milivojevic et al., 2008; Medic et al., 2011).

RESULTS AND DISCUSSION

Recycling of vehicles at the end of the life cycle in Serbia is still in its initial stages and does not engage a significant number of workers. The research within the project of technological development is defined by the model of integrated and sustainable recycling of motor vehicles at the end of the life cycle in Serbia. Thus were laid the basis of development of new industries, thus creating real conditions for intensive employment in the recycling business. These operations include the collection and transportation of waste motor vehicles, dismantling them, the selection of components and materials, recovery of components for reuse, crushing shells and chassis, the separation of materials, recycling materials, waste disposal of the final. All this requires a different structure of the professional staff, a variety of different technologies and recycling facilities and the composition of the relevant requirements for their location (Arsovski et al., 2010; Tsuji 2006). The paper by (Milivojevic et al., 2010; Aleksic et al., 2011), given the analysis of recycling of motor vehicles at the end of the life cycle of the Republic of Serbia, and review of integrated and sustainable recycling of the same that would be a permanent solution based on the principles of sustainable development. The proposed model includes the entire life cycle of a motor vehicle of its development, production, exploitation through to its end. The basic principle is the minimization of waste in all phases of life of the vehicle. In the period of research and development of the basic requirements are installing "green" materials that are totally recyclable, easy to uninstall, the application of alternative drive; between the maximum reduction of waste production; between sustainable exploitation of recycling waste at the end of the life cycle of repair and reuse parts and components and aggregates, to maximize recycling of materials and final waste minimization. In addition to the above request and return of energy and maximum energy efficiency. Integrity of recycling is reflected in the development of complete infrastructure in the country for the full and complex recycling of motor vehicles at the end of their life cycle.

According to (Pavlovic et al., 2006; 2011), the originality of the project of an integrated system of recycling of motor vehicles at the end of the life cycle is reflected in the development of the first national information technology system based on Web-base that seeks to register and monitor the motor vehicle during the whole life cycle until Check-out vehicles. Serbia has so far not joined any systemic solution to the problem of environmental and social, economic problems and even when it comes to preserving the natural resources of our country. The project objective is to waste the potential diagnoses of motor vehicles in Serbia that can be recycled or used for energy. The most important thing is to determine the scope and structure of the permanent disposal of motor vehicles in Serbia, especially hazardous waste and propose measures for their removal or safe storage. Project (Pavlovic et al., 2011), is predicted to form the corresponding Centers for dismantling of used motor vehicles to the appropriate regions. Partner on this project and the factory Zastava, which provides data on the number of cars to be recorded as appropriate models of Zastava to this moment in the market. At the same time flag gives you instructions how to dismantle it easier for vehicles belonging to their program.

The importance of the project for Serbia is large, because our country is quite deficient in terms of resources. If we know now about 120 thousand cars a year check-out, and therefore they are ready for the recycling process, the weight of each vehicle over 1 ton, of which approximately 70 percent ferromagnetic materials, there are also non-ferrous metals, plastics, rubber - we can not imagine how it is stored resources.

CONCLUSION

Recycling of vehicles at the end of the life cycle of the proposed model is based on the principles of sustainable development. By establishing this model in Serbia, in addition to environmental and economic effects and provides a high level of employment, which is very important for social policy of the state. Thus, the overall number of employees in the cycle of recycling vehicles at the end of the life cycle ranges from 6.000 to 20.000 employees. Number of employees varies as a function of:

- the available number of ELVs in the current year,
- degree of recyclability,
- dismantling of the vehicle level,
- recycling of existing technologies,
- production of new products from materials provided by the ELV.

Of course, as a factor in employment includes the gross national income per capita because of the wealth of the country and the population depends on the size of the fleet, and thus the number of motor vehicles at the end of the life cycle in one year. In addition, the state remains the recycling of motor vehicles in order and fully in line with the proposed model to develop a new profitable industry (Arsovski et al., 2010; Gareth et al., 2006).

Republic of Serbia is also facing the problem of used motor vehicles. For now, their recycling is done sporadically and very unorganized and incidental to the environment. The way to overcome this situation is the adoption of adequate legislation and implementation of integrated and sustainable model of recycling vehicles at the end of their life cycle. The introduction of rules in this area, in addition to improving the quality of the environment, to achieve other important benefits to the state (Milivojevic et al., 2010; Guise et al., 2005).

- meeting international regulations for export of motor vehicles,
- achieving economic gains by applying the proposed model for recycling,
- provision of high quality raw materials by recycling of used motor vehicles,
- minimization of permanent, first of all, hazardous waste,
- the development of recycling industries and motor vehicles to create new jobs.

In each of the used motor vehicles are a major problem for the environment, both in volume of waste and hazardous substances at a number of which have been built. That was the main reason that developed countries adopt and implement appropriate legal arrangements to run an organized recycling of motor vehicles at the end of their life cycle. On the other hand developing models for managing waste resulting from motor vehicle during the entire life cycle, which are based on the principles of sustainable development. In this way, minimize waste and maximize material recycling and reuse of parts and components and aggregates (Milivojevic et al., 2008; 2009; Djordjevic et al., 2004).

Since operators have to be deployed on the territory of Serbia, so that the citizens of their old cars can be submitted at the nearest recycling center which will be issued the certificate on the basis of which can be achieved certain benefits when purchasing a new car. In this way, the action will involve all those involved in recycling batteries, waste oil, antifreeze, glass, plastic and everything that makes a car, and it is necessary to invest a total of around 20 million Euros, (Medic 2011¸ Tadic et al., 2010; Kozic et al., 2005).

REFERENCES

Arsovski, S., Milivojevic, J., Grubor, S., Simon Arsic, A, Tonic, N. (2010). The influence of model of integrated and sustainable recycling of motor vehicles at the end of the life cycle of the level of employment in Serbia, Quality, no. 11-12.

Aleksic, A., Bian, S., Tonic, N., Grubor, S.) 2011). Resilience of ELV Dismantling centers, the National Conference on Quality - FQ, p.105-111.

Afgan, N.H., Hovanov, N., Andre, P.M. (2009). Sustainable Management Organization With Passenger Car Example of Sustainability Assessment, International Journal for Quality Research, Vol. 3, no.2.

Guise, S., Bosdorf, Z., Goldmann, D. (2005). Life Cycle Assessment of End-of-Life Vehicle Treatment, VOLKSWAGEN AG.

Gareth, C., Shahin, R. (2006). Cost models for Increased Value Recovery from End-of-Life Vehicles, The Centre for Sustainable Manufacturing and Reuse / Recycling Rate translation.

Hempfl, C. (2010). The commercialization of recyclable materials and recycling waste in USAID.
Ilic, I. (2002). Recycling of secondary raw materials and recycling non-ferrous metals, Bor.
Jovanovic, Z., Haase, H., Ziems, D. (2008). Development phases of waste management in the German-speaking countries and challenges for Serbia's EU membership ambitions. Ekolat 2008, Soko Banja.
Junbeum K, Junghan, B. Braden, A. (2007). Recycling Systems and Management of Endof-Life Vehicles (¨vs), A Center for Sustainable Engineering Education Module, October 23rd.
Kozic, A., Sudarević, D. (2005). Access to recycling of motor vehicles, the Association for Quality and Standardization of Serbia, the Festival of quality, 32 National Conference on Quality, Kragujevac, 19-21. May.
Krstic, M., Marjanovic, Z., Brzaković, R. (2007). Management and lifecycle emissions of vehicles, the Association for Quality and Standardization of Serbia, the Festival of Quality, 2 National conference on quality of life, Kragujevac, 8-11. May.
Milivojevic, J., Grubor, S., Simon, A. (2008). The development of an integrated and sustainable recycling system of motor vehicles at the end of the life cycle in Serbia, 3 National conference on quality of life, quality festival, Kragujevac.
Milivojevic, J., Grubor, S., Simon, A. (2009). Sustainable integrated system of recycling of motor vehicles during the life cycle, the First National Conference on recycling of motor vehicles in 2009, Ecka, 06. November.
Milivojevic, J., Bian, S., Djordjevic, M. (2010). The current system's approach to recycling of motor vehicles at the end of the life cycle of Serbia, Faculty of Mechanical Engineering Kragujevac, Zastava vehicles.
Medic, D. (2011). Analysis of the economic potential of the market of used cars in Serbia, Technical Faculty "Mihajlo Pupin", Zrenjanin.
Pavlovic, M., Tolmac, D., et al. (2011). Sustainable development of technologies and equipment for the recycling of motor vehicles, the Ministry of Science and Technology of the RS. SRO: Technical faculty "Mihajlo Pupin", Zrenjanin, (2011-2014.), No. Project: 035033.
Pavlovic, M. (2009). Directions for the Development of Recycling of used cars in Serbia, the Association for the recycling of motor vehicles of Serbia, Belgrade.
Pavlovic, M., Subaru, N. (2006). Environmental logistics, Technical faculty "Mihajlo Pupin", Zrenjanin.
Djukic, Dj. (2009). Recycling car. Politics, 23. November.
Djordjevic, M., Kokic, M. (2004). Management feasibility study of recycling of used materials cars, Project Management and Entrepreneurship, Proceedings of the page. 72-76, Zlatibor, 9-12, May.
Kozic, A., Sudarević, D. (2005). Access to recycling of motor vehicles, FESTIVAL OF QUALITY, May 2005.
Tadic, D., Bian, S., Stefanovic, M., Aleksic, A. (2010). A Fuzzy AHP and TOPSIS for ELV Dismantling selection, International Journal for Quality Research, Vol. 4, No.2.
Tsuji, A. (2006). Recyclability Index for Automobiles, A Thesis Presented to the Faculty of California Polytechnic State University, In Partial Fulfillment of the Requirements for the Degree Master of Science in Civil and Environmental Engineering.

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VALORIZATION OF POST CONSUMER ALUMINUM SCRAP IN THE SHREDDING PROCESS

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ABSTRACT

In this paper we tried to determine the extraction of several aluminum alloys in post consumer aluminum scrap, which is contaminated with various impurities, polymers, plastic, rubber, oil and dust. Examinations were conducted on several samples clustered particularly, with different chemical composition, with or without the addition of salt to dissolve.

Under the quite modest melting conditions, good efficiency of aluminum extraction was achieved. Also, good separation of steel, as well as other non-metallic components from aluminum has been successfully achieved. Good quality aluminum alloys were obtained and can be sorted into two groups: high-alloy aluminum (with silica) and low-alloyed aluminum. Adverse impact of the recycling process on environmental quality has been reduced through the reduction of total emissions (organic compounds, pollutants etc.).

Keywords: aluminum scrap, recycling, Auto Shredding, environment.

INTRODUCTION

Sustainable recycling of automotive materials can have a significant impact on the conservation of materials and domestic energy use. The automobile industry is one of the largest consumers of different materials. In the case of aluminum, the automotive industry uses about one-third of the total domestic aluminum consumption. The primary energy consumed in the production of the 33 million tons of material used in the automotive sector is estimated to be about 1.5 quadrillion Btu, which is roughly 20% of the domestic industrial energy use. This consumption is equivalent to about 250 million barrels of oil. In comparison, the energy consumed in 1999 to fuel the total automotive fleet, including cars, trucks and buses, was about 3,500 million barrels of oil equivalent (Ward’s, 2000).

Passenger vehicles are extremely complex products and roughly contain about 10,000 parts consisting of approximately 40 materials (Gruden, 2008). Table 1 shows typical portions of the main material groups.

Table 1: Main composition groups of an average passenger vehicle (Gruden, 2008)

Material	Amount [mass %]
Steel and iron metals	58 – 70
Light metals (Al, Mg)	3 – 8
Plastics	8 - 18
Rubber	3 – 5
Glass	3 – 4
Operating liquids	2 – 5
Others	5 - 11

At the end of use, automobiles are usually sold to automotive dismantlers who remove the still useable parts for reuse or remanufacture, and dispose of the hazardous materials (usually consisting of vehicle fluids) in an appropriate manner. The remaining hulks, often flattened to facilitate transportation, are sent to automobile shredders, who use hammer-mills to break them into fist-sized fragments. Most of the ferrous metals are recovered by magnetic separation, while the lightweight waste material or “fluff” (ASR), comprised mainly of foam, textiles, plastics and dirt, is removed by air cyclone separation. The ferrous metal scrap is sent to steel mills for recycling, and the fluff is land-filled.

The remaining mixture of high density, non-magnetic materials is rich in nonferrous metals. It is usually sent to nonferrous metal separators for the recovery of metals such as aluminum, zinc, copper, brass, magnesium, and stainless steel. The processes employed by the nonferrous separators are water elutriation, eddy current separation, and heavy media separation. The waste material that remains, consisting mainly of dirt and fines, is land-filled.

All the ferrous metals are recovered for recycling, while the subsequent non-ferrous metal separation processes result in the recovery of the following constituent weight fractions (Dhingra et al., 1999):

Aluminum: 70.0%,
Zinc: 18.5%,
Copper and Brass: 10.0%,
Stainless Steel: 1.5%.

The environmental issues of concern in the End-of-Life stage are:

- Solid waste generated (ASR), which is land-filled; and
- Energy consumed in operating the machinery used in the end-of-life processes.

By weight, about 75% of End-of Life Vehicles (ELVs) is currently recycled in EU countries and North America. The remaining part, i.e., about 25% by weight is Auto Shredding Residue (ASR) or fluff. Since the new EU policy for car recycling indicates that by the year 2006 only 15% of the shredding residue can be sent to landfill and by 2015 this amount shall be reduced to 5% there is certainly need for considering these facts and try to recycle fluffs. In addition the afore mentioned new EU policy states that 10% of ASR can be incinerated, which means the composition of the fluff to be combusted must be good enough to avoid any environmental problem (Manouchehri, 2007).

There are different ways for treating residues from shredding plants which result in material recycling or energy recovery or both. Most of the treatment methods are chemically oriented methods, however, there are some physical separation techniques in order to reduce the amount of metals content and some other reusable materials in order to improve the combustibility of the organic matters and protect the environment. Due to differences among the density of materials within ASR it should be possible to separate some components from other by density separation (Manouchehri, 2007).

The composition of a typical car has changed substantially in recent years. For example, ferrous metal content has significantly decreased as lighter; more fuel-efficient materials such as plastics are incorporated into vehicle design. Demands for more fuel-efficient vehicles to reduce energy consumption and air pollution are growing fast which is a challenge for automotive industry. Aluminum is a good replacement for heavier metals like steel and copper in automotive industry due to its characteristics regarding high strength stiffness to weight ratio, good formability, as well as good corrosion resistance and recycling potential. The consumption of aluminum for European automotive industry reaches to 1.9 million tones, in the year 2005 in comparison with its consumption of 0.675 million tones, in 1994. This means an increasing of 200% within 10 years. Due to recent information the total consumption of aluminum in a car will rise considerably from 110 kg in 1996 models to 250 or 340 kg, with or without taking body panel or structure applications into account, by the year 2015 (Lui et al., 1998, Field, 2000).

There are strong predictions for aluminum applications in hoods, trunk lids and doors hanging on a steel frame. With this respect significant increase in sheet aluminum consumption will be expected for automotive industry in Europe. For casting aluminum a key trend has been the switching the use of cast iron for engine blocks to aluminum, resulting in significant weight reduction. It was expected that more than 50% of motor engines change to aluminum blocks in 2000.This must be noted that although aluminum has a realistic chance to capture a grater share in car body and motor applications, but, its penetration in automotive industry has been limited up to now due to factors like, raw material cost, manufacturing cost, industrial structure, recycling, regulations, etc (Manouchehri, 2007).

Increasing share of aluminum has positive impact on the viability of dismantlers. It means that if more parts are made from aluminum the dismantling rate will be significantly higher than the today’s 15%. The profitability will increase to 50% or even more by 55% aluminum substitution. Shredders will also experience an improved profitability due to lower hulk weight and increased revenue from aluminum. With 15% aluminum substitution, the profitability of shredders will increase by 40%. However, the effect of non-ferrous separators is positive but not as high as shredders and dismantlers. By considering the current technology used for non-ferrous separation, it is assumed that the aluminum scrap is sold as a mixed scrap. However, if the separation of different aluminum products is achievable the profitability will be considerably enhanced. Today the recycling rate of automotive aluminum is estimated to be between 85 and 90%, and the product of recycling secondary foundry alloy casting constitutes fully 60-70% of the aluminum used on current vehicles. The sheet and extrusion scraps which form the minority portion of the total weight measured, are recycled into casting alloys because secondary casting in general have a greater tolerance for alloying elements and impurities than d sheet or extrusion products. With increasing growth in the use of sheet and extrusion there will be a need to separate sheet, extrusions and casting during the recycling process. Then sorting is needed for separating different aluminum alloys (Manouchehri, 2007).

EXPERIMENTS

Samples, used in further analysis, were taken from the shredder plant and represent post consumer aluminum scrap from the unclean construction waste and from automotive shredding process. In total there are four samples with different chemical composition, which are classified into specific groups of aluminum waste, based on the uniformity of the material (see also Table 2).

Table 2: Samples of aluminum waste, classification

Sample name	Sample type	Class of the sample
Sample 1	Low alloyed (LA) aluminum	S. 1.1 - small compact pieces S. 1.2 - large, thick pieces S. 1.3 - large compact pieces, profile and sheet S. 1.4 - Lighter, thin, crumpled pieces, painted and oiled
Sample 2	High alloyed (HA) aluminum (higher share of Si)	S. 2.1, 2.2, 2.3, 2.4 - identical shredder granulates without any visible impurities
Sample 3	Low alloyed aluminum	S. 3.1, 3.2, 3.3 - identical shredder granulates without any visible impurities
	Zorba scrap of aluminum* (with Cu, Zn, Fe)	S. 3.4 - silumin, pieces of broken material, oiled S. 3.5 – soft aluminum, crumpled sheets, strips, profiles S. 3.6 - combined, inconsistent
Sample 4	Low alloyed aluminum	S. 4.1 - clean pieces, wires, rods, tubes, profiles S. 4.2 - irregularly shaped pieces, painted S. 4.3 - crumpled sheet, larger pieces, various forms
	High alloyed aluminum *	S. 4.4 – silumin, smaller equal pieces S. 4.5 – silumin, larger pieces S. 4.6 - combined plate pieces with irregular shapes pieces, painted, oily

* Manually removed the brass, Zn, Fe, Cu - cables, plastics, rubber, dust

The impurities, dust, non-metallic fractions (polymers, plastics, rubber, textile), and metallic parts made of tin, brass, zinc, copper, steel, etc. are removed manually from the samples. Some of the samples are shown in Figure 1.

After classification, each batch (sample) has a weight of 10-13 kg. Batch is melted in induction furnace, under the following operating conditions: plumbago crucible with and without salt as liquefier, open bath, mechanical removal of slag with intensive combustion. Temperature in the furnace was maintained above 690^{o} C. After melting the samples were cast into molds and cooled at room temperature.

During intense merging of samples, the smoke of different intensity and colour was released. In more contaminated samples (oil, paint) the smoke was dense and more intense.

Figure 1. Samples of aluminum waste: a) Sample 1.1, b) Sample 1.4, c) Sample 2, d) Sample 3.4, e) Sample 4.6, f) Sample 4.2

Chemical analysis of aluminum castings was performed on optical emission spectroscopy, according to the standard method: JUS C.A1.011:2004. The results of chemical analysis are shown in Table 3.

Table 3: Chemical analysis of cast aluminum, optical emission spectroscopy

Sample	Al	Si	Cu	Fe	Zn	Mg	Mn	Ni	Pb	Sn	Ti
	Weight %										
S 1.1	93.57	0.87	1.31	0.54	2.00	0.35	0.22	0.28	0.20	0.39	0.09
S 1.2	95.75	1.07	0.24	0.60	0.52	0.23	0.44	0.20	0.42	0.34	0.05
S 1.3	96.81	0.93	0.23	0.50	0.60	0.24	0.15	0.10	0.10	0.15	0.05
S 1.4	90.35	0.81	5.77	0.57	0.73	0.13	0.31	0.28	0.36	0.46	0.08
S 2.x [a)]	82.83	7.57	2.91	0.62	2.80	0.69	0.36	0.34	0.92	0.67	0.15
S 3.x [b)]	97.49	1.34	0.03	0.27	0.08	0.50	0.12	0.01	0.03	0.05	0.02

S 3.4	89.11	7.60	1.50	0.44	0.20	1.60	0.20	0.005	0.036	0.05	0.021
S 3.5	97.05	0.86	0.074	0.31	0.92	0.45	0.16	0.016	0.036	<0.05	0.021
S 3.6	84.74	6.78	1.11	0.73	5.43	0.67	0.21	0.09	0.10	0.044	0.039
S 4.x [c)]	94.37	0.91	0.51	0.47	2.18	0.45	0.28	0.18	0.18	0.28	0.05
S 4.x [d)]	82.85	6.94	2.04	0.78	4.42	0.61	0.39	0.46	0.51	0.70	0.14

a) Average chemical composition of HA aluminum S 2.1, 2.2, 2.3, 2.4
b) Average chemical composition of LA aluminum S 3.1, 3.2, 3.3
c) Average chemical composition of LA aluminum S 4.1, 4.2, 4.3
d) Average chemical composition of HA aluminum S 4.4, 4.5, 4.6

Melting of Samples 1 and 2 was proceeded without adding of salt as liquefier, while the Samples 3 and 4 were treated with salt as liquefier (type ZDJAR new). Removed slag is rich in aluminum and other metals, so it is possible to treat and commercialize it. Utilization of aluminum, percent of slag, burnt and magnetic fractions was measured and results are shown in Table 4.

Table 4: Utilization of aluminum from aluminum waste, share of slag, loss and magnetic fractions

Sample	Input, kg	Out, kg	Utilization, %	Slag, %	Loss, %	Magnetic fractions, %
S 1.1	11.00	9.46	86.04	11.18	2.82	
S 1.2	11.00	9.56	86.90	11.18	1.91	
S 1.3	11.00	9.35	85.00	13.72	1.27	
S 1.4	11.00	8.90	80.90	16.77	2.36	
S 2.x [a)]	50.68	47.70	94.12	3.72	1.69	0.47
S 3.x [b)]	39.00	35.54	91.11	8.23	0.54	0.11
S 3.4	11.20	9.285	82.90	12.63	0.64	3.83
S 3.5	10.10	8.94	88.51	9.45	1.84	0.19
S 3.6	11.30	9.16	81.06	8.67	10.01	0.26
S 4.x [c)]	33.90	29.71	87.59	9.62	3.04	0.35
S 4.x [d)]	41.50	37.98	91.50	7.52	0.96	0.00

a) Sum of HA aluminum, samples: S 2.1, 2.2, 2.3, 2.4
b) Sum of LA aluminum, samples: S 3.1, 3.2, 3.3
c) Sum of LA aluminum, samples: S 4.1, 4.2, 4.3
d) Sum of HA aluminum, samples: S 4.4, 4.5, 4.6

DISCUSSIONS

In this paper we tried to, under controlled conditions, determine the possible extraction of aluminum from post consumer aluminum scrap (unclean construction waste, low economic value of scrap and aluminum scrap from automotive shredding process). This types of aluminum waste was contaminated with a variety of impurities (dust, oil, paint, polymers, textile, rubber) as well as other metals and alloys (steel, brass, Zn, etc.).

Before the melting of waste, manual removal of visible impurity was preformed, but some of the oil, grease and paint remain on the aluminum filings. This directly affects on aluminum extraction from waste, which indicates that utilization of aluminum from the sample S 1.4, which is very oiled and painted, is 80.50 % and utilization of same sort of sample (S 1.2, 1.3, 1.4) is over 85 %, which are much cleaner and less painted.

In addition to reducing extraction of aluminum from the waste, these types of pollution have very harmful impact on the environment, so it is a necessary to accomplish a previous treatment of waste. This treatment can be chemical (e.g., in solution) or physical treatment (e.g., flow of warm air).
On utilization of aluminum from the waste also affects the compactness of sample pieces. Greater compactness and increased thickness of the pieces lead to a larger excerpt of aluminum from waste.

Removing the slag was carried out mechanically and batch melting was done in relatively small quantities (the average weight of the charge is around 12 kg) which led to a high percentage of slag. Thus obtained slag is very rich in metals so the further treatment is necessary.

Based on these results we conclude that, in the industrial conditions, this type of waste is necessary to be pre-treated (removal of dirt, oil, paint, dust, rubber, polymers, pressing of pieces etc.) to get as much utilization of aluminum. Also, larger batch quantities are required as well as better treatment of slag.

Chemical analysis of aluminum castings demonstrate that it is possible to get several aluminum alloys. Melting of LA (low alloyed) aluminum we obtained alloys with up to 97 % of aluminum and about 1 % of silica. Melting of HA (high alloyed) aluminum (S 2, S 4.4, 4.5, 4.6) we obtained alloys with up to 82 % of aluminum and about 7 % of silica. The share of iron in mold of aluminum alloys is fairly constant and is ranges from 0.27 % to 0.78 %. The share of cooper in mold of aluminum alloys is ranges from 0.27 % to 0.78 %. The percentage of zinc varies from 0.08 % to 5.43 %, as a consequence of different share of zinc reach pieces.

Alloying and combination with other aluminum alloys it can be obtained 6000 series and 5000 series aluminum alloys which are widely used in the automotive industry.

Alloys in 6000 series utilize magnesium and silicon in various proportions to form magnesium silicide, making them heat treatable. A major alloy in this series is 6061, one of the most versatile of the heat-treatable alloys. The magnesium-silicon (or magnesium-silicide) alloys possess good formability and corrosion resistance with high strength. Parts made of this alloys are: body components (extruded), brackets (extruded and sheet), suspension parts (forgings), driveshafts (tubes), driveshaft yokes (impacts and forgings), spare tire carrier parts (extruded), bumper reinforcements, mechanical fasteners, brake cylinders (extruded), wheels (sheet), fuel delivery systems, outer and inner body panels, load floors, bumper face bars, bumpers reinforcements, structural and weldable parts, seat shells, etc. (The Aluminum Transportation Group).

Magnesium is one of the most effective and widely used alloying elements for auto aluminum, and is the principal element in the 5000 series alloys. When it is used as the major alloying element or combined with manganese, the result is a moderate- to high-strength, non-heat-treatable alloy. Alloys in this series are readily weldable and have excellent resistance to corrosion, even in marine applications (The Aluminum Transportation Group).

In our research we obtained different types of aluminum alloys. Processing LA aluminum waste (samples: S 1, S 3.1, 3.2, 3.3, S 4.1, 4.2, 4.3) less share of silica was derived (up to 1%), and processing HA aluminum waste (samples: S 2, S 4.4, S 4.5, S 4.6) higher share of silica was derived. Share of magnesium was various from 0.13 to 1.6 wt. %, and it is extremely dependent of casting conditions. In industrial conditions of the aluminum waste processing, higher proportion of magnesium is expected. Mixing of these alloys with small quantities of primary aluminum and the appropriate amount of alloying elements it is possible to obtain alloy series 6000 and 5000. This is important because it would achieve closed loop recycling of aluminum in automobiles industries (see also Figure 2).

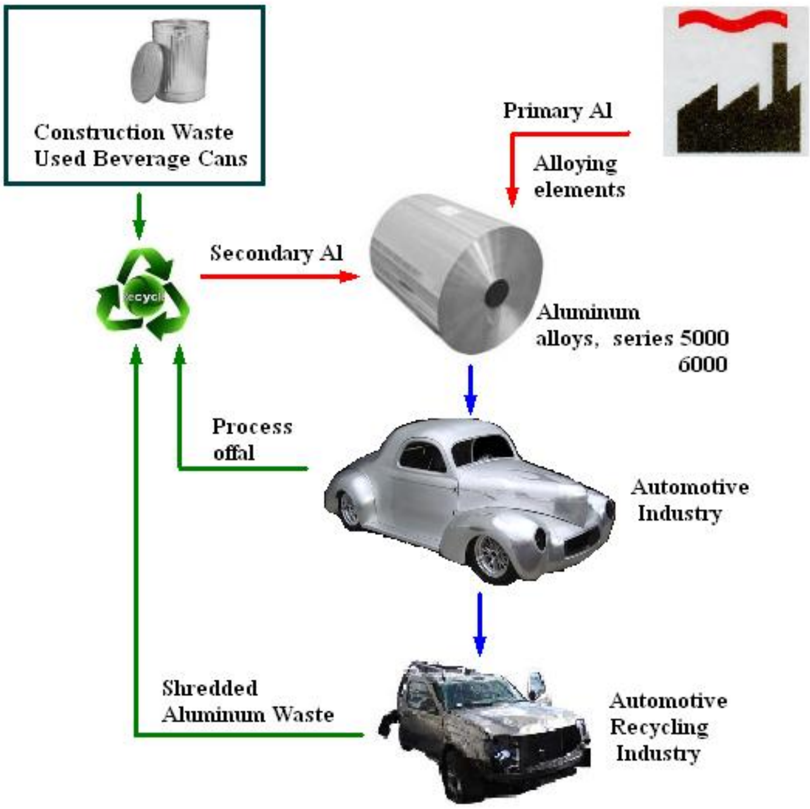

Figure 2. Closed loop recycling of aluminum

Geoff Scamans (2006) suggested obtaining aluminum alloy series 5754 with mixing of secondary aluminum from automotive recycling industry, secondary aluminum obtained from the UBC (used beverage cans) and primarily obtained aluminum.

This is important both for the Automotive Industry and Automotive Recycling Industry, because it would close the loop in flow of the aluminum which has a positive impact on the sustainability of these industries. In the automotive industry it would be possible to increase uses of parts made of aluminum-based alloys obtained in this way, due to lower prices. Automotive recycling industry would produce a greater amount of secondary aluminum (which is several times more expensive than secondary steel), which directly affects on development of this industry.

CONCLUSION

As the automotive industry is one of the largest consumer of many materials, it follow that the automotive recycling industrial is a very important source of secondary raw materials. In recent decades, with technological development, customer demand is increasing so that the complexity of the vehicle is inevitable. The complexity of the vehicles is reflected in the variety of materials, which require special treatment after the end of life cycle of vehicles. If the recycling of ELV is not properly carried out, without major losses in the material and energy efficiency, it can highly affect on the automotive industry as well as other related industries.

Replacement of steel parts in a car with aluminum parts is inevitable, hereby necessary special treatment of such waste in the automotive recycling industry is essential.

In this paper it is shown, under controlled conditions, extraction of aluminum from unclean construction waste (low economic value of scrap) and from automotive shredding process is possible with efficiency up to 97%. In industrial conditions, with the previous batch preparation and melting of large quantities of waste, it is easy to achieve aluminum extraction up to 99% (or even more). This high usage of aluminum from the waste is attributed to the process of preparing of waste before melting, and by that is meant to remove ferrous parts, non-ferrous parts as well as non-metal parts (plastics, rubber and dust) from the aluminum waste. Thus obtained aluminum alloys can be mixed with other alloys of aluminum (which have also received with recycling procedures), obtaining an aluminum alloy that is suitable for vehicle manufacturers.

Besides economic benefits, recycling and increased use of aluminum in the automotive industry strongly influences on the ecology of urban areas. Traffic sector is the most significant emission source, primarily due to large number of old vehicles and the use of low quality fuel (Ministry of Environment and Spatial Planning of the Republic of Serbia, 2010).

A large number of cars in urban areas lead to a major environmental problem, which is reflected primarily in the exhaust gases. This amount of exhaust gas can be significantly reduced by introducing lighter materials in automobiles, first of all aluminum alloys, which will reduce weight of vehicle, decrease energy consumption and after all emission of gases. Influence of vehicles powered by alternative energy sources, to reduce environmental pollution in urban areas, is a great. The complexity of these vehicles entails the complexity of the recycling process which must be taken deliberately and without large losses in the material and energy.

Despite this, a problem caused by inappropriate and inefficient procedure of recycling materials from vehicles or consumer goods is significant. The PCDD/PCDF (polychlorinated dibenzo-*p*-dioxins, polychlorinated dibenzofurans) and PCB (polychlorinated biphenyls) released from shredder plants are from industrial, intentional production and have been introduced with oils, dielectric fluids, and other materials contained in these vehicles or consumer goods and which are simply set free through this mechanical process. Sources of dioxin precursors that may result in the formation of PCDD/PCDF when burnt include PCB-containing condensers, PCB- or chlorobenzenecontaminated waste oils or textiles, and polymers containing brominated flame retardants (formation of polybrominated dibenzo-p-dioxins (PBDD) and polybrominated dibenzofurans (PBDF) as contaminants) (Stockholm Convention Secretariat, 2004).

In our experiments by removing of non-metallic materials (primarily polymers, rubber, oil and dust), from this types of waste, emissions of harmful compounds (PCB, PCDD/PCDF, etc.) in the environment are significantly reduced.

REFERENCES

Dhingra, R., Overly, J., Davis G., (1999) Life-Cycle Environmental Evolution of Aluminum and Composite Intensive Vehicles, *The University of Tennessee Center for Clean Products and Clean Technologies, Report.*

Field, F., (2000) Recycling infrastructure stability transfer pricing analysis, *IMVP Meeting Presentation.*

Gruden, D., (2008) Umweltschutz in der Automobilindustrie, *Vieweg + Teub-ner, Wiesbaden*, pp. 289-327.

Liu, S.X., Winslow, G.R., Yester, S., Gromek, G.P., (1998) Shredding late model Chrysler vehicles, ASR sample collection and characterization of ASR, *International Congress & Exposition, SAE Technical Paper Series, 980480.*

Manouchehri, H., R., (2007) Looking at Shredding Plant Configuration and Its Performance for Developing Shredding Product Stream, *Northland Oretech Consulting Co., Report (ISSN 0280-249X).*

Ministry of Environment and Spatial Planning of the Republic of Serbia, (2010) National Implementation Plan for the Stockholm Convention

Scamans, G., (2011) Closed Loop Recycling of Aluminum Sheet: from Cans to Cars, *Innoval Technology and BCAST*, Brunel University.

Stockholm Convention Secretariat, (2004) Shredder Plants for Treatment of End of Life Vehicles, *Information document prepared for the 3rd Session of the Expert Group on BAT/BEP*, website: www.pops.int

The Aluminum Transportation Group, (2011) Aluminum Processes and Materials, website: http://aluminumintransportation.org/main/aluminum-processes-and-materials/aluminum-processes-and-materials, The Aluminum Association, INC.

Ward’s (2000) Ward’s Motor Vehicle Facts & Figures 2000, *Ward’s Communications*, Southfield, Mich.

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LFG COLLECTION SYSTEM – NOVI SAD CASE STUDY

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ABSTRACT

Bearing in mind that only small number of the landfills in Serbia are merely controlled dump sites and that good waste management practice is not widely applied; some difficulties arise when collection of landfill gas (LFG) at these landfills comes to the question. Regular LFG analysis on gas extraction wells was conducted for several years at Novi Sad landfill and an idea of gas collection experiment formed. The idea was to connect gas extraction wells with highest methane concentration to a single pipeline that would collect LFG from these wells using a vacuum pump and to see what data can be obtained about concentration of LFG constituents and how the system would behave at non sanitary conditions. The main goal of this paper is to present the problems that occur with landfill gas collection at non sanitary landfills in Serbia and possibilities of its utilization.

Key words: Landfill, gas, collection, problems, utilization.

INTRODUCTION

Landfill gas (LFG) is a flammable and potentially harmful gaseous mixture consisting mostly of CH_4 and CO_2 together with trace amounts of a number of volatile organic compounds (VOC).

Methane (CH_4) is an important green house gas, with a global warming potential of 21-25 times greater than carbon dioxide (Brasseur, 1998; He 1997). Methane emissions from landfills are estimated to account for 3-19% of anthropogenic CH_4 on a global scale (US EPA 1994). The Kyoto protocol defines the need to reduce imbalance between methane and carbon dioxide emissions, and the White book of the European Union defines the policy for utilizing renewable energy sources. Methane from landfills as an energy source became attractive partly in order to prevent atmospheric pollution, and partly due to energy potential of methane. The policy of increasing proportion of renewable energy sources in the overall energy production, as well as great dependence of energy imports in our country, have oriented re searches towards possibilities for utilizing LFG.

Landfill gas is produced by bacterial decomposition, which occurs when organic waste is decomposed by bacteria naturally present in the waste and in the soil used for landfill cover (Dunfield et al, 1993; Fornes, 2003; Hanson et. al, 1996; Higgins et. al, 1981; Wise et. al, 2001). When deposited in a landfill a proportion of biodegradable waste fraction will begin to degrade through biological and chemical reactions. Waste components that contain significant biodegradable fractions are food, garden waste, textiles, paper, and cardboard products. Bacteria decompose organic waste in four phases, and the composition of the gas changes during each phase (Cheremisinoff, 2003).

Permanencies of methane generation rate and concentration level are crucial for determination of landfill gas energy potential. For achieving optimum energy utilization, composition, and constancy of land fill gas, the generation level represents the most important factors. However, there are many factors affecting the composition and generation of land fill gas. The most important factors are meteorological parameters (temperature, precipitation, atmospheric pressure, and air humidity), age and type of waste, as well as the site management practice (Akesson, 1998; Mata-Alvarez, 2003).

Meteorological parameters have great influence on the generation, composition, and migration of landfill gas into landfill body. Decreases in atmospheric pressure are associated with increased emissions of LFG and hence methane from landfills. Precipitation, snow cover and ice sheets at the landfill surface may substantially influence on emission and composition of landfill gas (Meres et. al, 2004, Christophersen et. al, 2001). However, increased precipitation may result in enhanced generation of CH_4. Seasonal changes also affect on landfill gas generation.

LANDFILL GAS GENERATION PROCESS

Methane production is an anaerobic biological process. It occurs naturally in the gut of living organisms, such as cows and humans, or on landfills in absence of oxygen. In MSW landfills organic components start to undergo biochemical reactions after disposal. In the presence of atmospheric air that is near the surface of the landfill, the natural organic compounds are oxidized aerobically, a reaction that is similar to combustion because the products are carbon dioxide and water vapor. However, the principal bioreaction in landfills is anaerobic digestion that takes place in three stages. In the first, fermentative bacteria hydrolyze the complex organic matter into soluble molecules. In the second, these molecules are converted by acid forming bacteria to simple organic acids, carbon dioxide and hydrogen; the principal acids produced are acetic acid, propionic acid, butyric acid and ethanol. Finally, in the third stage, methane is formed by methanogenic bacteria, either by breaking down the acids to methane and carbon dioxide, or by reducing carbon dioxide with hydrogen (Schwart R., et. al., 2005).

The process that produces methane is a naturally occurring process that can be managed, and is compatible with nutrient recycling, waste treatment, and odor control at landfill site. Both temperature and pH are critical to the production of methane. Methane only occurs in the absence of oxygen (anaerobic atmosphere), but can occur between 4° C and 60° C. Gas production increases with increasing temperature and anaerobic bacteria are most comfortable in a slightly alkaline environment (pH 7.5-8.5) (Schwart R., et. al., 2005).

Methane produced in an anaerobic landfill conditions is similar to natural gas emerging from a gas well. However, natural gas has a higher calorific value than pure methane because natural gas contains other high energy hydrocarbons. Methane in the presence of oxygen is a highly combustible gas and it can be burned in an internal combustion engine to turn an electricity generator or to heat water (Schwart R., et. al., 2005).

Part of the methane generated in landfills can be captured and used as a renewable energy source. In contrast, when methane is allowed to escape to the atmosphere, it has a global warming potential that IPPC estimates to be 23 times greater than that of the same volume of carbon dioxide (Themelis J.N., Ulloa A.P., 2006).

The simplest utilization of landfill gas is burning it with flare, which represents better solution to letting the gas go freely in the atmosphere.

NOVI SAD LANDFILL CHARACTERISTICS

The existing landfill is located 6 km north of the Novi Sad city centre. The distance from the nearest residential settlements is around 700 m (Vujic, et. al., 2010).

Total area of land fill covers 56 ha of which area covered by waste is approximately 22 ha, with fill depth of 2.5-15 m. Landfill has been operating almost 30 years and around 2.000.000 m^3 of municipal and building-demolition waste have been deposited until now. Today landfill receives 360 tons of waste per day, while 3.6 tons of recyclables per day is extracted within the waste separation unit located at the landfill site. Remaining amount of waste is landfilled without any pretreatment. After closure of this site, waste will be deposited at the new landfill site which is located near operating landfill (Vujic, et. al., 2010).

Landfill exploitation started on Field IIIa (see figure1), and after closure of that field it continued on Field I, Field II, and Field IIIb. During closure of Field I, Field II, and Field IIIa in 2001, waste was covered with inert material. Also, leachate drainage and passive gas extraction system were installed and collection tanks for leachate were built. These improvements have contributed to elimination of odors, prevention of water courses pollution and reduced risk of explosion. During closure, installation of gas extraction wells was also performed in order to enable migration of landfill gas into the atmosphere and to prevent accumulation of methane in land fill body. The Field I has 29 gas extraction wells installed, Field II has 33, while Field III consists of two subfields IIIa and IIIb, with 43 gas extraction wells. The wells are distributed across entire landfill body but most of them were placed near land fill boundaries in order to prevent horizontal migration of landfill gas outside the landfill body (Vujic, et. al., 2010).

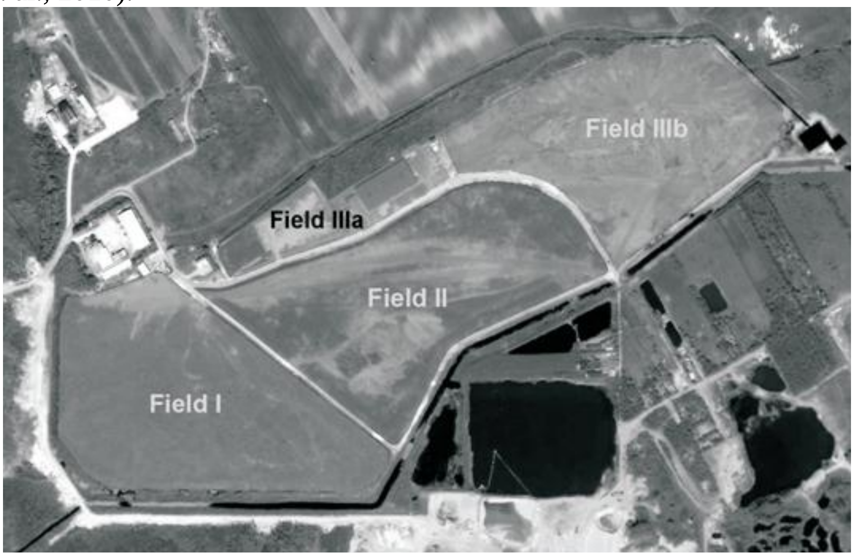

Figure 1. Position and view of Novi Sad landfill (Vujic, et. al., 2010)

Installed passive system for landfill gas extraction, passive gas wells, operates on pressure difference and gas diffusion from landfill body into the atmosphere (Gebert and Groengroeft, 2006). Adopted standards for passive systems are ventilation openings “wells” which are made from perforated plastic tubes wrapped with a layer of gravel (see also figure 2). Extraction well diameters are 0.5-1.0 m and their depth varies 50-90% of the waste depth (Vujic et. al., 2010).

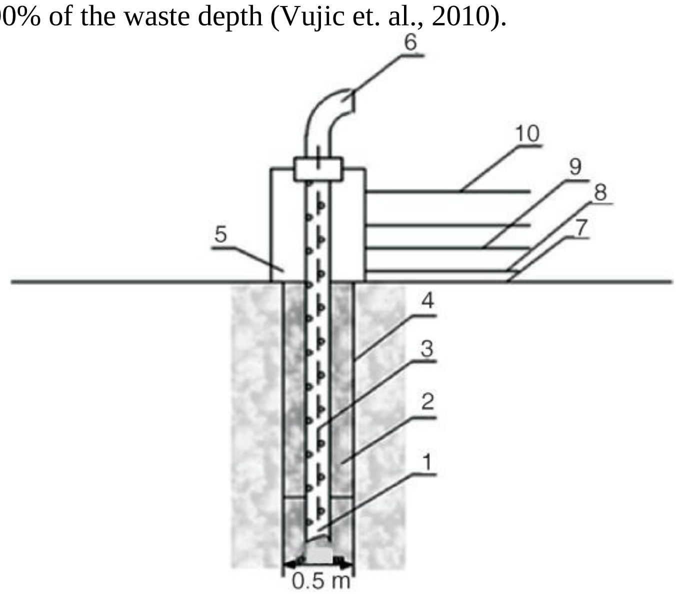

Figure 2. Gas extraction well scheme: (1) – existing garbage, (2) – gravel with granulation over 32mm, (3) – plastic perforated tube Ø160mm, (4) – protective insulation, (5) – concrete cover Ø700mm, (6) – exhoust pipe, (7) – final layer of waste, (8) – foil, (9) – inert cover, (10) - humus (Vujic, et. al., 2010)

EXPERIMENTAL LFG COLLECTION SYSTEM

Concentration of methane in LFG at gas extraction wells at Novi Sad landfill had been monitored for several years, especially in last 3 years, when, whole landfill area had been covered with wells. The gas analysis was carried out four times per year (one analysis per season) and its results implied that there are 14 wells with concentration of methane higher than 25%vol, of which 10 are located at Field IIIb.

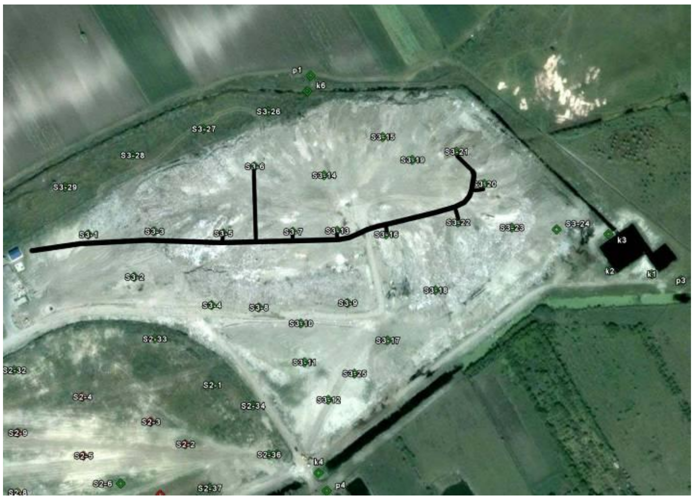

Figure 3. Connected gas extraction wells and main pipeline

This field is most appropriate for building experimental LFG extraction pipeline as it is closed for garbage disposal for 3 years and there are no machines working at it. Other than that, this field is the only one that was recently closed hence the methane production is at its beginning phase. Having all this in mind it was decided that Field IIIb is the best option for conducting research.

Based on perennial landfill gas analysis which showed constant high concentration of methane gas at several wells the decision was made to experiment with connecting these wells on a central pipeline, to investigate their behavior and possibilities of LFG usage and its benefits at non sanitary landfills. The idea behind this project is to learn how LFG collection would work on non sanitary landfills and to use the collected gas for operating a flare, thus reducing the amount of methane gas released to the atmosphere.

For purposes of this project a main pipeline had been constructed with 8 gas extraction wells, which fulfilled certain criteria, connected to it (see figure 3). The main pipeline was then connected to the side channel blower with frequency regulator (figure 4). The criteria for well selection were the methane concentration and proximity to the pump station. Methane concentration at these wells ranges from 15–53%vol depending on the well and time of the year (see table 1).

Figure 4. Side channel blower

Table 1: Results of seasonal gas analysis at connected gas extraction wells

Well	Concentration [%vol]							
	August 2009.	November 2009.	December 2009.	April 2010.	July 2010.	November .2010.	February 2011.	July 2011.
S3-5	24,2	34,1	-	22,7	15,7	29,5	19,5	23,3
S3-6	50,5	30,4	30,2	28,6	25,5	47,1	29,3	25,6
S3-7	42,4	21,5	20,9	43,4	29,1	44,1	30,9	35
S3-13	46,3	34,1	33,1	59,6	21,1	59,8	42,5	34
S3-16	40,5	46	49,4	61,3	53,2	51,5	35,1	35,2
S3-20	40	58,7	59,8	60,9	52,7	58,1	53,8	47,8
S3-21	49,1	49,8	51,3	45,5	-	50,4	38,9	37,4
S3-22	46,5	-	62,9	59,5	25,7	39,9	27,8	24,2

When the pipeline was put into operation first measurements were taken and gas flow adjusted to avoid excessive gas drainage and with it oxygen infiltration through the landfill surface. Methane concentration at exhaust of the pump was measured at 35.5%vol with flow rate of 26m^3/h, but unusually high concentration of oxygen emerged (7.6%vol). Later inspection of pipeline showed that this was due to incorrectly built gas extraction wells (figure 5) and too high gas flow through the line.

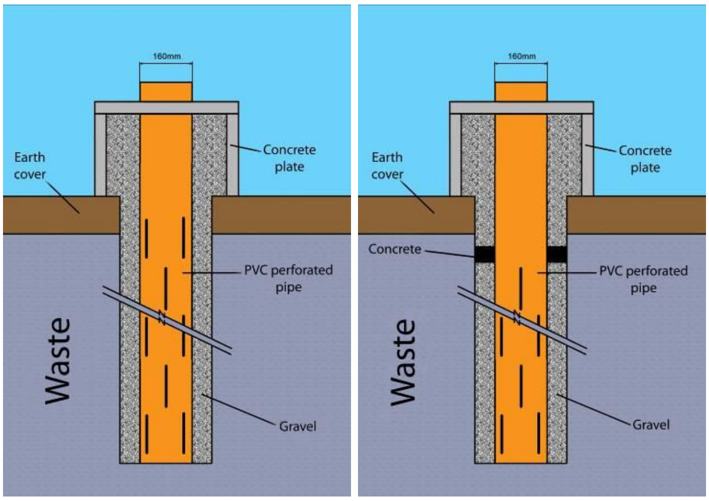

Figure 5. On the left – incorrectly built well, on the right – correctly built gas well

Modifications to the wells were needed to correct the flaws in their construction. The action consisted of putting a 110mm wide solid pipe, 3m long with two seal rings into the well. The diameters of the seal rings are 159mm and 170mm. The purpose of the smaller seal ring is to reduce the amount of oxygen pulled from the surface part of the perforated well pipe as it is placed 2.5m into the well and purpose of the larger ring is to hold the smaller solid pipe from falling into the well (figure 6). All the junctions at the wellheads were sealed with silicone to ensure there is no air infiltration at the pipeline itself. This action showed little effect because of absence of valve at the wellhead which regulates gas flow through the well and because there is no way of making a perfect seal at that depth.

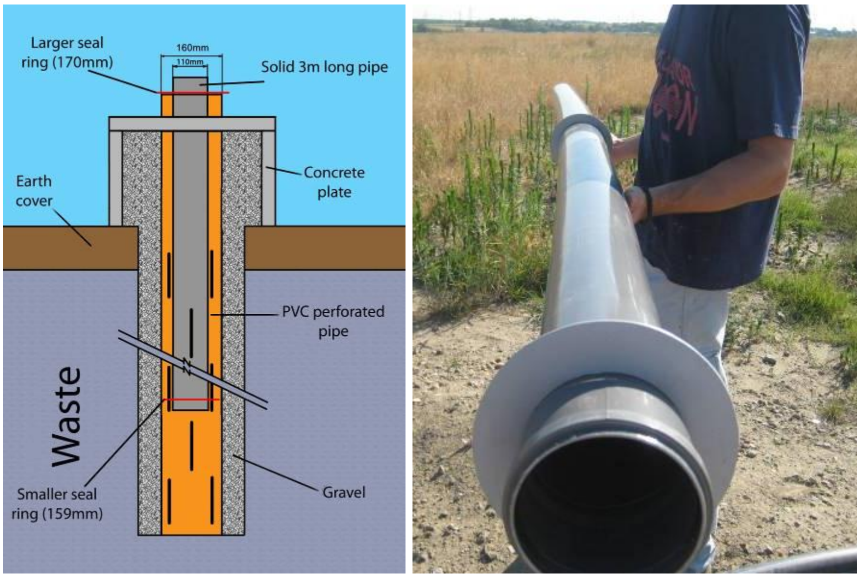

Figure 6. On the left – modifications done to the gas extraction wells; on the right – solid pipe drawn into the well

After the modifications to the wells mentioned above and adjustment of the gas flow another set of gas analysis were taken. As mentioned above the results of well modifications showed little effect, methane concentration was unchanged, which was not so unusual, but the oxygen concentration was unchanged also. Because of high oxygen concentration the only solution to remove its presence was to further reduce the gas flow rate through the pipeline. When gas flow was reduced from 26 to $13m^3/h$, oxygen levels in the pipeline dropped to 3.4%vol which is an acceptable value for safely combustion and methane concentration rose to 47%vol (figure 7).

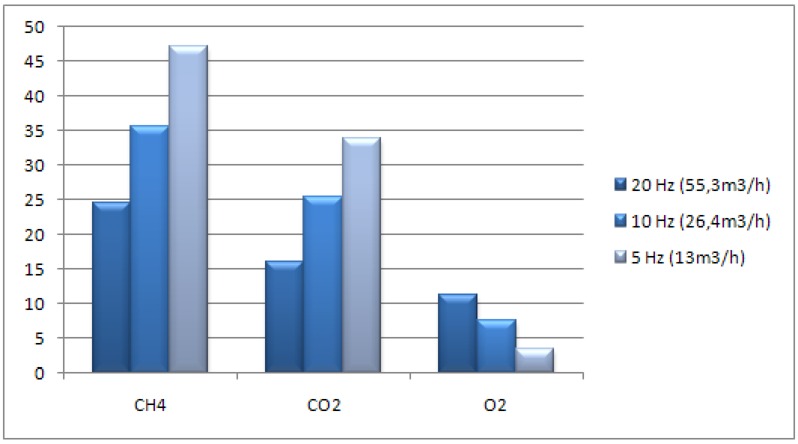

Figure 7. Methane, carbon dioxide and oxygen concentrations at different gas flow rates

CONCLUSIONS

This is the first project of this type in Republic of Serbia and this paper is representing operational and managing problems occurring during project development. There are some modifications to the pipeline that need to be done before the project is finished. To be more precise, a valve to each wellhead needs to be installed in order to reduce the oxygen concetration.

The most important part of collecting landfill gas which this project showed is careful gas extraction. The landfill processes are giving off methane at their own rate and it can be collected at that rate only. Any excessive gas collection, especially at non sanitary landfills, will result in shutting down of methanogenic processes and, as direct consequence, a drop in methane production. This happens because the oxygen from the surface is being pulled into the landfill body thus creating conditions for aerobic waste decomposition.

After the modifications are placed and gas flow adjusted at each well it will be time to install a flare that will combust the collected landfill gas.

REFERENCES

Brasseur, G. P., *et al*., European Scientific Assessment of the Atmospheric Effects of Air craft Emissions, *Atmospheric Environment*, *32* (1998), 13, pp. 2329-2418

He, C., *et al*., A Catalytic/Sorption Hybrid Process for Land fill Gas Cleanup, *Industrial and Engineering Chemistry Research*, *36* (1997), 10, pp. 4100-4107

Dunfield, P., et al., Methane Production and Consumption in Temperate and Subarctic Peat Soils: Response to Temperature and pH Soil, Biology and Biochemistry, 25 (1993), 3, pp. 321-326

Fornes, L., Ott, C., Jager, J., Development of a Landfill Cover with Capillary Barrier for Methane Oxidation – Methane Oxidation in a Compost Layer, Proceedings, 9th International Waste Management and Landfill Symposium, Sardinia, Italy, 2003, pp. 167-168

Hanson, R. S., Hanson, T. E., Mathanotrophic Bacteria, Microbiol. Rev., 60 (1996), 2, pp. 439- 471

Higgins, I., et. al., Methane-Oxidizing Microorganisms, Microbiological Reviews, 45 (1981), 4, pp. 556-590

Wise, M. G., Mc Arthur, J. V., Shimkets, L. J., Methylosarcina Fibrata Gen. Nov., Sp. nov. and Methylosarcina Quisquiliarum sp. nov., novel type 1 Methanotrophs, International Journal of Systematic and Evolutionary Microbiology, 51 (2001), 2, pp. 611-621

Cheremisinoff, N. P., Hand book of Solid Waste Management and Waste Minimization Technologies, Elsevier Sciences, 2003

Akesson, M., Nilsson, P., Material Dependence of Methane Production Rates in Landfills, Waste Management & Research, 16 (1998), 2, pp. 108-118

Mata-Alvarez, J., Fundamentals of the Anaerobic Digestion Process, in: Biomechanization of the Organic Fraction of Municipal Solid Wastes (Ed. J. Mata-Alvarez), IWA Publishing, Lon don, 2003, pp. 1-19

Meres, M., et. al., Operational and Meteorological Influence on the Utilized Biogas Composition at the Barycz Landfill Site in Cracow, Poland, Waste Management & Research, 22 (2004), 3, pp. 195-201

Christophersen, M., et al., Lateral Gas Transport in Soil Adjacent to an Old Landfill: Factors Governing Emissions and Methane Oxidation, Waste Management & Research, 19 (2001), 6, pp. 595-601

Schwart R., et. al., Methane generation, final report to the state energy conservation office, (2005)

Themelis J.N., Ulloa A.P., Methane Generation In Landfills, Earth Engineering Center and Department of Earth and Environmental Engineering Columbia University, New York, NY10027, USA, (2006)

Vujic G., et. al., Influence of Ambience Temperature and Operational-Constructive Parameters on Landfill Gas Generation – Case Study Novi Sad, Thermal Science: year 2010, Vol. 14, No. 2, pp. 555-564

Gebert, J., Groengroeft, A., Passive Landfill Gas Emission – Influence of Atmospheric Pressure and Implications for the Operation of Methane – Oxidising Biofilters, Waste Management, 26 (2006), 3, pp. 245-251

WATER QUALITY IN URBAN AREAS (GROUND WATER, DRINKING WATER, WASTE WATER AND FACILITIES)

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FEA MODELLING OF GROUNDWATER REGIME IN THE EMBANKMENT OF ECOLOGICAL BRIDGES

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ABSTRACT

A surface arrangement of ecological bridges and used vegetation influenced their usage by animals. The proper growth of vegetation is subject to suitable groundwater flow regime in the embankments. The paper describes modelling of water flow with sample of simulation of influence of embankment height, surface arrangement and vegetation on the distribution of the water content.

Key words: groundwater, green bridges, surface arrangement, vegetation.

INTRODUCTION

The construction of linear structures, which include motorways and highways, are established in locations selected on the basis of long-term monitoring special ecological structures called ecological bridges, see example on Figure. 1.

Figure 1. Ecological bridge on highway D11 and motorway R35 in Czech Republic (a), (b), ecological bridge (c) and ecological tunnel on highway D1 (d) in Slovak Republic and ecological bridge on highway A4 (e) in Austria

These structures are classified with respect to the design load between buried structures. The human population is trying using these structures to prevent irreversible changes that come with line construction gives, among which can include damage to biological relationships, current movement restrictions on animals in the landscape, fragmentation of habitat leading to isolation of subpopulations, as well as well as killing a large number of animal by traffic, with which is directly related to protecting human health and reduce of material damage.

Design of structure system of ecological bridges depends on several factors such as the construction time (Foglar et al., 2009) on the technology and materials (Foglar et al., 2010) and the structural system (Pěnčík, 2010; Pěnčík et al., 2010). Among the factors that affect functionality of these structures, so their utility for migrating animals, include width, location relative to the linear structure, surrounding environment, technical equipment, additional measures (fencing, trip arrangements, etc.). and also arrangement of the surface.

INFLUENCE OF WATER REGIME ON VEGETATION

The arrangement of the surface of an ecological bridges and used vegetation influence usage of animals. Embankments should be designed to allow growth of roots and trees vegetation. Proper growth of vegetation is subject to a suitable water regime and water flow in embankments.

Surface humus layer should be covered with turf grass, the underlying compacted layer should be permeable, and on the back face of the structure should be permeable layer of sand covering impermeable insulation to prevent moisture penetration into the structure, as described in (Brnušák et al., 2003). Water witch penetrates by the soil layers to the insulation surface must be drain off using slopes outside the structure.

On Figure 2 is shown the surface of ecological bridges shown in Figure 1 with root and tree vegetation. The proposed vegetation in these examples is appear from the surrounding vegetation and landscape. It can be assumed that it will produce after its growing a perfect image of the natural surrounding environment.

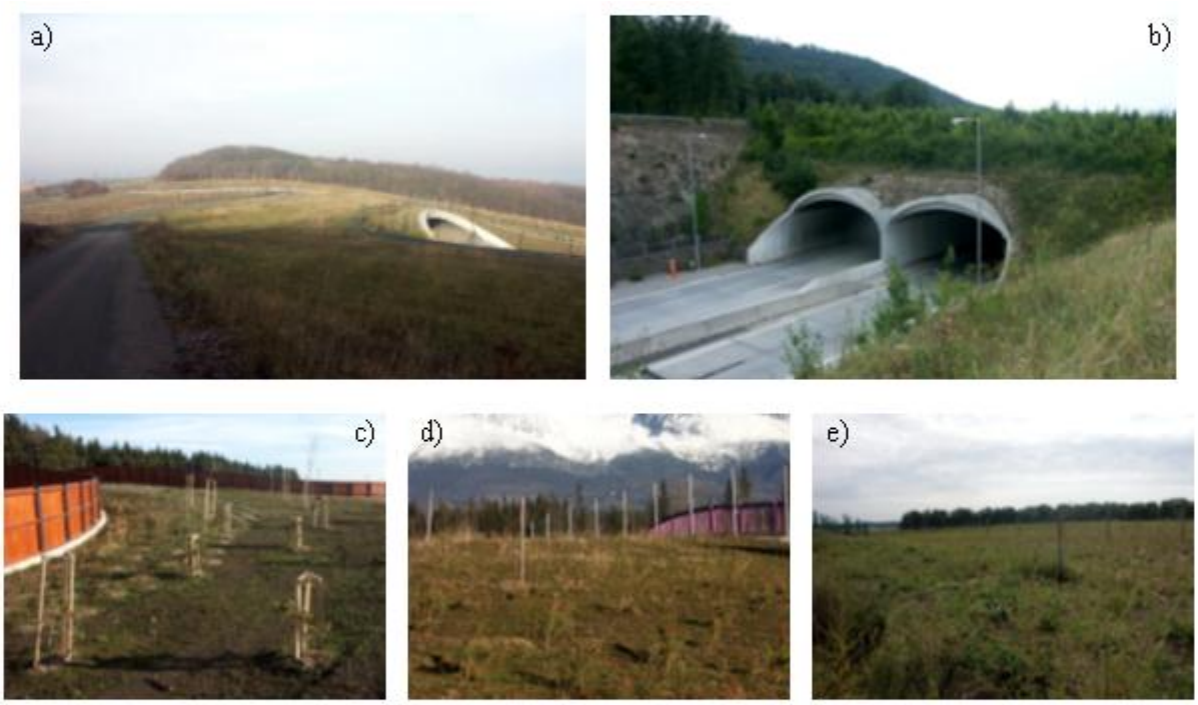

Figure 2. Surface of ecological bridge on highway D11 and motorway R35 in Czech Republic (a), (b), ecological bridge (c) and ecological tunnel on highway D1 (d) in Slovak Republic and ecological bridge on highway A4 (e) in Austria

FEA MODELLING OF GROUNDWATER REGIME

For solution of prediction of water movement in the embankments of green bridges, where in general exists saturated/unsaturated porous environment, can be used two-dimensional FEA model. Principal equation of flow in variably saturated soil environment, assuming incompressibility of water and porous matrix, and neglecting the influence of air flow to water flow is a Richards' equation (1). This is a general partial differential equation that arises by putting Darcy-Buckingham law into the equation of continuity

$$\frac{\partial\theta(h,z)}{\partial t} = \frac{\partial\theta}{\partial h}\frac{\partial h}{\partial t} = \frac{\partial}{\partial z}\left[K(h,z)\left\{\frac{\partial h}{\partial t}+1\right\}\right] - S(h,z) \qquad (1)$$

where θ is the humidity, h pressure head, z the height, t time, K hydraulic conductivity tensor, S fall/source such as intensity of root extraction and $\partial\theta/\partial h$ retention curve. Fall/source member of S represents the amount of water removed per unit time from per unit volume of soil due to water extraction by plant roots.

To describe the hydraulic properties of the soil of unsaturated soil environment, i.e. the description of dependencies between θ humidity and h pressure head and between K hydraulic conductivity and h pressure head can be used Brook-Corey functions, van Genuchten-Mualem functions or modified Genuchten-Mualem funkce. The functions describing soil hydraulic properties of unsaturated soil environment are included in the software Hydrus (Šimůnek et al., 2006). For presented FEA simulations was used van Genuchten-Mualem functions state in (Šimůnek et al., 2006)

$$\theta(h) = \begin{cases} \theta_r + \dfrac{\theta_s - \theta_r}{[1+|\alpha h|^n]^m} & h < 0 \\ \theta_s & h \geq 0 \end{cases}$$

$$K(h) = K_s S_e^l\left[1-\left(1-S_e^{1/m}\right)^m\right]^2 \qquad (2)$$

$$m = 1 - 1/n \quad n > 1$$

van Genuchten-Mualem functions (2) contain six independent parameters: θ_r residual moisture, θ_s saturated humidity, K_s saturated hydraulic conductivity, n, α and l ($l = 0.5$) which are regression coefficients. These parameters are determined from experimentally observed points of retention lines, for each part of the soil environment (Bortlová, 2007).

The solution of general partial differential equations that describe the water movement in the soil, it is necessary to describe the geometric area in which water is transferred, the initial distribution of pressure heads in the soil profile, soil parameters and soil hydrophysical characteristics depending on the function describing the hydraulic properties of soils of unsaturated soil environment, the initial conditions for the system and the boundary conditions that determine the interaction between the solution areas dealt with the surrounding environment.

To describe the boundary conditions is possible to use pressure head, i.e. Dirichlet boundary condition or also prescribed flow, i.e. Neumann boundary condition. In addition to these conditions can be considered as an atmospheric boundary condition that determines the conditions on the boundary of the land surface and atmosphere in relation to the potential atmospheric conditions.

The solution of nonlinear partial differential equations (1) using the functions describing soil hydraulic properties of unsaturated soil environment as (2) can be described moisture regime of ecological bridges depending on the soils used, style of storage and compaction, the effect of sealing and drainage layers in the embankment and influence the construction adaption which effects the retention of water in the embankment body.

CASE STUDY: INFLUENCE OF EMBANKMENT HEIGHT ON THE DISTRIBUTION OF MOISTURE FIELDS

One of the critical points, which occur in the embankment of ecological bridges insight to the distribution of moisture fields, is a place in the mid span that is in the top of the arch. At this point embankment reaches a minimum thickness. At this point there is the watershed.

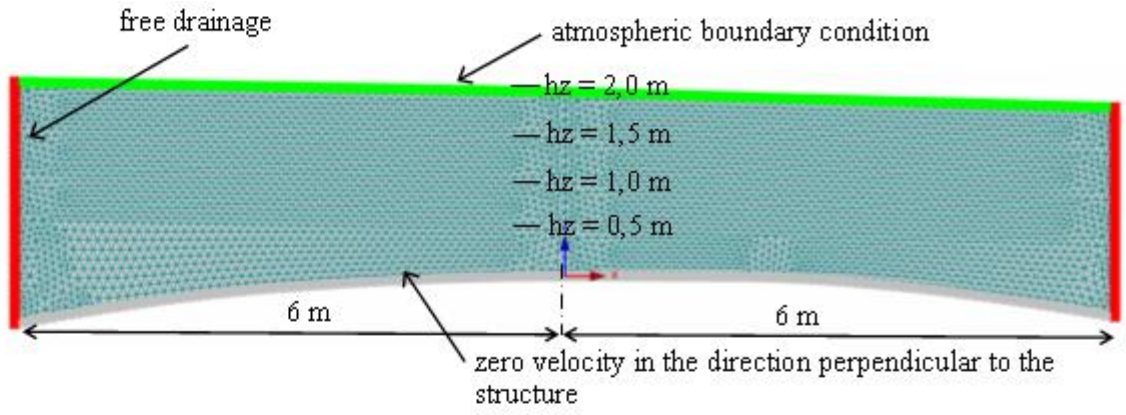

Figure 3. FEA model for solution of case study of influence of embankment height on the distribution of moisture fields

The analysis model, see Figure 3, consists of the arch surface (geometry was taken from the ecological bridge on highway D11 in Czech republic, Figure 1a) and parts of the surrounding soil at distance of 6 m from the axis of the arch on both sides. Height of soil at the top of the arch was chosen in 4 heights of 0.5 m, 1.0 m, 1.5 m and 2.0 m; the slope of a terrain was considered according to geodetical measurement specified in project documentation. The simulations were considered for two typical homogeneous soils that meet the requirements of water flow described by Richards equation (1) without the occurrence of preferential flow - mould sand and sand-clay mould. The characteristics describing the soil and hydraulic properties of soils are listed in Table 1.

Table 1: Hydraulic properties of soils

	θ_r [-]	θ_s [-]	α [1/cm]	n [-]	θ_m [-]	K_s [cm/day]	l [-]
mould sand	0,057	0,41	0,124	2,28	0,410	350,2	0,5
sand-clay mould	0,01	0,39	0,059	1,48	0,481	31,44	0,5

In the ground surface is considered an atmospheric boundary condition, course of 6-hour precipitation in the 14 days obtained from the CHMI (Figure 4). Total rainfall for this considered period is 164 mm. The calculations are considered, that the surface of the ecological bridge is green or grassy and that there is no evaporation from the surface. Consumption of water plant roots to a depth of 300 mm was considered constant over time about the size of 3.0 mm/day.

In the part of a model, which represents the surface of the arch, has been defined the boundary condition of zero velocity in the direction perpendicular to the structure surface. On model sides were considered free drainage. Using this condition was model surrounding the soil, which has the same properties as the hydraulic properties of soil at the calculation model.

The initial pressure and moisture conditions for soils are shown at t = 0 days (Figure 5 and 6). The initial pressure ratios have a linear change in the height calculation model, the soil thickness 2.0 m is considered on the upper surface pressure height 250 cm and the lowest point of the model was considered the pressure height of 100 cm. The derived models were changed to pressure head on the top surface so that the directive remained constant changes.

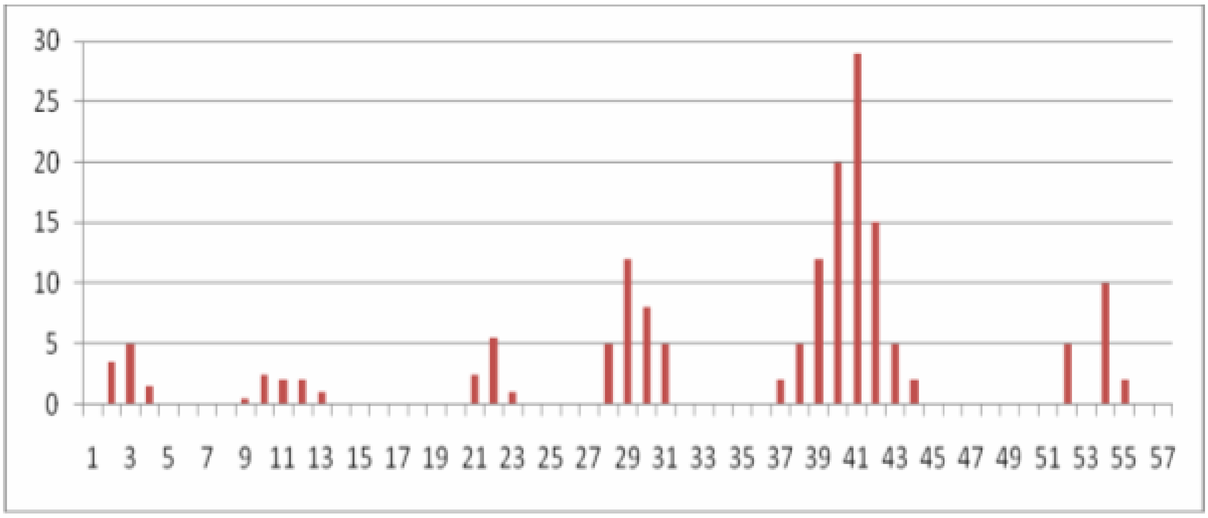

Figure 4. Course of 6-hour precipitation in the 14 days

Overall, 64 simulations were performed, from which they were selected for further evaluation of the above options structure calculation model. Apart from the results for the initial time t = 0 days were selected times before and after significant rainfall, at times t = 0 / 0.25 / 1.0 / 1.75 / 3.25 / 4.75 / 5.75 / 6.5 / 7.75 / 9.0 / 11.0 / 12.75 / 13.5 and 14.0 days. To render times were chosen 11.0 and 14.0 days (Figure 7 to 10).

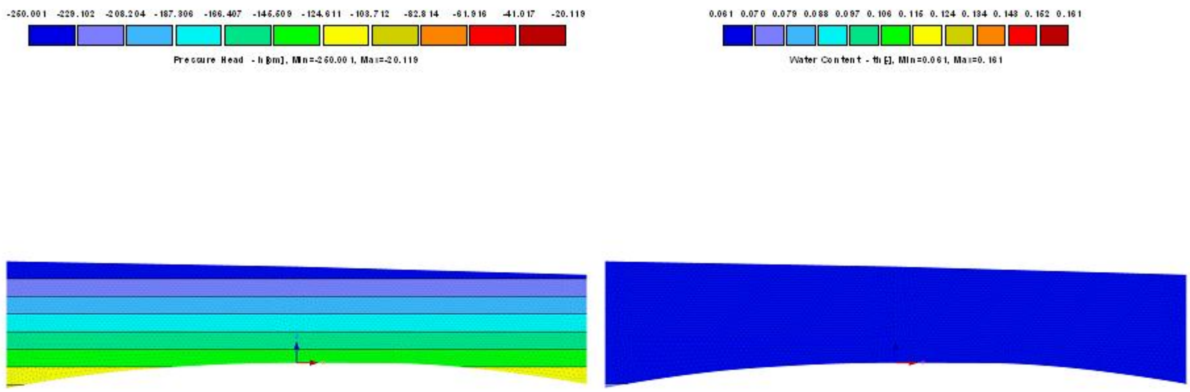

Figure 5. The initial pressure and moisture conditions at time t = 0 days for mould sand (Notes: analysis model with embankment height 2.0 m)

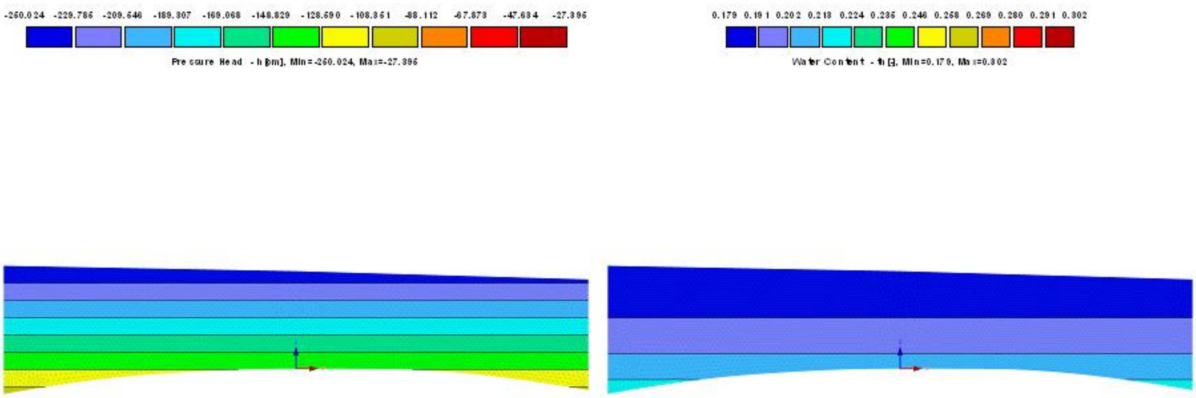

Figure 6. The initial pressure and moisture conditions at time t = 0 days for sand-clay mould (Notes: analysis model with embankment height 2.0 m)

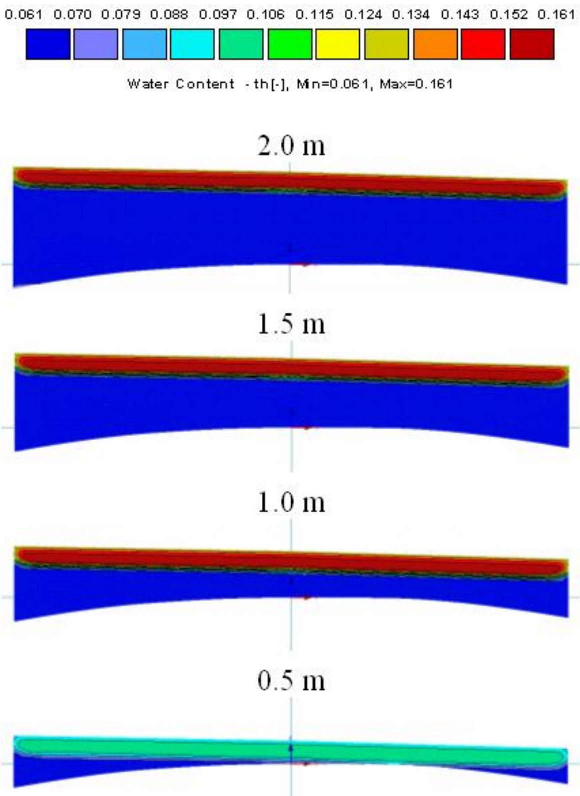

Figure 7. Soil moisture at time 11 day for different height of mould sand

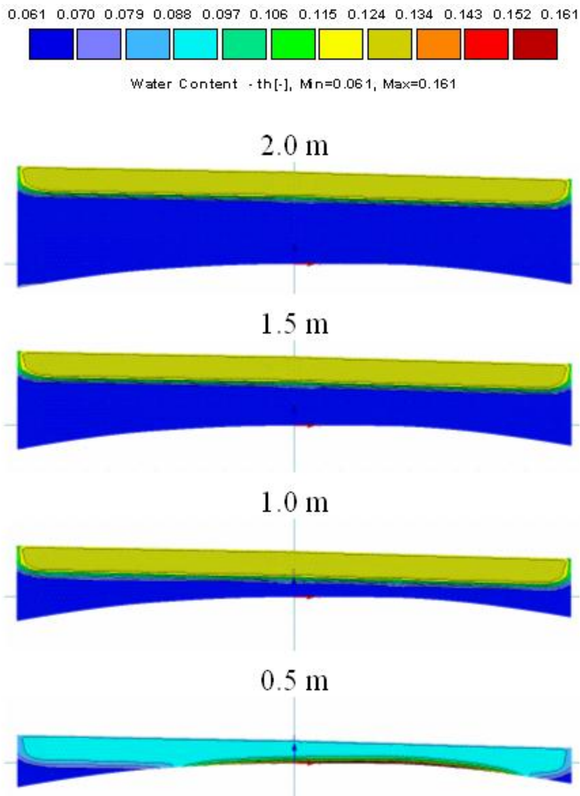

Figure 8. Soil moisture at time 14 day for different height of mould sand

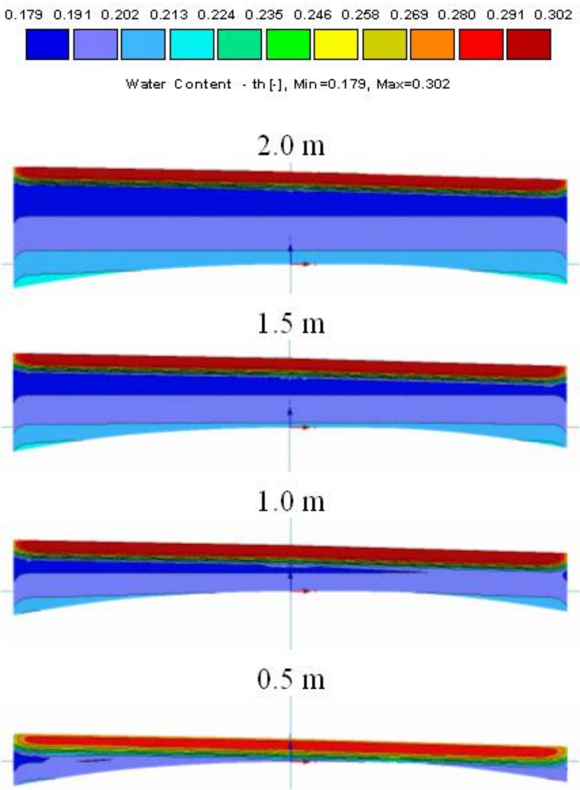

Figure 9. Soil moisture at time 11 day for different height of sand-clay mould

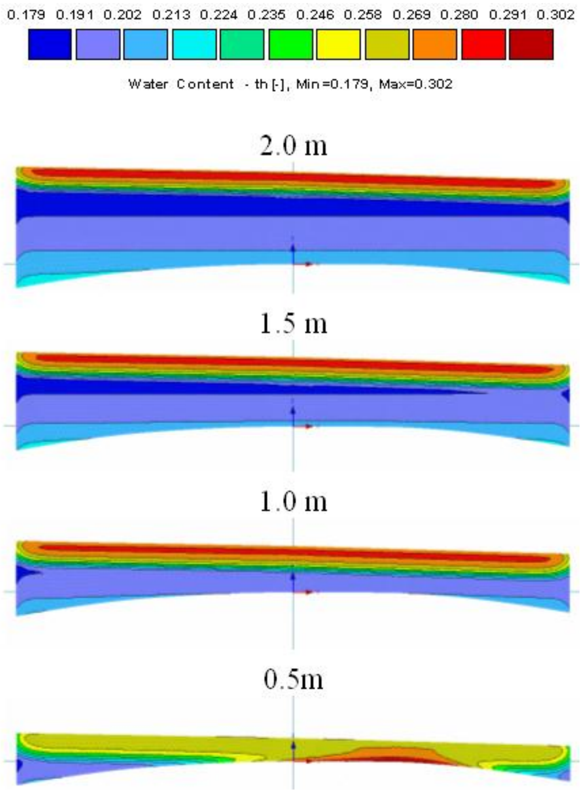

Figure 10. Soil moisture at time 14 day for different height of sand-clay mould

RESULTS AND DISCUSSION

At Figure 7 to 10 are shown soil moisture for two typical of homogeneous soil conditions, which meet the conditions of water flow described by Richards equation without the occurrence of preferential flow - mould sand and sand-clay mould. Total rainfall during the considered calculation was 164 mm.

By comparing the results it is possible to determine significant dependence of the distribution of moisture fields on the type of soil respectively on their hydraulic characteristics.

Height of embankment in the top of the arch also has an influence on the distribution of moisture and pressure fields. In the case of low-height of embankment model occurs the concentration of moisture near the structure of ecological bridge, which could subsequently lead to preferential drainage along the surface of the structure or along its waterproofing. The results are also influenced by the size of the selected vegetation transpiration, considering plant roots to a depth of 300 mm. Depending on the type of vegetation in the case of the lowest size of embankment root system could reach the structure of ecological bridge and break structure waterproofing.

CONCLUSION

The arrangement of the surface of ecological bridges and used vegetation greatly influence his own use by animals. Proper growth of vegetation is subject to a suitable water flow regime in embankments, respectively type of soil that is used for embankment.

In the system "ecological bridge - soil" exist some critical points. One of these places is a place in the mid span of arches that is in the top of the arch. At this point, reaches an embankment a minimum thickness. The analysis of presented case study analyzed using HYDRUS shows the effect of embankment height to the distribution of moisture. The results of simulations show that the height of embankment has a great influence. Same conclusion applies to type of soil used in embankment.

During analyses was founded that for proper design of e embankments of ecological bridges in terms of used soil types, their composition and heights are needed to get in addition to mechanical properties of soil and also hydraulic characteristics optimally founded by in situ measurement. It is also necessary in the analysis appear from in-situ observation of precipitation profiles identified in advance before the actual construction of ecological bridges. Depending on the type of vegetation or on the depth of the roots is then possible design height of soil layers and soil types with suites the local situation and conditions.

ACKNOWLEDGEMENT

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REFERENCES

Foglar, M., Křístek, V. & Pěnčík, J. (2009) Structural arrangement of ecological bridges for construction during operation of the motorway. In *Migrations versus Motorways*.Hochgurgl, Austria: ECON publishing, s.r.o. ISBN 978-80-86433-36-3.

Foglar, M., Křístek, V. & Pěnčík, J. (2010) Variantní řešení ekologického mostu přes Jablunkovskou brázdu. In *Ekodukty 2010*, Brno, Czech Republic: ECON publishing, s.r.o. ISBN 978-80-86433-38-7.

Pěnčík, J. (2010) Konstrukční systémy ekologických mostů používané v oblasti střední Evropy. In *Ekodukty 2010*, Brno, Czech Republic: ECON publishing, s.r.o. ISBN 978-80-86433-38-7.

Pěnčík, J. & Foglar, M. (2010) Comparison of ecoducts structure systems in the region of Central Europe. In *2010 IENE International Conference on Ecology and Transportation: Improving connections in a changing environment.* Velence, Hungary: SCOPE Meetings Ltd., 2010.

Brnušák, A. (2003) Ekodukty. *Inženýrská akademie České republiky*, Brno, 2003.

Šimůnek, J., van Genuchten, M. Th. & Šejna, M. (2006) The HYDRUS Software Package for Simulating the Two- and Three-Dimensional Movement of Water, Heat, and Multiple Solutes in Variably-Saturated Media, Technical Manual, Version 1.0.

Bortlová, H. (2007) Využití prostředí MATLAB k proložení diskrétních bodů spojitou retenční křivkou. In *Juniorstav 2007*. Brno, Czech Republic : FAST, VUT v Brně. ISBN 978-80-214-3337-3.

van Genuchten, M. Th., Šimůnek, J., Leij, F. J. & Šejna, M. (1998) RETC for Windows, The RETC Code for Quantifying the Hydraulic Functions of Unsaturated Soils.

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SCADA CONTROL OF THE BIOLOGICAL WASTEWATER TREATMENT PROCESS IN AERATED LAGOONS

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ABSTRACT

This work focuses on the SCADA control of the biological treatment of rural wastewater conducted in an aerated lagoons treatment system. Application of SCADA (Supervisory Control And Data Acquisition) enables the possibility to change the set points in remote controllers, and to conduct measuring and control simultaneously. Hence, obtained results through the implemented dynamic supervision are presented graphically in correlation to the main process parameters. Besides scientific value, obtained results from this work have also practical significance in the area of process' eco-engineering, which represents one of the main segments in the sustainable development for cleaner and healthier environment.

Key words: SCADA, aerated lagoons, biological wastewater treatment

INTRODUCTION

Choosing the ''Most Appropriate Technology'' is not an easy task but it could reduce the risk of future problems and failures. The two key issues in choosing a treatment technology are affordability and appropriateness. Affordability relates to the economic conditions of the community while appropriateness relates to the environmental and social conditions. The identification of adequate wastewater management for small communities is a complex problem as it demands integration of data from different sources, such as community needs, receiving environment, landscape, or available and affordable wastewater treatment technologies (Massoud et al. 2008). In this sense, several WWTP exploiting various technologies (Activated Sludge System, Aerated Lagoons, Trickling filter, Constructed wetlands etc.) have been installed in the Republic of Macedonia with financial support of the Austrian Government with special attention to the energy consumption per Population Equivalent (P.E.), Fig.1., as well as the application of the SCADA System Fig 2-9., is discussed (Kuvendziev S. 2009).

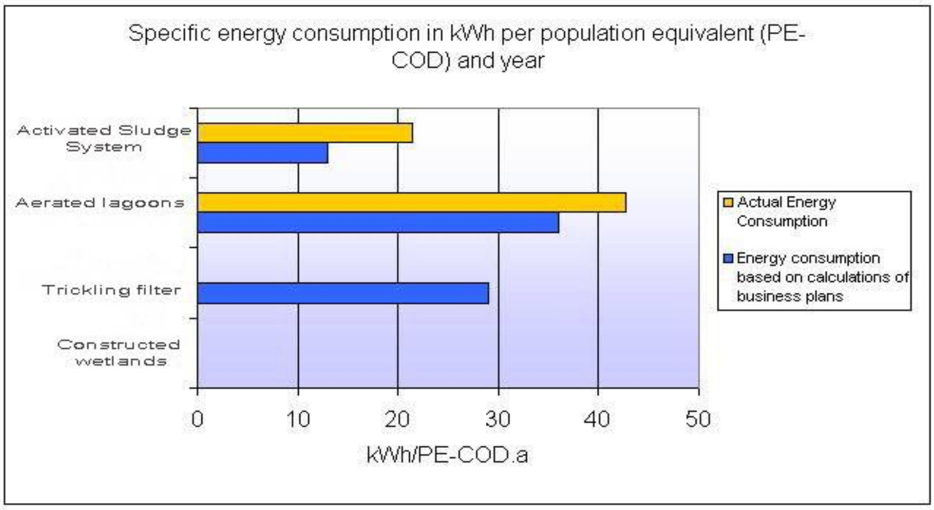

Figure 1. Specific energy consumption of the conventional treatment technologies in Macedonia

The process of aeration included in the biological stage of the aerated lagoons treatment technology contributes the most to the total energy consumption. As this process dictates the treatment efficiency through the nutrient removal efficiency, it is the aeration that is subjected to optimization in order to establish economically sustainable treatment system in terms of energy consumption (Nowak O. et al. 1999). Properly optimized treatment technology is practically applicable and sustainable only by introducing automatic regulation. In these particular cases, a SCADA system was implemented through installation of a SESAME STEP software package.

SCADA (Supervisory Control And Data Acquisition) control

SESAME STEP is a software package for automation and supervision of small and medium-sized water treatment plants (Coen F. et al. 1997; Kuvendziev S. 2009).
Three main functions are available to SESAME STEP users:

1. Controlling the installation, which includes :
   - controlling local or remote equipment (pumping stations),
   - displaying operating states and alarms,
   - monitoring process variables in real-time,
2. Managing the station, where the following are available to the user :
   - events time-stamped at source, maintenance reports,
   - alarm, measurement and operating time archives,
   - log analysis tools (Comparison of curves or trend diagrams),
   - interface with specialized third-party programs,
3. Remote Supervision and Remote Maintenance of the process by means of :
   - Pager system remote warning,
   - Remote control of the system.

By implementation of the SESAME STEP application from the SCADA system, which provides continuous computer control and regulation of the monitoring and the menagement of the process, a complex automatic control on the entire process could be conducted, shown in Fig.2-4.

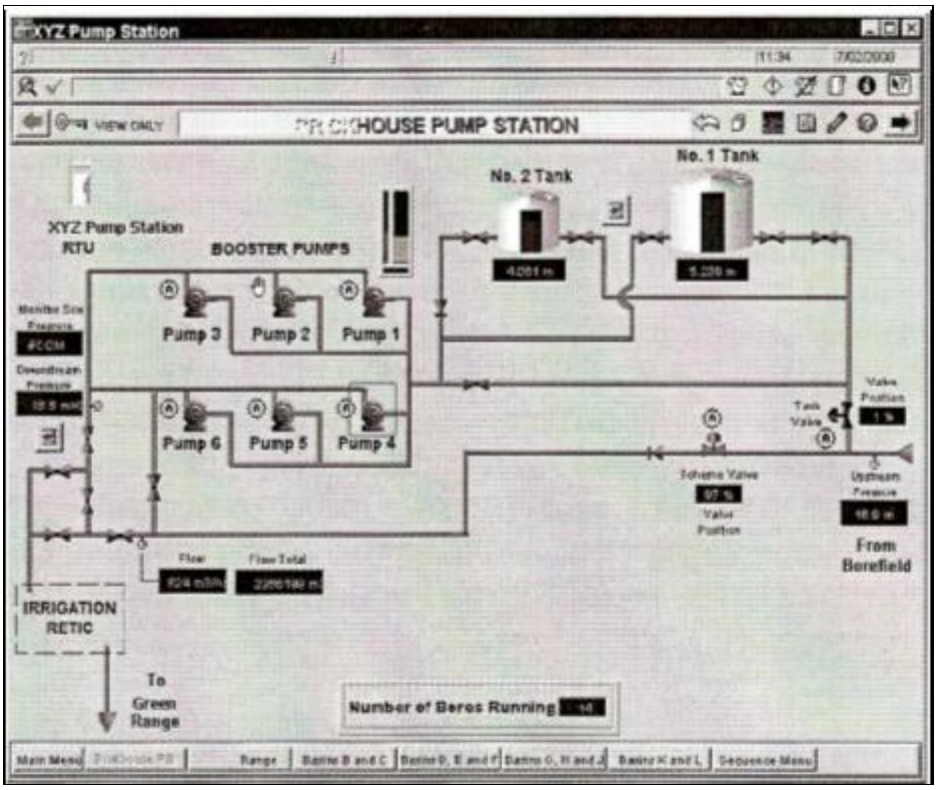

Figure 2. Operator’s interface

Description	Symbol	Meaning
- Green arrow :		The object is being selected : The user can then access a Popup window.
- Red exclamation mark :	!	At least one alarm is masked.
- Red frame :		Summary alarm.
- Yellow frame :		Maintenance alarm.
- Red cross :		Communication fault. When this occurs, other animations are masked.
- Yellow triangle :		Abnormal operating mode.
- Circle drawn in the triangle :		- Blue when the operating mode is controlled by the system. - Brown when in offline mode. The circle disappears in automatic operating mode.
- Character string :	XXXXXX	Contains the name of the object.

Figure 3. Symbols common to all objects controlled by the SESAME STEP

- A **functional supervisory control level** (Popup),
  Attributes are associated with each object, and the user can access these characteristics via Popup windows after selecting the desired object. The following icons are used to access these characteristics :

Tabs	Meaning	PLC object	Actuator object	Measurement object
	Supervisory control	Operating mode Up/down loading the program Up/downloading data		Switching to manual mode Switching to auto Entering setpoints
	Time programming	Time programming for load shedding.	Time programming for operation.	Time programming for supervision.
	Maintenance	PLC status Maintenance.	Preventive maintenance (MTBF on threshold, counting, etc).	Preventive maintenance (MTBF on threshold, timer, etc).
	Alarms	Alarm on modification of operating mode, maintenance, etc.	Alarm on improper use, maintenance, etc.	Alarm on range, levels, maintenance, etc.
1	Setting 1	Access to the PLC application data.	Access to data specific to the actuator and load shedding management.	Scaling and alarm on thresholds.
2	Setting 2	Management of PLC alarms.		Access to parameters of PID type controllers.
	Dynamic trending	Electrical energy contract.		Measurement dynamic trending.
	Information	Information about the object (Status, suppliers, etc).	Information about the object (Status, suppliers, etc).	Information about the object (Status, suppliers, etc).
	RTUSetUp	SetUp of RTU (phone number)		

Figure 4. Defining of Tabulators with-in the SESAME STEP Application

RESULTS AND DISCUSSION

By application of SCADA control - supervisory control by dynamic surveillance is achieved in the biological stage of the wastewater treatment in an aerated lagoons treatment plant, shown in Fig.5.

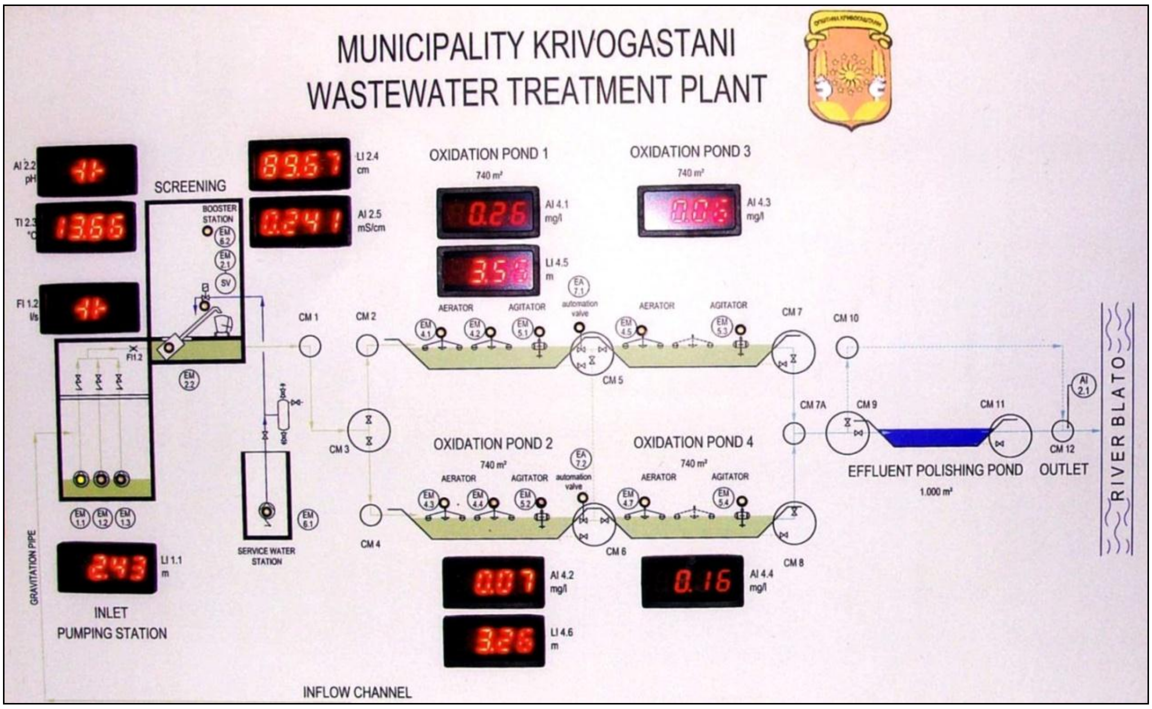

Figure 5. Scheme of complex control board for SCADA control

In this sense, on – line measurments of various parameters (Flowrate, pH and others) are performed by the SCADA System, shown in Fig.6-9.

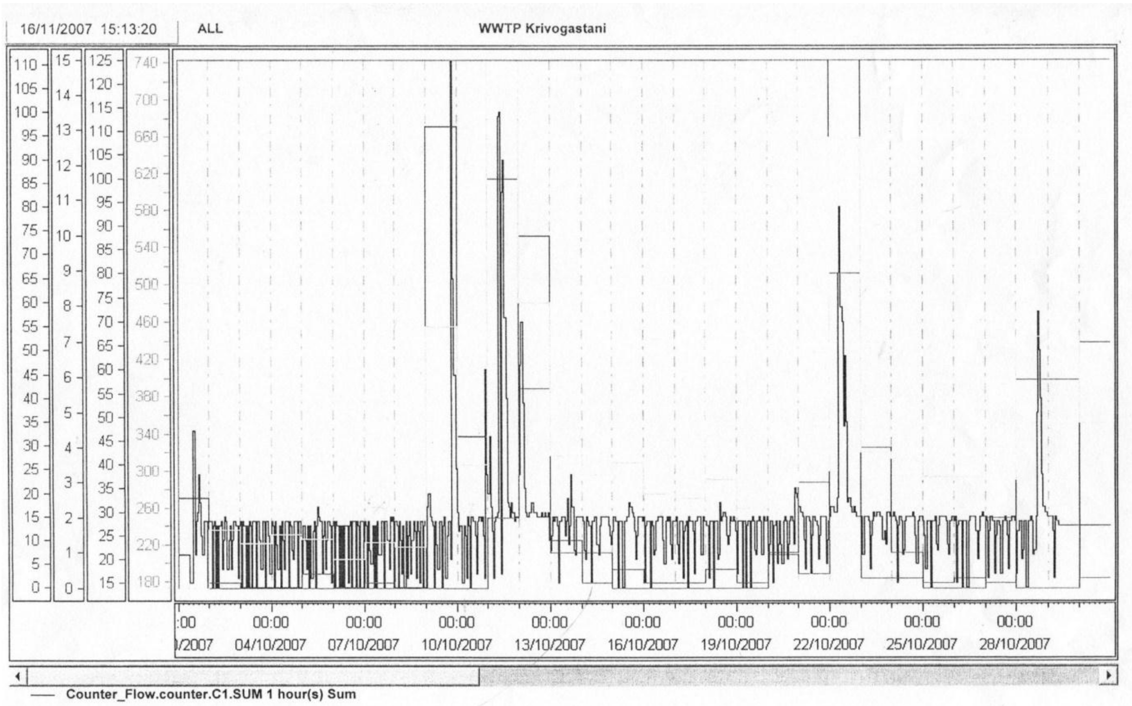

Figure 6. Dynamic on-line flow rate measurement

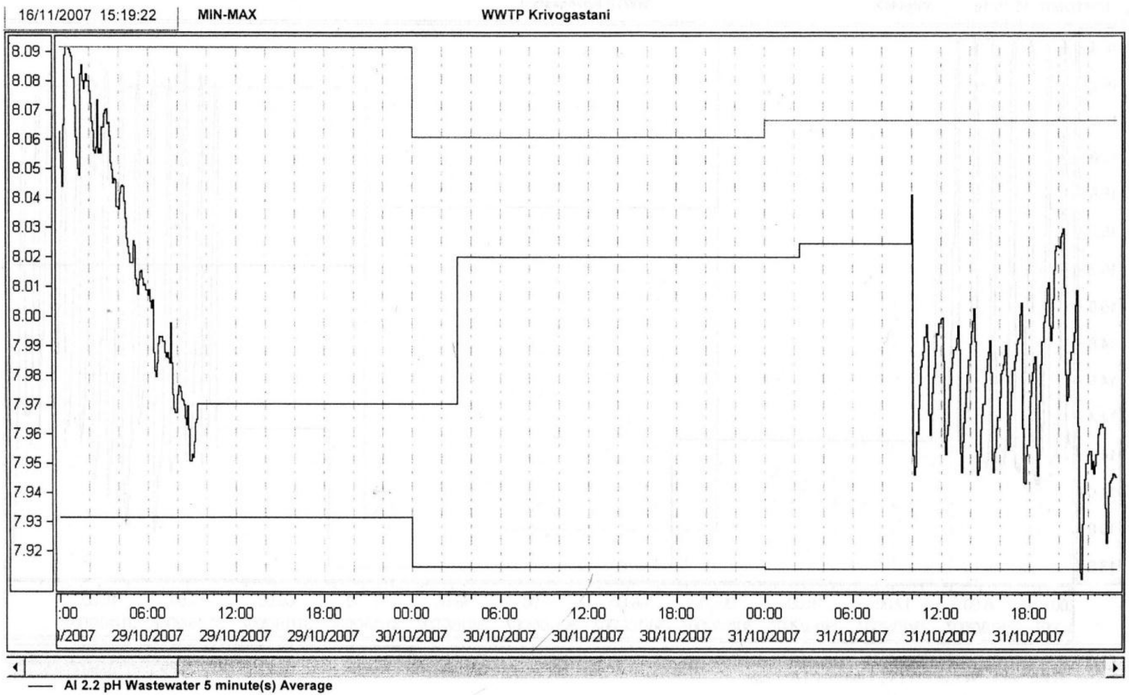

Figure 7. Control panel of pH value measurement

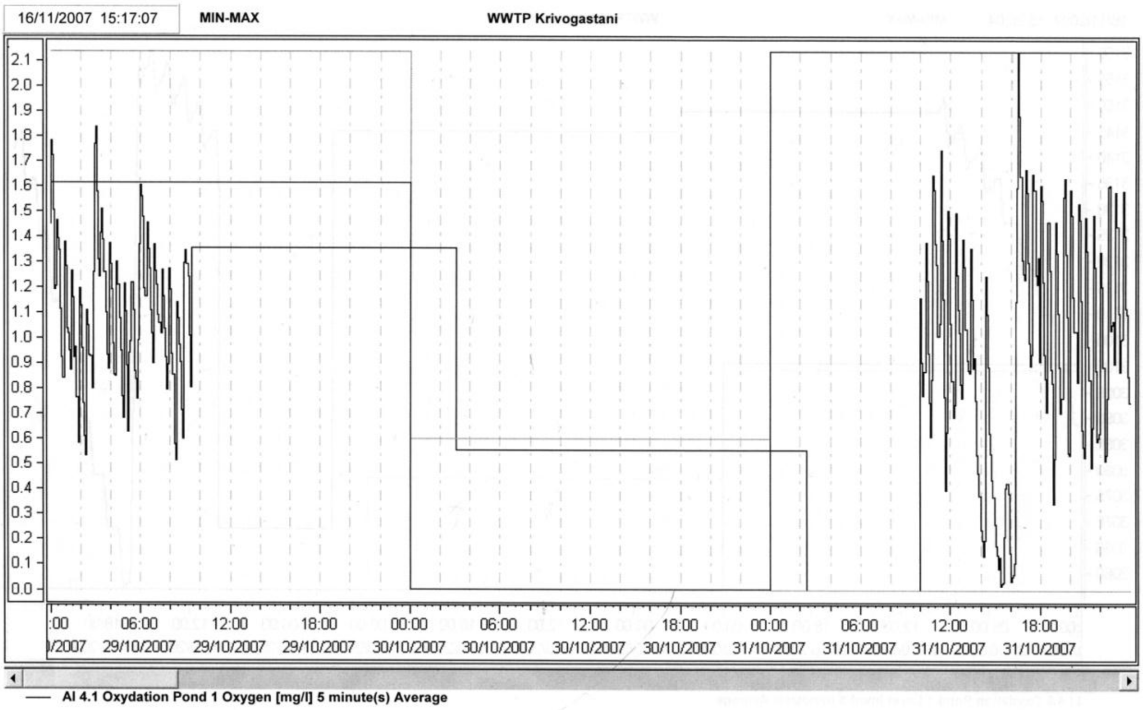

Figure 8. On-line dynamic response for closed-loop configuration (for dissolved oxygen concentration)

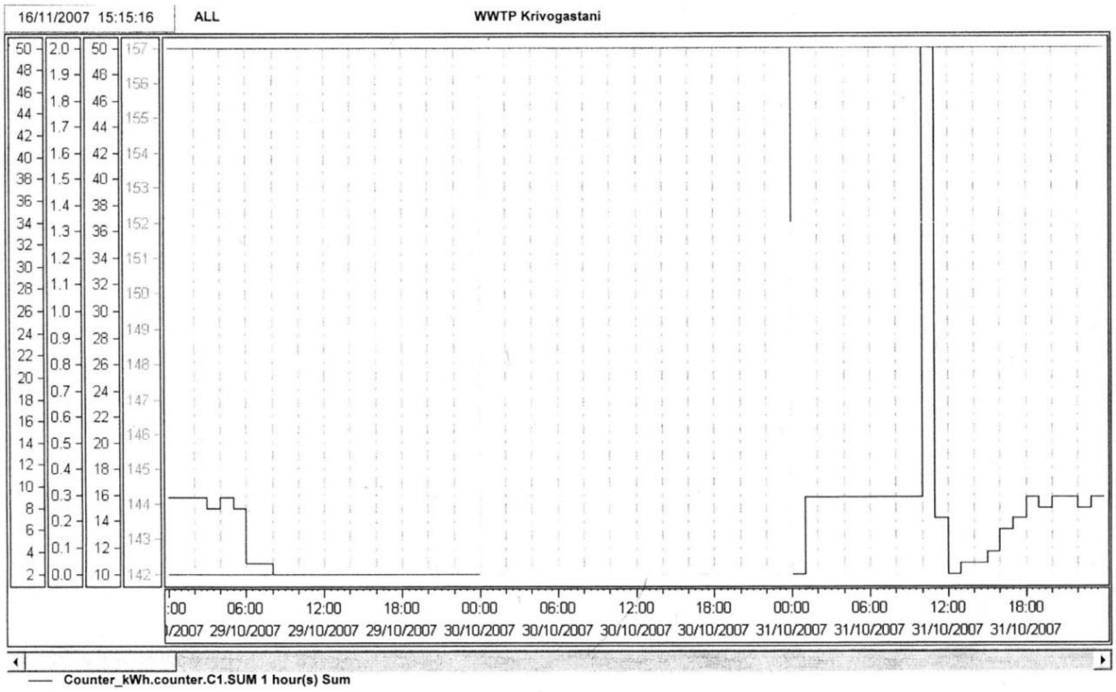

Figure 9. Control panel of Energy consumption rate measurement

On such a way, the system is enabling to conduct the whole proces all the time under the control with the preadjusted parameters.

CONCLUSIONS

- SCADA controlled Aerated Lagoons wastewater treatment plant provides optimal rates of treatment efficiency;
- The application of complex automatic control on the entire process has been performed by implementation of the SESAME STEP application from the SCADA system, which provides continuous computer control and regulation of the monitoring and the menagement of the process;
- Economic sustainability and benefits from the application of SCADA control through the SESAME STEP application.

REFERENCES

Kuvendziev S., Master thesis, Faculty of Technology and Metallurgy, Skopje, 2009.

Coen F., Vanderhaegen B., Boonen I., Vanrolleghem P.A. and Van Meenen P. (1997) Improved design and control of industrial and municipal nutrient removal plants using dynamic models. Water Sci. Technol., 35(10), 53 – 61.

Nowak O., Franz A., Svardal K., Muller V. and Kuhn. (1999) Parameter estimation for activated sludge models with help of mass balances. Water Sci. Technol., 39(4), 113 – 120.

May A. Massoud, Akram Tarhini, Joumana A. Nasr, Decentralized approaches to wastewater treatment and management, 2008.

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PLAN-PARALLEL UV REACTOR A PRIORI DESIGN DESIGN PARAMETERS FOR POTABLE AND WASTE WATER TREATMENT

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ABSTRACT

In this paper UV radiation intensity distribution in an open plan-parallel UV reactor was studied through an arbitrary virtual horizontal plane in the water. Sources of UV radiations in this model are approximated as infinite, cylindrical in shape and they are equidistantly distributed in a parallel horizontal plane above the water surface. Intensity and flux radiation distribution, near bottom of the reactor, were analyzed both when reflection of reactor bottom is zero, as well as when it is nonzero.

Keywords: UV reactor, plan-parallel design, water disinfection, water treatment.

INTRODUCTION

Plan parallel (PP) UV reactors were considered in the early stage of its development, [1-4], but later on they were cast aside and mostly cylindrical reactors were analyzed. PP type of UV reactors have advantages in some areas of application, i.e. for final water disinfection or for advanced oxidation processes, such as wastewater or potable water due to their low investment price, simple construction, easy maintenance, for they do not need quartz sleeves and pressurized vessels, as these are open reactors, and there is no need to clean the quartz sleeves. Disadvantages, at the very first glance, are that approximately one-half of UV energy is used for water treatment, while the remainder is wasted if ceiling of the reactor is not enough reflective for UV radiation. Also the mathematical modeling is not as simple as it is for cylindrical reactors. Those could be the possible reasons for leaving PP UV reactors. According to our considerations, PP UV reactors could have similar UV energy efficiency, and other advantages which will be demonstrated later in this paper.

THEORY

Typical plan parallel UV reactor is given in Fig. 1. In this paper, we will make the following assumptions:
A1. Lamps will be approximated as the infinite-length sources. This is in accordance to the following conclusion "For situations where the average intensity within the reactor is adequate to define kinetic rates, there is no practical reason to use the more complex finite-length lamp model instead of the infinite-length lamp model. In many cases, especially for reactors with large length to lamp radius ratios and overall reactor radius to lamp radius ratios, the finite-length model can predict higher average intensities than can the infinite length model" [5].

A2. If reflection exists from the flat ceiling of the reactor then the lamps shadowing will be neglected. Also, UV reactor sidewall reflection is neglected as well.
A3. Laminar water flow is accepted as the worst condition for intensity calculations.
A4. When considering bottom reflection we will calculate only the distribution of radiation intensity (fluence rate) in the plane near the bottom of the reactor, for on the bottom of the reactor reaches the smallest amount of UV radiation due to water absorption for laminar flow.

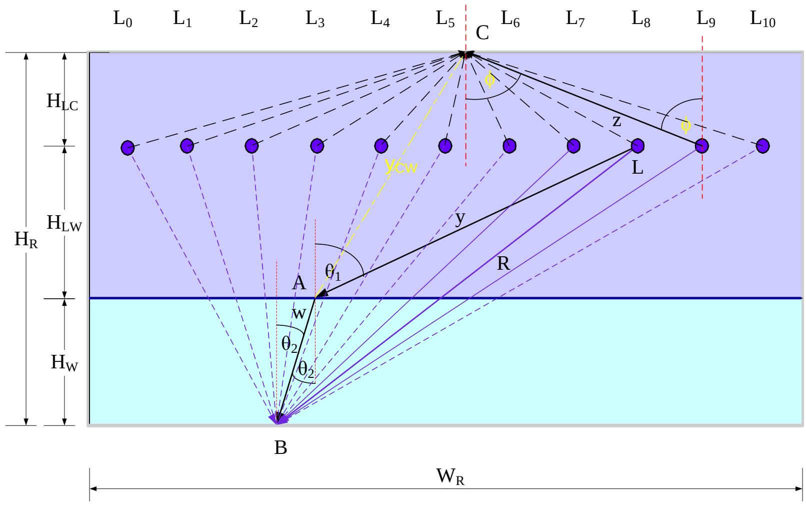

Figure 1. Cross-section of an typical PP UV reactor; H_R, H_{LC}, H_{LW} and H_W are the heights: of the reactor, lamps from the ceiling, lamps from water surface, and water respectively; W_R is the reactor width, C is an arbitrary point at the reactor bottom.

A5. In the plane, which is very close to the bottom that reflects UV radiation we can make rough assumption that intensity will be sum of incident radiation and product of incident radiation and reflection coefficient of the material from which the bottom is made of.
A6. UV radiation reflection from the ceiling will be treated, in the very first approximation, as a plane source, in order to obtain rough analytical mathematical model that will include ceiling reflection.
A7. Consequently, surfaces of interest, for infinite length sources (according to A1.) in PP UV reactor are horizontal (area S_H) and vertical (area S_H) surfaces that have total area $S=2\cdot(S_H+S_V)$, without vertical surfaces that are orthogonal to the lamps’ axes.

If we would like to make *a priori* mathematical design of this rector, we are going to apply Modified Divergence Theorem (MDT, in earlier literature known as Gauss-Ostrogradsky Theorem), described previously [6]. After applying MDT to all reactor surfaces of interest (A7) one can obtain:

$$\oint\!\!\oint_S \Phi \cdot d\vec{S} = \sum_{i}^{N} \vec{P}_{i,k} \ , \tag{01}$$

As we are interested in horizontal surfaces, and do not take into account neither influence to the side parts of the reactor, nor reflections from them, then we can rewrite (01) for reactor bottom and ceiling respectively in the following form:

$$\Phi_{Bk} = \sum_{i=1}^{N} \frac{P_{i,k} \cdot \cos\gamma_{Bi,k}}{S_{Bi,k}} = \frac{\eta \cdot P_0}{2 \cdot \pi \cdot L_e} \cdot \sum_{i=1}^{N} \frac{T_{Bi,k}}{R_{Bi,k}} \cdot \cos\gamma_{Bi,k} = \Psi_{Bk} \cdot \cos\gamma_{Bi,k} \ , \tag{02}$$

$$\Phi_{Ck} = \sum_{i=1}^{N} \frac{P_{i,k} \cdot \cos\gamma_{Ci,k}}{S_{Ci,k}} = \frac{\eta \cdot P_0}{2 \cdot \pi \cdot L_e} \cdot \sum_{i=1}^{N} \frac{T_{Ci,k}}{R_{Ci,k}} \cdot \cos\gamma_{Ti,k} = \Psi_{Ck} \cdot \cos\gamma_{Ci,k} \ , \tag{03}$$

where $P_{i,k}$ is power of i-th lamp that reaches k-th point (line) on a horizontal surface, Φ_B and Φ_C are fluxes (in this paper we define flux to be power per unit area multiplied by the cosine of incident angle) at bottom and ceiling surfaces respectively. Ψ_k is adequate radiation intensity at analyzed surfaces (here we define radiation intensity as flux divided by the cosine of incident angle). $S_{i,k}=2\cdot\pi\cdot L_e\cdot R_{i,k}$ is surface area at point (line) k, from i-th lamp (of N lamps), and $R_{i,k}$ is radial distance from i-th source axes line to the k-th point on the appropriate surface.

$$\vec{P}_{i,k} = \eta \cdot \vec{P}_0 \cdot T_{i,k}\,, \tag{04}$$

$$T_{i,k} = exp(-a_A \cdot y_{i,k} - a_W \cdot w_{i,k}) \cong exp(-a_W \cdot w_{i,k})\,, \tag{05}$$

where P_0 is the initial power of every lamp, and $T_{i,k}$ transmission coefficient between *i*-th source and *k*-th line, and $\vec{P}_i$ is power vector from *i*-th lamp to point *k*, and $y_{i,k}$, $w_{i,k}$ are UV radiation paths through air and water respectively. Absorption coefficients through air and water are denoted as: α_A and α_W respectively. As $\alpha_W >>> \alpha_A$, then approximation (05) is satisfied.

$$\eta = \eta_A \cdot \eta_T \cdot \eta_V \cdot T_F\,, \tag{06}$$

$$T_F = \left[1 - R_{F1}\right], \tag{07}$$

where η is coefficient of losses, including η_A lamp ageing factor, η_T power transmission factor from the lamp to the fluid (as described by [5], η_V voltage line factor, which could have great influence to lamp operation. T_F is Fresnell´s transmission coefficient on air-water interfaces. R_F is reflection coefficient (according to [7]) and α_A, α_W are air and water absorption factors respectively for air and water layer depth between source envelope and a point in the reactor. Intensity distribution near the bottom and the ceiling of the reactor can be derived from (02) and (03):

$$\Psi_{Bk} = \sum_{i=1}^{N} \frac{P_{i,k}}{S_{Bi,k}} = \frac{\eta \cdot P_0}{2\cdot\pi\cdot L_e} \cdot \sum_{i=1}^{N} \frac{T_{Bi,k}}{R_{Bi,k}}\,, \tag{08}$$

$$\Psi_{Ck} = \sum_{i=1}^{N} \frac{P_{i,k}}{S_{Ci,k}} = \frac{\eta \cdot P_0}{2\cdot\pi\cdot L_e} \cdot \sum_{i=1}^{N} \frac{T_{Ci,k}}{R_{Ci,k}}\,. \tag{09}$$

$$\Psi_{BPCk} = (1+\rho_B)\cdot\Psi_{Bk} + \rho_C \cdot T_{F\perp} \cdot \Psi_{CBa} \cdot \exp(-\alpha_W \cdot H_W)\text{, where} \tag{10}$$

$$\Psi_{CBa} = \frac{1}{K} \cdot \sum_{k}^{K} \Psi_{Ck}\,, \tag{11}$$

$$T_{F\perp} = \frac{4\cdot n_A \cdot n_W}{(n_A + n_W)^2}\text{, Fresnel coefficient for plane wave normal incidence;} \tag{12}$$

$exp(-\alpha_W \cdot H_W)$ transmission loses through the water, for normal plane wave incidence.

Ψ_{BPCk} is UV radiation distribution near the bottom of the reactor that comes from: direct radiation (08) plus bottom reflection (having average effective reflection coefficient ρ_B) and average radiation that reaches to and reflects from the ceiling (average effective reflection coefficient ρ_C) (11) [average value from (09)], treated as plane wave.

$$\Psi_{BMCk} = (1+\rho_B)\cdot\Psi_{Bk} + \rho_C \cdot T_{Fk} \cdot \Psi_{Ck} \cdot \exp(-\alpha_W \cdot w_{Ak})\text{, where} \tag{13}$$

Ψ_{BMCk} is radiation intensity in thin film of water near bottom where intensity radiation distribution at the ceiling Ψ_{Ck} is directly transmitted, after reflection with reflection coefficient ρ_C, as plane wave to the water surface without losses. As in (10), this approximation is rough approximation too, but could give us rough picture about radiation intensity in any water layer from surface to the bottom. T_F is given by (07) and $exp(-\alpha_W \cdot w_{Ak})$ is transmission losses through the water, for arbitrary angle of incidence, where w_{Ak} is radiation path through the water.

$$\Psi_{BMCa} = \frac{1}{K} \cdot \sum_{k}^{K} \Psi_{BMCk} \text{, is average value of (13),} \tag{14}$$

Appropriate dose D that is delivered to the water is the product of corresponding radiation intensity Ψ and retention time T_R:

$$D = \Psi \cdot T_R, \tag{15}$$

$$T_R = \frac{L_R \cdot W_R \cdot H_W}{Q_F} \text{, where:} \tag{16}$$

$L_R = L_e$ is reactor length, W_R is reactor width and Q_F is fluid flow rate.

FINDINGS (RESULTS)

Now we can apply previous results to a reactor that is to treat potable water, having laminar flow (the worst condition). Water absorbance is α_W=0.04/cm. Eleven (N=11) low-pressure UV lamps are equidistantly distributed over water surface, in horizontal plane: a) starting 30 cm from the reactor edge (Fig. 2), b) starting 0 cm from the reactor edge (Fig. 3). Vertical lamp disposition is H_{LC}=5 cm, H_{LW}=15 cm, H_W=25 cm. UV initial lamp power is P_0=26 W, and outside radius r_o=13 mm. Length of the reactor L_R is chosen to be the same as length of the UV lamp arc L_e=111 cm (i.e. effective length $L_e=L_R$). Reactor has the width W_R=3.6 m. Refracting indices for air and water (at 254 nm) are n_A=1, n_W=1,376. Parameters for η are η_A=0.8, η_T=0.994 for $L_e/(r_o)$=85, (according to Suidan and Severin, 1986), η_V=1. Reflection of ceiling is ρ_C=0.7, and reflection of the reactor bottom is ρ_B=0.4. If we would like to determine intensity distribution on the reactor bottom for laminar water flow (the worst condition), we should apply relations (03)-(07). Results of analysis are given in Fig. 2 and Fig. 3. At the very first glance it is seen that high reflection of the ceiling could have high contribution to overall dose effect. Intensity is higher when the first and the last lamps are shifted 30 cm from the edge of the reactor (reactor A, and another is reactor B). One part of that conclusion comes from the assumption which neglects the side wall reflection. But in both cases it is obvious that it is better to have water flow in transverse rather then in the longitudinal direction in relation to the position of the lamps, for then we have averaging or integrating function in relation to the intensity and the dose. Calculating average dose for laminar flow for water thin film near the bottom at the exit of both analyzing lamps disposition over the reactor we obtain results that confirm the previous conclusion: $D_A \approx 49$ mJ/cm^2 and $D_B \approx 33$ mJ/cm^2, for flow rate of 60 m^3/s and given parameters of water and reactor. From obtained results from Figs. 1 and 2 one can see that results given by plot G3, even under the unreal assumption of mirror reflection from the ceiling, give us more reliable results (i.e. estimates) for intensity distribution than plane-wave approximation that gives us non realistic results.

In the years 2001 and 2002 we designed, built and installed two PP UV reactors for a bottling factory having a capacity of 30 liters per second each. These facilities had to meet two tasks. The first one was to apply AOP (interaction UV+H_2O_2) in order to oxidize existing Ferro bicarbonate in the water to ferry-hydroxide before sand filters. The second task was to disinfect water prior to entering the sand filters, for sand filters are breeders for bacteria coming from water wells. Both tasks were successfully achieved, although before that project commenced we only knew that this was theoretically possible. One PP UV reactor was installed over existing closed aeration basin with 48 lamps with initial power

17 W at 254 nm, and another, with 33 lamps with initial power 26 W over a new basin. In both reactors water depth was varied between 15 cm and 30 cm to obtain the best results. Water transmittance per 1 cm depth was about 0.87-0.90, because of relatively high concentration of ferrous ions (3-5 mg per liter). Hydrogen peroxide (H_2O_2) was added into water in small quantities one drop per second.

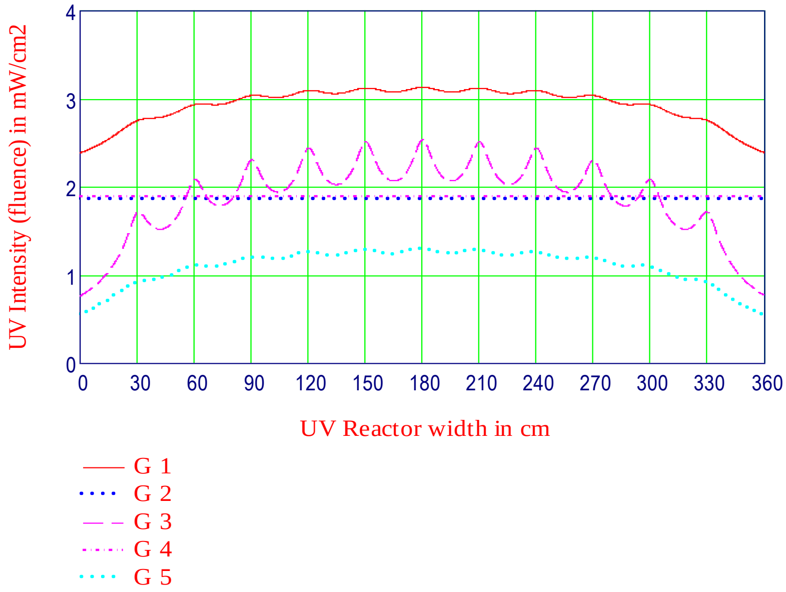

Figure 2. Radiation intensity distributions near the bottom of the reactor in various cases, when UV lamps are equidistantly placed a) starting at 30 cm from the reactor edge; G 1 includes bottom reflection (ρ_B) and reflection from the ceiling (ρ_C) in plane wave approximation; G 2 is only reflection from the ceiling in plane wave approximation; G 3 includes bottom and ceiling mirror plane wave reflection; G 4 is average of G 3; G 5 includes only direct lamp radiation and bottom reflection.

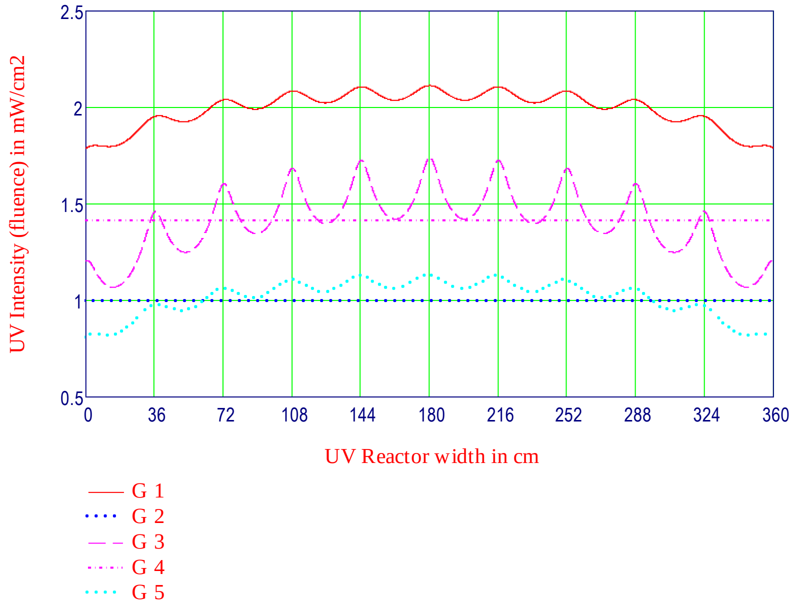

Figure 3. Radiation intensity distributions near the bottom of the reactor in various cases, when UV lamps are equidistantly placed b) starting at 0 cm from the reactor edge; G 1 includes bottom reflection (ρ_B) and reflection from the ceiling (ρ_C) in plane wave approximation; G 2 is only reflection from the ceiling in plane wave approximation; G 3 includes bottom and ceiling plane wave mirror reflection; G 4 is average of G 3; G 5 includes only direct lamp radiation and bottom reflection.

DISCUSSION

Results from this paper are combination of exact calculations for direct radiation and very rough calculation model for reflecting radiation, especially for the influence of the ceiling. Obtained results lead us consequently to optimizations that are necessary to apply, in order to obtain maximum dose for the same energy input. Optimization in this case should be multilateral involving careful selection of materials for the reactor, choices of reactor geometry and selection of appropriate water quality.

CONCLUSIONS AND IMPLICATIONS

From previous results and practical experience the authors have seen that open PP UV reactors are capable of having wide application in water treatments where contact with water should be avoided, especially because of water content. Additionally, they are cheap and do not require high technology, and over all operator can modify either manually or automatically (if constructed for that purposes) water depth, lamps vertical and horizontal disposition. Also, it is possible to change the number of lamps and their type and enable a variety of experimental work at the facility. All of this is not possible when fixed geometry exists, and then influence to the output dose is possible only by changing water flow through the reactor. Optimization of PP UV reactors represents a very interesting area of investigation aimed application. Another very interesting field of investigation should be even the rough model (at the beginning) of reflection and its influence to intensity distribution and overall dose in PP reactors as well as use of a variety of other geometries.

REFERENCES

LUCKIESH, M., “Applications of Germicidal, Erythemal and Infrared Energy”, Van Nostrand, New York, 1946.

KAMIMURA, M., and SUZUKI, N., “The Investigated Report on the Purification Facility of Cultured Oyster Institute”, Sato Oyster Nursery at Matoya Bay Japan Export Frozen Marine Products Inspection Corp., 1954.

KELLY, C. B., “Disinfection of sea water by ultraviolet radiation”, Am. J. Public Health, 51, 1670-1680, 1961.

HILL, Jr., W. F., HAMBLETT, F. E., and BENTON, W. H., “lnactivation of poliovirus type 1 by the Kelly-Purdy ultraviolet seawater treatment unit”, Appl. Microbiol., 17, 1-6, 1969.

SUIDAN, M.T., SEVERIN, B.F., “Light Intensity Models for Annular UV Disinfection Reactors”, AIChE Journal, 32(11), 1902-1909., 1986.

MILANOVIĆ, Đ. R., SAJFERT, V., OBRADOVIĆ, S., VUJOTIĆ, LJ., ROSIĆ, B., MILANOVIĆ, S., “Modified divergence theorem for UV reactor analysis and optimization”, Hemijska Industrija 2011.

BORN, M., and WOLF, E., “Principles of Optics”, Pergamon Press 1986., p.40.

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RISK ASSESSMENT OF RIVER WATER POLLUTION WITH SLAUGHTERHOUSE’S BLOOD

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ABSTRACT

Private slaughterhouses establishments in Bulgaria resulted in increasing the sources of surface waters polluted with waste animal’s blood. It is emitted with the wastewater of different types. The aim of the paper is to set the influence of the blood pollution upon the bioindicators in the water of the river of Danube and the river of Rusenski Lom. For solving the problem modeling method is applied. Analyses of the main parameters with and without pollution were made. The following characteristics were investigated first: amount of the dissolved oxygen, pH, transparency, chemical oxygen demand and total nitrogen changes of drink water, used in slaughterhouse manufacture, wastewaters from different slaughterhouse’s processes and river waters. Drink and river waters were artificially polluted adding some blood. The changes in waste water characteristics were defined. It was used as a medium to define the risk for the fish. As a bioindicators were used 10-14 grams weighted carp fishes. The mortality in different blood concentrations and exposures in the waste river water was defined. The risk is evaluated and an assessment was given for the criticality of the pollution.

Keywords: river water, animal’s blood, pollution.

The slaughterhouse’s blood is a specific pollutant of the waters. It contains a variety of the main biogenetic substances – proteins, fats, carbohydrates. After getting into the water they results rot processes with the influence of the micro flora. The environment gets anaerobic and the amount of the dissolved oxygen is reduced. The water pH, transparency are changed, ammonia and hydrogen sulphide are emitted, influencing the flora and fauna [3].

The aim of the investigation is to define the risk of river water pollution with animal’s blood.
The main purposes of the investigations are:

- the influence of the blood upon some main water quality characteristics - amount of the dissolved oxygen, pH, transparency, chemical oxygen demand and total nitrogen, using for total protein calculation;
- risk assessment for bio-objects;

For the needs of the investigations was used fresh obtained animals blood from cattle. It was added to drink and river water with preliminary defined quality characteristics.
It was investigated the change of:

- amount of the dissolved oxygen:

It was added an animals blood to the drink water It quantity was between 0 and 60 g/l with a step of 2 g. The concentration of the dissolved oxygen was measured on every blood concentration increment. For the dissolved oxygen’s concentration monitoring an oximeter OXI 91-WTW was used. The environment was continuously mixed with a laboratory homogenizer. The interval of the dissolved oxygen changes was between 0 and 99 % intensity or between 0 and 50 in mg/l. The error in percentage when measure was less than 1 %, and less than 0,1 mg/l when measurement is in mg/l.
Permissible value of the dissolved oxygen is 4 mg/l for II category water intakes, used for fish-farms, water sports, culture needs, drinking pools and etc. [1]

- pH of the water:

A potentiometric method was used.
Permissible value for pH is 6,0-8,5 for II category water intakes [1].

- water transparency when adding the blood:

For transparency measurement the method of Snellen's standard font reading is applied. And the homonymous device is used.

– chemical oxigen demand – COD:

The bichromate method was applied for the measurements. In a sulphur-acid environment, potassium bichromate oxidizes reduction components in the water. The excess of potassium bichromate titrates with a solution of Mohr's salt with known consternation with indicator of feroine. As a catalyst Ag_2SO_4 is used.

The permissible value of COD is 70 mg/l [1].

– Total nitrogen concentration:

The Keldal method is applied. It consists of wet burning of nitrogen-containing products with concentrated sulphuric acid in high temperature with catalyst inserted until receive carbon dioxide, water, ammonia, that transforms in presence of sulphuric acid into ammonia sulphate. Ammonia sulphate, upon the influence of sodium base emits ammonia, able to catch in a determinate volume of sulphuric acid with known concentration, taken in excess and successive titration of the excessive acid with base.

All the experiments are held on with triple repeat with using different water sample in each experiment. The samples of drink water were taken from the quarter of "Vazrajdane", the samples from the river of Rusenski Lom – from its outflow, and the samples of the Danube River's water – from the shipyard east.

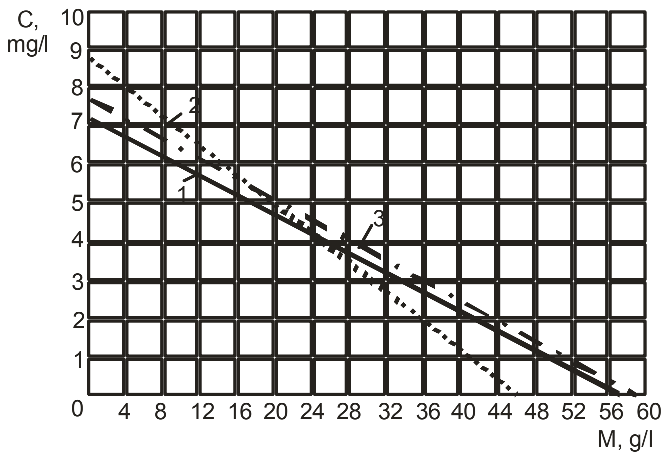

Figure 1. Dissolved oxygen change – C depending of the blood concentrations M: 1 – drink water; 2 – water from the river of Rusenski Lom; 3 – water from the Danube river

The criticality is assessed using:

a) permissible values of the water parameters;

б) bio indicator's mortality.

For each experiment as bio indicators were used 60 numbers of 10-14 grams weighted carp fishes.

For correlation influence of two controllable factors upon the dissolved oxygen were planned and held experiments with alteration of the concentration of added blood – M and temperature – T of the environment on 3 levels -10, 20, 30^{o}C and the alkalinity of the environment pH, accordingly – 6, 7 and 8.

The determination of the criticality, using bio-indicators was held with the extent of the pollution of the water with blood and the exposure of the indicator influenced definition. For assessment of the pollution result the mortality frequency of the indicators was calculated. The planned experiment B2 was used [2]. The rest indexes were controlled – total nitrogen, COD, pH and temperature. The blood pollution and exposure were altered on 3 levels.

When the water is polluted with slaughterhouse blood the dissolved oxygen decreases linearly (fig.1). For the experiment's results approximation the software SPSS was used. Using it the following regression models of the dissolved oxygen – C, were obtained:

$$
\begin{aligned}
&C=7{,}35-0{,}1174M\text{-for drinking water;}\\
&C=7{,}84-0{,}1022M\text{- for the water from river of Rusenski Lom;}\\
&C=8{,}85-0{,}2401M\text{-for the water from the Danube River,}
\end{aligned}
\tag{1}
$$

where M is the blood concentration in the water, g/l.

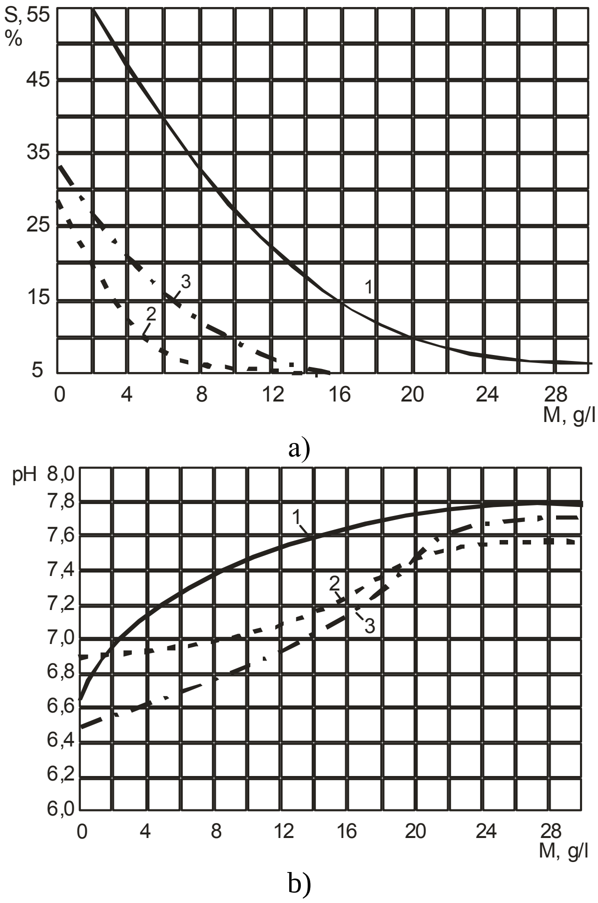

Figure 2. Dependencies of the transparency S (a) and pH (b) from the blood concentration M: 1 – drink water; 2 – water from the river of Rusenski Lom; 3 – water from the Danube river

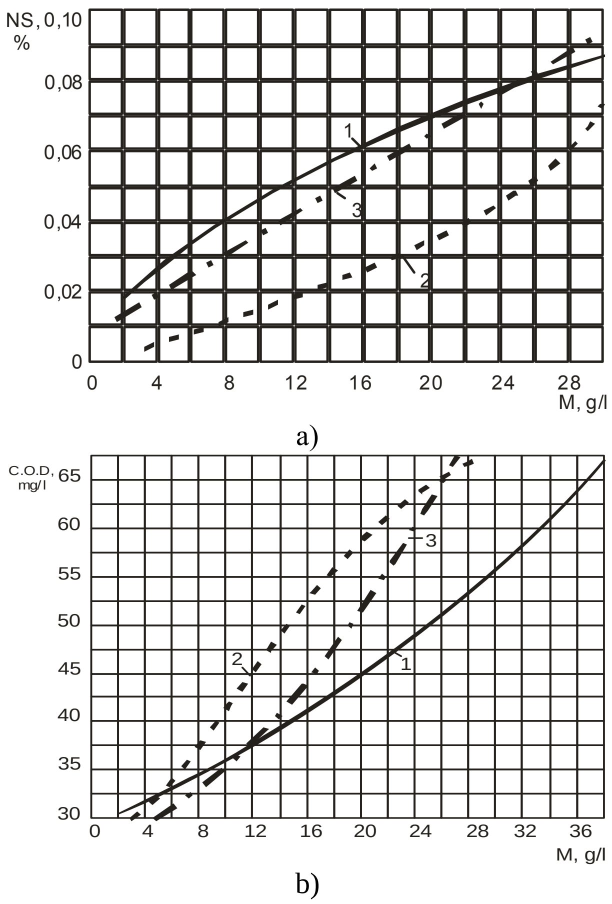

Figure 3. Dependencies of the total nitrogen NS (a) and COD (b) from the blood concentration M: 1 – drink water; 2 – water from the river of Rusenski Lom; 3 – water from the Danube river

Increasing the blood concentration decreases the water transparency S more than 10 times (fig.2a). It affects the light penetration and influences negative upon the biological results and photosynthesis.

Fig. 2b presents the pH change. From the initial value of 6,5-6,9 it grows up to 7,5-7,8. In spite of this it remains in the permissible values for the second category waters. When pH is above 7,0 the ammonia cations are transformed into ammonia, strongly dangerous for the fish.

Fig. 3a presents the tendencies of total nitrogen alteration. It is shown that the total nitrogen in the water alters almost proportionally with increasing the blood added.

The chemical oxygen demand increases from 18 mg/l when blood is 2 g/l up to more than 87 mg/l when the blood concentration is 38 g/l in the water from the river of Danube.

Using SPSS some regression models for the rest water parameters alteration were obtained:

a) drinking water:

$$S=66,2635-5,4380M+0,1653M^2-0,0017M^3; \quad (2)$$
$$pH=6,6626+0,1214M-0,0045M^2+5,8.10^{-5}M^3;$$
$$NS=0,0110M^{0,6129};$$
$$COD=26,2095+1,1507M-0,0190M^2+0,0042M^3;$$

b) water from the river of Rusenski Lom:

$$S=33,1235-3,3672M+0,2561M^2-0,0052M^3; \quad (3)$$
$$pH=6,8933+0,16743M-0,0023M^2+2,4.10^{-5}M^3;$$
$$NS=0,0293M^{0,4392};$$
$$COD=21,5277+1,2451M-0,02406M^2+0,0021M^3;$$

c) water from the Danube River:

$$S=28,9122-8,4255M+0,3252M^2-0,0026M^3; \quad (4)$$
$$pH=6,4677+0,1542M-0,0053M^2+3,3.10^{-5}M^3;$$
$$NS=0,0561M^{0,3428};$$
$$COD=18,3892+1,0836M-0,00773M^2+0,0032M^3.$$

An investigation was held to establish the influence of the alteration of the initial pH of the water samples and the blood ability to combine with the dissolved oxygen. The dissolved oxygen in different pH with constant initial value was defined. With alkalinity increase, the amount of the dissolved oxygen decreasing upon the permissible value begins at lower blood concentration in the water.

Two-factorial experiments were made.

The blood concentration M was a controllable factor in both the experiments. It was altered on 3 levels 10, 25 and 40 mg/l. During the first experiment the water temperature was altered from 10 ^oC up to 30 ^oC with a step of 10 ^oC. The alkaline reaction during the second experiment was altered from 6 to 8 with a step of 1. The experiments were made under plan B2. After results processing with software for multifactor regression analyses, the following models for the content of the dissolved oxygen C were obtained:

a) Drinking water:

$$C=3,10072-2,40239M-0,23320T+0,47500MT+0,09316M^2+0,09316T^2; \quad (5)$$
$$C=3,40082-2,56352M-0,72118pH+0,08687M^2+0,33679pH^2;$$

b) water from the river of Rusenski Lom:

$$C=2,2783-1,2286M-0,1782T+0,5723MT+0,0988M^2+0,09637T^2; \quad (6)$$
$$C=3,0275-2,0327M-0,5372pH+0,0628M^2+0,36377pH^2;$$

c) water from the Danube river:

$$C=2,1722-1,0183M-0,3027T+0,5273MT+0,09103M^2+0,0830T^2; \quad (7)$$
$$C=3,2677-2,2291M-0,6726pH+0,0572M^2+0,3018pH^2.$$

For boundaries alterations of the controlling factors when testing, using bio-indicators of the criticality it was investigated the influence of the exposure time - T_V. The experiments were held with constant controllable factors – total nitrogen NS=0,07-0,09%, COD=45-66mg/l, pH=7 and T=20^oC. The time Tv of exposure upon the chosen bio-indicators was altered from 0,5 to 4h. The water was polluted on 3 levels: M=28 g/l (C=3,4 mg/l); M=36 g/l (C=2,6 mg/l); M=44 g/l (C=1,7 mg/l). The results of the mortality alteration Pmort of the bio-indicators is illustrated on fig.4.

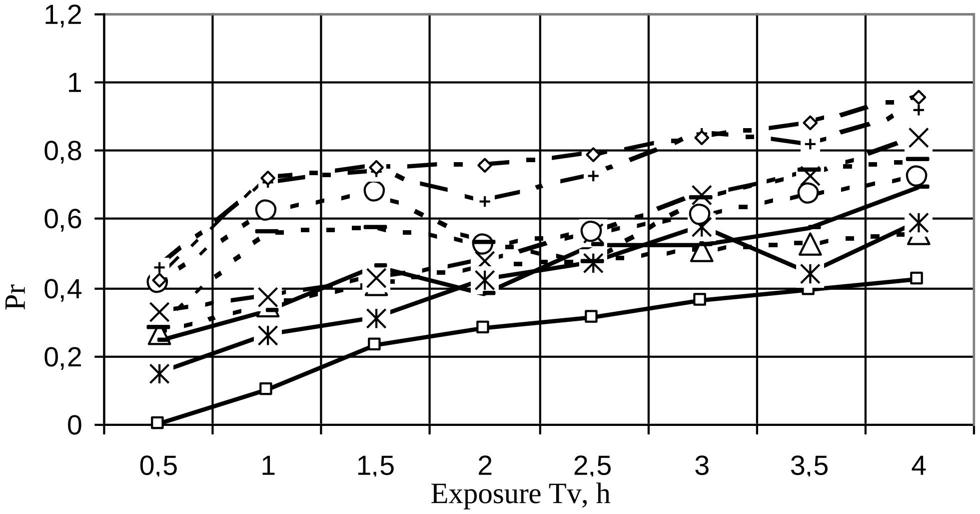

Figure 4. Frequency change - Prompt of the bioindicator’s mortality in water polluted with animal’s blood: —— - M=28g/l; - - - - - - M=36g/l; – – – – – - M=44g/l; ∗, O, ◊ - river of Runski Lom; □, _, + - drink water; x, –, Δ – Danube river

Based on these results it was planned two factor experiment with alteration of the pollution on the same levels. The exposure was also changed on three levels-0,5; 2 and 3h. The total nitrogen, COD, pH and T was held in the boundaries shown above.

The data from the experiments processed using the software for multifactor regression analyses and the following models of the criticality of the blood pollution were received:

a) drinking water:
$Pmort(M,Tv)=0,828695-0,083582M+0,530554Tv-0,011458MTv+0,001854M^2+0,000517Tv^2$; (8)

b) water from the river of Rusenski Lom:
$Pmort(M,Tv)=0,87824-0,07583M+0,463772Tv-0,027182MTv+0,0015266M^2+0,000326Tv^2$; (9)

c) water from the Danube River:
$Pmort(M,Tv)=0,872882-0,06271M+0,58392Tv-0,016277MTv+0,003522M^2+0,000426Tv^2$. (10)

As a result from the experiments the following conclusions were made:

- A linear dependency (1) of the amount of dissolved oxygen in river waters, polluted with blood is acquired. When the pollution is increased from 2 to 60g/l the amount of dissolved oxygen is reduced from 6,8-7,6mg/l to 0,4-0,8mg/l.
- The river water transparency depends hardly from the pollution and for the investigated interval it was reduced more than 10-15 times.
- The active reaction was also changed but retains in the permissible boundaries.
- The total nitrogen increased more than 5-8 times, but still remains in the permissible values;
- The chemical oxygen demand also was increased, remaining in the permissible values;
- Some regression models of the investigated water quality parameters were obtained –curves (2)-(7);
- To establish the extent of criticality of the water pollution with slaughterhouse blood the dependency – formulas (8)-(10) of the bio-indicator’s 10-14 grams weighted carp fishes mortality is defined, using exposure and the concentration of the blood in water. It is

applicable for danger effects prediction and gives new information for the common influence of two main factors.

The presented results and those received in our older investigations [3], are data base for a future extensive experimental investigation with different samples of water, in different seasons, extent of pollution with chemical agents, different bio-indicators and conditions. They allow defining the appropriate circumstances for stock water intakes with fish, which has an economical importance.

REFERENCES

Наредба №6 от 9.11.2000г. за емисионни норми за допустимото съдържание на вредни опасни вещества в отпадъчните води, зауствани във водни обекти (обн. ДВ, бр.97, от 2000г.).

Томов, В.Теория на риска. Анализ и оценка на риска в производството. Монография. Русе, Русенски университет, 2003, 440с.

Tomov, V. About criticality of contamination of waters with animal blood. Proceedings of Second international congress of mechanical and electrical engineering and marine industry. MEEMI 2005,07-09 October 2005, Varna, v.IV, pp.176-183.

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RELATIONSHIP BETWEEN FOREST AND WATER

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ABSTRACT

This paper presents the research of complex relationship between water, soil and vegetation. Among other factors, forest ecosystem plays mediating role between rainfall and water runoff. Regarding their mediation capability, different forest types and their soils are more or less hydrologically relevant. Therefore, in terms of hydrology, beech plant communities stand out as the most important type of vegetation since they secure high quality water supplies in hilly-mountainous areas.

Key words: forest, water, water yield, forest soil, ecosystem, water runoff.

INTRODUCTION

Water resources are the most appreciated component of the biosphere and important physical and geographical environmental element on Earth. Beside the fact that the first forms of life evolved in water and are mostly made up of water, strategically, water presents and very important raw material. Industrial production growth in the world is increasing every year following a large-scale population growth on the planet. Water demands have been multiplied especially in the agricultural sector. Water usage has reached a figure of over 5.130 km^3 per year, where the largest part (69%) belongs to agriculture, 23% to industry and 8% to households (Hanneberg, 1993).

High atmosphere temperature and the reduction of rainfall induced by current climate changes increased water consumption and therefore made the problem of water shortage even more serious. There is also a growing problem of surface and groundwater pollution which, in addition to the abovementioned, creates general picture of the world's available water supplies and therefore indicates global deficit of this essential resource. According to certain authors such as Velašević et al., 2002, "water stress" is to be expected in the upcoming decades of this century.

AVAILABLE WATER SUPPLIES

An area is considered to have a self-sufficient water supply if it is able to provide annually around 3.000 m^3 per capita, out of which approximately 50% is for consumption and 50% covers biological minimum in hydrographic network (Đorđević, 1993). The total of available water supplies in the territory of Serbia is about 5.671 $m^3 s^{-1}$ or $178.662 \cdot 10^6$ m^3, out of which 91% belong to transit water, and only 9% to its own water.

In the territory of Serbia, the supplies of indigenous water or its own water are very modest and their specific runoff of 5,7 $l \cdot s^{-1} \cdot km^{-2}$ provides annually only 1.500 m^3 per capita. Therefore, in terms of water, Serbia is classified as one of the poorest countries in Europe. Considering the fact that indigenous water supplies in Serbia are not sufficient to satisfy growing water demands, it is necessary to use transit water which is usually of a lower quality. However, it is even less favorable that low water quality cannot be directly affected.

FOREST WATER RESOURCES

Forest vegetation plays very important role in mediation between rainfall and water runoff during ground phase of water cycle in nature. On spatial-ecological unit, catchment, complex processes of water mass exchange take place and the incoming rainfall is distributed in space and time. The hydrographic network consists of one portion of rainfall that returns to the atmosphere through complex process of evapotranspiration, one portion that goes into soil water supply, one that becomes part of living organisms cells, and one portion that forms runoff (partly forming surface and subsurface runoffs and partly forming underground aquifers). In addition to hydro-geological and other catchment features, the relationship water-soil-plants has positive effect on retention and water runoff since it reduces harmful surface runoff and increases useful subsurface runoff. The physical characteristics of soil, in terms of water and air, humus content and quality and the presence of the layer of fallen dry leaves contribute to favorable infiltration characteristics of (structural) forest soils which are therefore the best runoff regulators and reservoirs of significant high quality water supplies. In addition to favorable hydrological characteristics, forests and forest soils are also a natural filter for (mechanical, chemical and biological) water purification which is a very complex process that takes place as atmospheric water passes through the forest ecosystem.

Therefore, the forest areas in Serbia, which are primarily in hilly-mountainous areas, with high rate of forest coverage (over 27%) and low population density still have pure water supplies and represent natural reservoirs of significant high quality water resources.

Figure 1: Water and Beech Forest Ecosystem

The estimation of average water quantities that can be expected from certain types of forests in Serbia's hilly-mountainous regions are presented in Table 1 (Letić et al., 1995; Letić, 1998; etc.). The table includes basic spatial distribution of forest types by altitude zones above 200 m. In addition to data regarding area and average rainfall per given altitude for mentioned forest types, the analysis presents experimentally measured coefficients for certain forest ecosystems.

Table 1: The estimation of total runoff from hilly-mountainous forest region of Serbia

Forests	Area	Altitude	Average rainfall	Runoff coef.	Runoff (W)
	$ha \cdot m^{-3}$	m	mm	cm	$m^3 \cdot y^{-1} \cdot 10^{-3}$
oak, oak-beech and OTL	1.150	200-600	717	0,27	2.226,3
beech, beech-oak, beech- hornbeam and OTL	925	600-800	825	0,37	2.823,6
beech-fir-spruce	80	800-1400	969	0,36	279,1
spruce and other conifers	110	>1400	1.077	0,27	320,0
total	2.265				5.649,0

Source: Letić et al., 1995

The analysis of expected water quantities from forest ecosystems points out that the beech forest zone is expected to provide the largest quantities of water. The expected yield from homogeneous beech forests is around $3.000 \cdot 10^6$ $m^3 \cdot y^{-1}$ or 55% of total water quantity from forest areas in Serbia that is estimated to be $5.649 \cdot 10^6$ m^3 per year (Letić et al., 1995). If stands also contain beech are calculated in the estimation, this percentage increases to significant 85%. The analysis points out that beech is hydrologically most significant species since it creates life structure with characteristics that are optimal for useful water yield i.e. improved high-quality water.

CONCLUDING REMARKS

Having regard to pervious analysis on estimation of water yield from forest ecosystems of hilly-mountainous area in Serbia, the following conclusions can be made:

- It is estimated that available water supplies from forest areas range from $5.000 \cdot 10^6$ - $6.000 \cdot 10^6$ $m^3 \cdot y^{-1}$. This amount of useful water can be increased by appropriate useful water yield-increasing management measures (forest management planning is also a "water management" in forest areas);
- In terms of hydrology, beech is the most favorable species since it creates optimal conditions (spongy structure and deep soil) for maximum rainfall infiltration and the accumulation of significant water quantities, or, in other words, it creates the optimal conditions for slow water discharge from springs;
- Favorable soil characteristics in terms of water and air, humus content and quality and the presence of the great layer of fallen dry leaves point out forest soils as the best natural filters. Water obtained from forest ecosystems especially from beech forests, represent the highest quality drinking water, suitable for improvement of industrial conditioned water.

Therefore, the natural reservoirs of significant high-quality water quantities are located in hilly-mountainous regions of Serbia and their use is conditioned by special forest management method.

REFERENCES

Đorđević, B., (1993): *Water management development in Serbia and its further strategic orientation, Water management*, The Yugoslav Society for irrigation and drainage, Belgrade;

Hanneberg, P.,(1993.): *Acidifikacion and airpollution*, Swedish Environmental Protection Agency, Solna;

Letić, Lj., (1998): *Effects of forest on water quality in the hilly-mountainous regions of Serbia*, The collection of Essays, Symposium, *Water Resources of Velika Morava catchment and its exploitation,* Krusevac;

Letić, Lj., & Đorović, M., (1995.): *Water potential of forest area-preserving, organization and rational exploitation,* Monograph , *The potential of forests and forest areas and their importance for the development of Serbia*, Belgrade Faculty of Forestry;

Letić, Lj.,(2001.): *Bioregulation - organization and exploitation of water in forest areas*, Textbook, Faculty of Forestry, Belgrade.

Nikolić, V., & Letić, Lj., (2009): *Ecological approach to the natural managment of Dičina watershed*, Iinternational conference "land conservation"-Landcon 09 05-may 26-30, 2009 Tara mountain/Serbia.

Velašević, V., Đorović, M., & Letić, Lj. (2002) Ekološki aspekt očuvanja, zaštite i uređenja voda šumskih slivova. Beograd: Unija Bioloških naučnih društava Jugoslavije.

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HYDRO-GEOLOGICAL AND GEO-CHEMICAL PROSPECTION OF WATER SUPPLY IN LAKTAŠI

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ABSTRACT

Using new electromagnetic method, a hydro-geological and geo-chemical prospect has been done, in order to spread the water source of Laktasi water supply. Sites with the best filtrating characteristics have been defined by horizontal prospect while using the vertical prospection lithologic units of soil saturated with water have been specified as well as the content of pollution until the depth of 100 meters.

Key words: ground water, new method RADIJAN-2001SF.

INTRODUCTION

During the first phase of hydro-geological researches, applying electromagnetic geophysical method by RADIJAN-2001SF apparatus, geometric characteristics of soil levels saturated with water were defined by the depth of 100 meters (number, way of spreading, thickness of levels) as well as the level of pollution of various polluters.

The final goal of this research is to define the conditions that cause accumulation of the ground water, of such chemical content that is suitable for the creation of the new water source for water supply and spreading existing exploitable capacity of JKP ”BUDUĆNOST“ in Laktaši.

METHODS

In Laktaši, at the water source for water supply, a new electromagnetic method of geo-chemical prospect has been applied, RADIJAN-2001SF, invented by Zvonimir Janković. Emitter of low frequent electromagnetic waves with the regulator of emitting ray is used by directing the emitting arrow which irradiates emitting beam in wanted direction, while with the beam regulator we can adjust the size of the beam in order to discover the subject i.e. chemical element. The author set the frequencies of the all chemical elements in Mendeleyev system as well as of the substances defined as the most often polluters of the ground water and soil. The low frequent field (from 2 to 20 Hz) can discover the profile of ore deposit or underground infrastructure, which can be applied in mining, archeology, in search for missing people during the natural catastrophes, but in ecology as well: in discovering the damaged underground objects containing dangerous substances, which can pollute environment, wild trash heaps, cattle graveyards etc. The range of detection with this instrument can reach until 3 km in both horizontal and vertical prospects.

At several water sources for water supply in Laktaši, littoral content, the degree of saturation in soil level containing water, direction of the greatest ground water filtration and polluters were qualitatively defined.

THE RESULTS TAKEN OUT OF GEOPHYSICAL RESEARCHES

To set the priority of research at the water sources, during the first phase the vertical and horizontal prospect have been made with RADIJAN-2001SF instrument, at five sites determined by the representative from JKP „Buducnost” – Laktaši (see also Figure 1).

Figure 1. Location of exploration with the new method RADIJAN-2001SF for water supply system in Laktaši Legend: 1-current spring–way to Mahovljane, 2-location of „Šljivik“, 3–old spring that is periodically activated, 4–future spring Maglajani.

Location at the water supply Laktaši: Using horizontal hydro-geological prospect, the dominant direction of underground water’s flow has been set, in southeast part of the protected area, because other two directions have been used for the exploitation with the existing wells. The analyzed area is approximately 160 ha. Using vertical prospect until the depth of 135 m, three pebbly-sandy like layers partially containing water were defined at measuring point MT1, with the frequency set on the accumulated underground water of 60 Hz in the first and the third layer, while in the second one is 40 Hz. Polluters or dangerous substances have not been found.

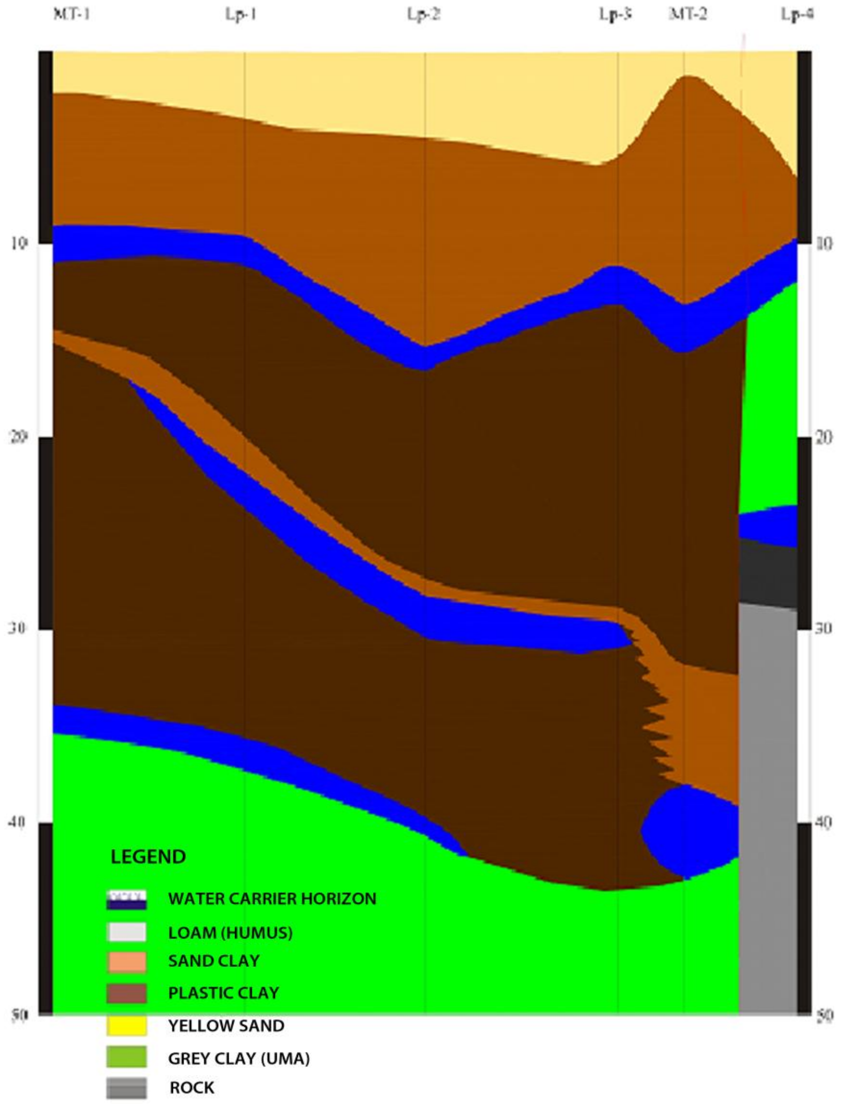

Figure 2. Extension of the water supply Laktaši with the location points MT1, MT2 and lithologic profile

Location No. 1: (MT1 and MT2, see also Figure 1, 2) it is found in the extent of the existing water source, towards north, i.e. Mahovljani brook. By vertical hydro-geological and geo-chemical prospect until 140 meters, five pebbly-sandy intervals were found which thickness vary from 2 m to 4 m, while the intervals saturated with water are even smaller. It is assumed that the years of intensive exploitation have caused pouring of ground water from all pebbly-sandy layers and lenses in alluvial sediments in the wider zone of the water source. This assumption should be confirmed by setting the experimental well.

Considering the polluters, (the natural content as the consequence of geological content and regional geo-stratographic conditions) non-convenient ions in the soil, there are manganese with 5 units at the depth of 53-55 meters and sulfur with 10 units at the depth of 14-16 meters. Starting from the surface, the littoral profile contains the next ingredients: potter’s clay/argil and the sandy clay until 9.4 m, then the first layer containing water in the interval from 9.4 m to 11.1 m, homogeneous clay and sandy clay till 22 m, the second sandy layer containing underground water till 23.4 m, clay till 35.4 m, the third sandy layer from 35.4 to 37.3 m, and the gray clay till 50 m. The profile is completely different comparing to littoral profiles of the exploited wells. At the transversal profile, the first sandy layer is continually extending in the zone of the existing water source. Other identified sandy layers are suddenly laterally replaced with sandy clay or marl and they do not continually develop in such a small space. At the last measuring point LP-4, littoral profile is different because the layer of gray clay begins at the depth of 11.6 meters, while the interval from 25 to 28 meters is the homogeneous plaque of gray clay determined by geophysical measuring, and in continuation there are tied sand-stones until the depth of 50 meters. Layer of deluvial sediments (clay containing marl) in the zone of the water source begins approximately at the depth o 43 meters.

Location No. 2: (MT3, see also Figure 1,3) it is placed across the existing water source in a plum orchard. Its approximate area is about 160 ha. An investor gave up from the former location 4 (highway in future) so this location was set later on, because of the possibility to join it to the existing water distributive system very fast at the very source. It is found with geo-chemical prospect that the soil contains increased level of sulfur in some layers from 50 m to 79 m with 5-20 units. The appearance of sulfur at the deeper levels in zone Laktasi, can be the consequence of the sedimentation conditions and geological area, as well as the consequence of the diffuse pouring of thermal water along the dislocated zone.

Location No.3: (MT4, see also Figure 1,4) near the old well, which is again in use. The well is used as the additional supply during the extra-water consumption, joining it directly to the system for water supply. This location is in the centre of Laktaši near a spa and it is the nearest one to the river course of Vrbas. However, even this well has lower capacity comparing it to the measured and predicted capacities done during 1974. The figure no. 4 shows micro-location with the future experimental well and littoral profile till 90.00 m. At this location a layer of alluvial sediments is also found at 54 m, and water repellent layer of rocks at the depth of 87 m. At the profile of the old well (Turalija, 1974, 1976) diabase hornfels debris was found at 14.7 m. If this is correct, then this source is also in the splitting zone. There is a natural thermal spring of the spa Laktaši, very near, which is drained over the canal of the spa in Vrbas river.

In general, all natural thermo-mineral springs appear at the cross-section of two splitting systems, when on one side are systems of cracks with ground water, and on the other side of the split at the same hypsometric height is water repellent barrier (maybe diabase hornfels debris or formation). Groundwater source is moved under the gas pressure of carbon dioxide or sulfur dioxide upward along the splitting zone, towards the surface, where it pours out diffusely to the river alluvium or above the river. To confirm this, there is also a spring that contains sulfur in the spa Slatina, which is also an upward type and it is placed in the splitting zone. It is assumed that the best hydro-geological parameters of the alluvium are at this location because it is additionally fed by the spa spring or the ground water.

By geo-chemical prospect till 19 m, the next polluters have been identified: ammonium with 5-15 units of strength, manganese with 5-15 units, nitrates with 10-30 units and sulfur with 10-50 units.

Location No. 4: (MT5, see also Figure 1,5) it is placed in the new built water source of the water supply Maglajani, on the left side of the international road, near the sawmill. By horizontal hydro-geological prospect, two dominant directions of ground water currents were set and the micro-location of the experimental well was placed at the cross-section. The alluvial sediments are 57 m with four intervals of sandy layers thick from 2 m till 4 m. In the older clay layers containing sand or marl, three sandy intervals were detected thick from 2 m till 4 m. At the depth of 85.4 m till 96 m was found a rock, probably a sand-stone, with a sandy interval from 90 m till 92.5 m. Neither one water level is completely saturated with water. By geo-chemical prospect, the next polluters were detected: ammonium (15-20 units), mercury (5 units), manganese (15-30 units), and nitrates (15-30 units) till 10.00m of depth in various intervals and sulfur in the zone of water-repellent level of basin Field Lijevče at 85.4 m of depth and with 15-25 units of strength.

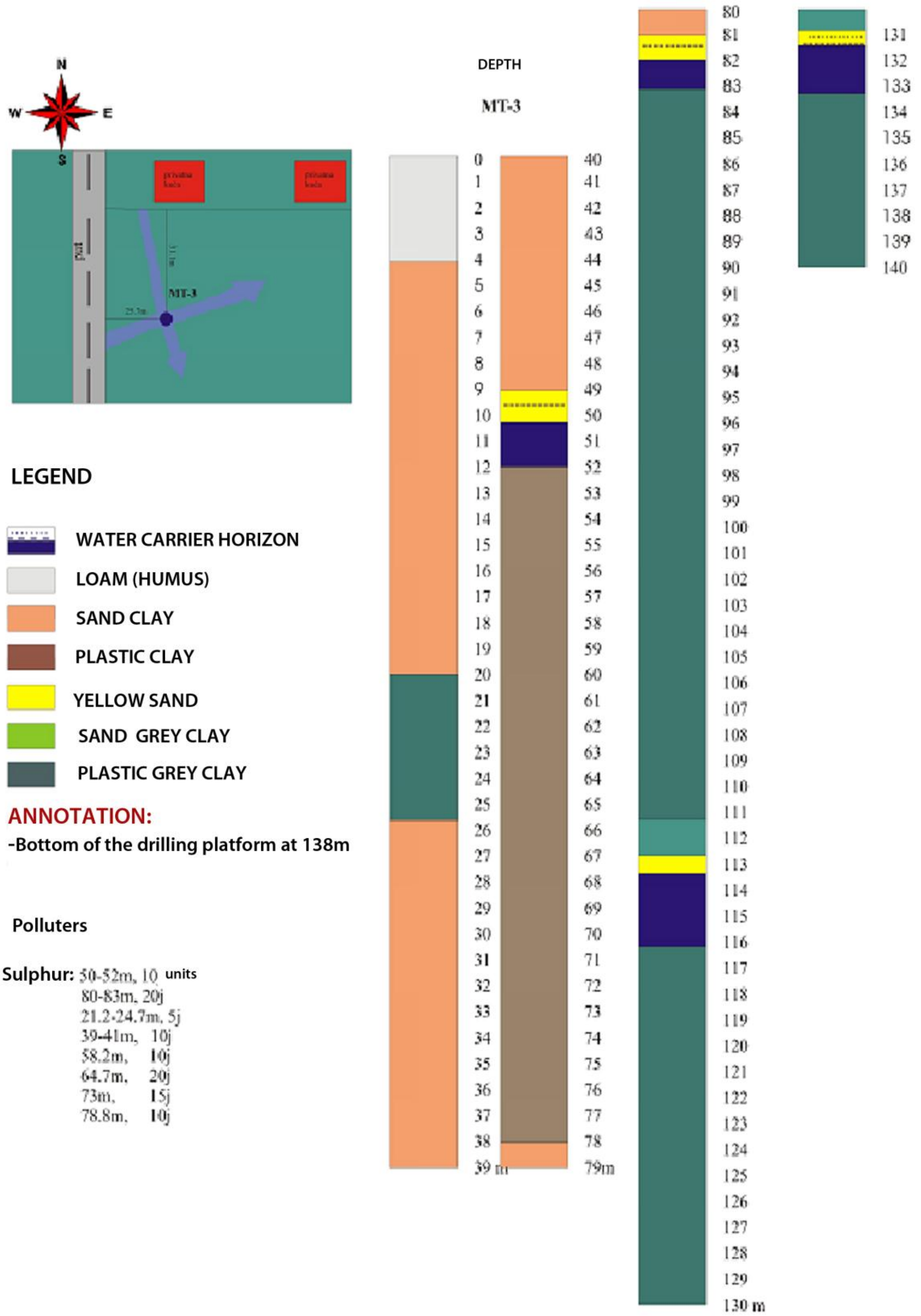

Figure 3. Extending of the water source "Šljivik" with the location MT-3 and lithologic profile

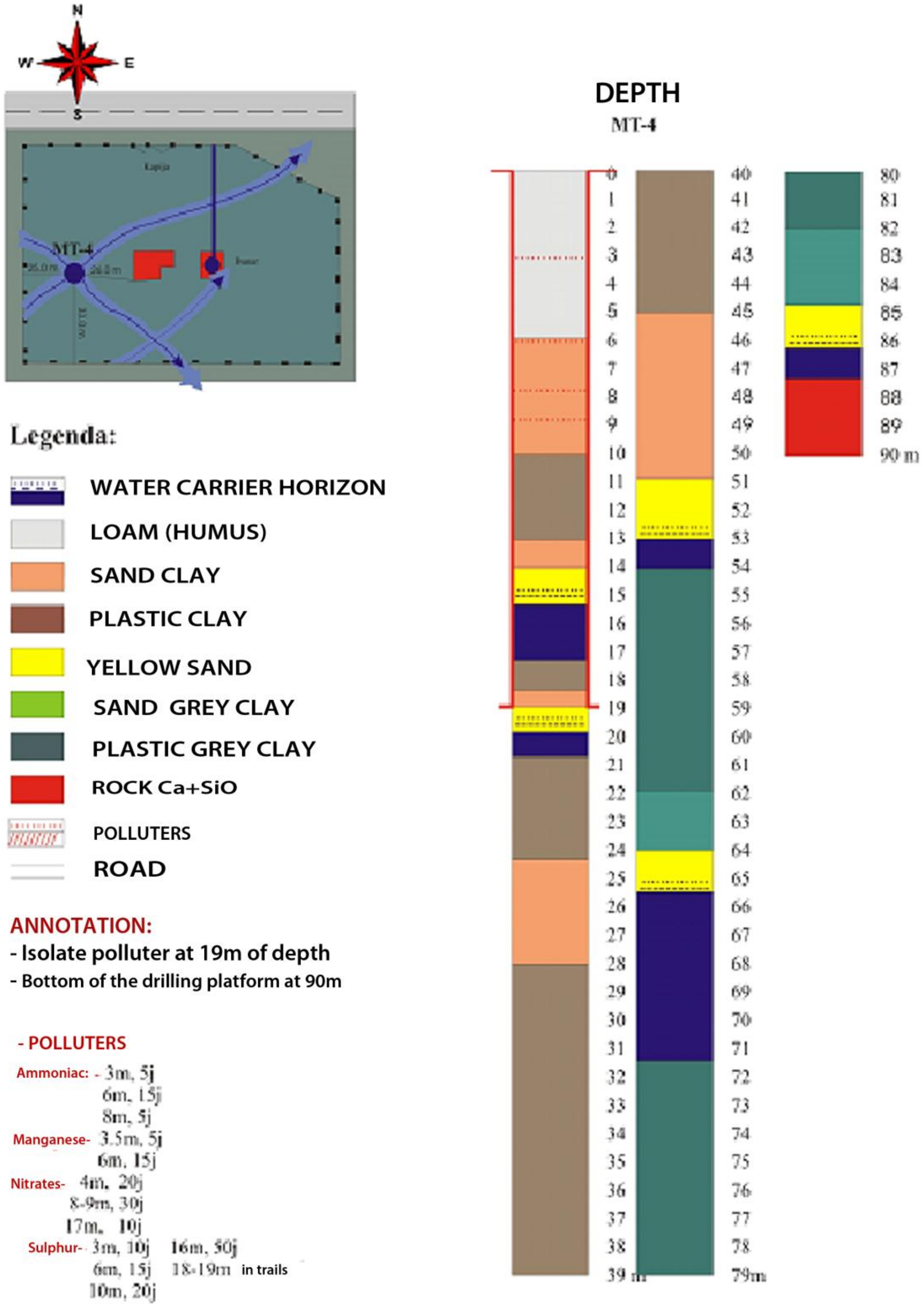

Figure 4. The old water supply Laktaši with the location MT4 and lithologic profile

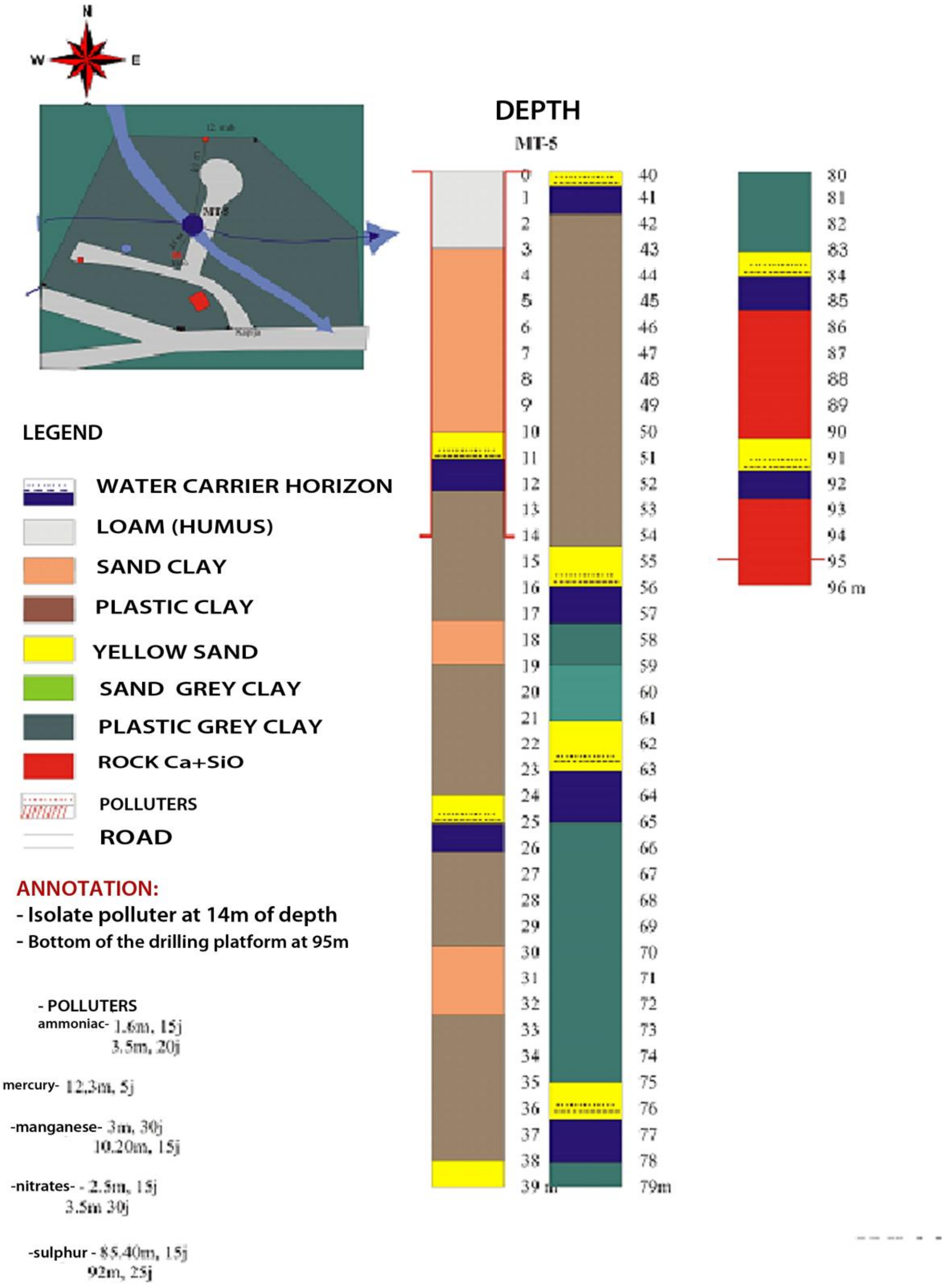

Figure 5. The new water supply Laktaši- Maglajani with the location MT5 and lithologic profile

CONCLUSION

Considering hydro-geological and geo-chemical prospect done with geo-physical method of the RADIJAN- 2001SF apparatus, as well as the analysis of available documentation, it is concluded that at the six locations which were proposed by the investor, using horizontal prospect, the main current of the ground water was set, then by vertical prospect the layers full with water were defined in the soil profile with the strongest frequency set on ground water and finally the potential polluters were detected in soil and water.

At all locations, in lithologic profiles, the most present are: sandy clay or yellow and gray plastic clay, clay with marl. At two locations, near the prolluvialy delluvial cones and alluviums, the hard limestone-siliceous rocks were detected or the diabase hornfels debris at the existing exploited wells. The clay is laterally replaced by sandy clays, clay sand, then pebbly clay or weakly tied clay-sandy pebble, and only in thin lenses-like layers without continual spreading, the yellow fine sand.

According to the lithologic content, there are three types of layers: alluvial or proluvially deluvial sediments till 52 m of depth or 57 m (depending on location) with sand or pebble of various granulation near Vrbas, developed in the river bed and more or less clay-like sediments near the edge of Field Lijevče, i.e. in the zone of the present water source. It is replaced laterally with sandy-pebbly clay; the second one represents the layer of alluvium till 140 m or less if it is spread over the hard rocks. It is represented by the various types of clay from that with marl till that with sand thick sometimes even 60 m within which there is inter-stratified sand thick 2-3m at the location plum orchard, and till 6 m at the location near the old water source; the third one represents the hard limestone-siliceous rock which is detected at the location near the old water source at 87 m, and near the old well, the diabase hornfels formation was found at 14 m of depth. At the location of the present water source near the measured point MT2, a rock has been found, probably the sand stone at 25 m of depth. At the new water supply that is being built, Maglajani, a limestone-siliceous rock was found at 85 m of depth.

According to the frequency strength set on the ground water accumulation, and number of the sandy layers, the most perspective location is the one near the old water source, and then the other ones. Hydro-geological conditions are inconvenient for the exploitation with the separate capacities of the wells, which are being exploited in water supply.

REFERENCES

Turalija A. (1974): Reports of results from drilling the experimental exploited well for water supply purposes of Laktaši, “Geoinženjering” Sarajevo, Professional documents fund JKP „Budučnost“ Laktaši.

Turalija A. (1976): Reports of results from drilling the experimental exploited well for water supply purposes of Laktaši, „Geoinženjering“ Sarajevo, Professional documents fund JKP „Budučnost“ Laktaši.

Stojiljković D., Tadić D. (2007): Reports from geophysical prospection at locations of the current and potential spring for water supply in Laktaši, Professional documents fund “Ekosolar”, Beograd.

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WASTE FLOWS FROM PRETREATMENT OF LIGNOCELLULOSIC RAW MATERIALS FOR BIOETHANOL PRODUCTION

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ABSTRACT

World energy crisis encourages the development of alternative energy sources. Among others, as a promising direction seems to be the production of bioethanol from different raw materials. Lignocellulosic raw materials are widespread in large quantities and the cheapest, but on the other side they are the most complicated to implement. It is necessary to remove pectin, lignin and other ballast substances from lignocellulosic materials in pretreatment procedures after which cellulose could be degraded to glucose from which the yeast produces bioethanol. One of the raw lignocellulosic materials existing in significant quantities in our country are sugar beet shreds. This paper analyses the wasteflows that obtained during the pretreatment of that raw materials. These are the wastewaters from pectin and lignin removal and wastewaters from washing, which were analysed separately. It was found that wastewater from pretreatment is middle contaminated. Wastewater from the pectin removal is acidic and has COD value of about 4500 mgO_2/L while wasteflow from removal of lignin is neutral having about 8500 mgO_2COD/L. Based on the particular composition, the paper discusses the different possibilities of processing of these wastewaters.

Key words: Sugar beet shreds, Pretreatment, Wastewater, Pectin, Lignin

INTRODUCTION

The rising price of fossil fuels, its limited quantities and influence on environment bring economical investments in development of alternative, renewable fuels. One alternative fuel that has great potential to become cost-effective and ecologicaly acceptable fuel of future is bioethanol. Almost all bioethanol today is produced from starch-based agricultural crops, but lately there is a great interest in bioethanol production from lignocellulosic biomass, especially from crops residues and wasted crops. Lignocellulosic materials are the most abundant renewable biomass with estimated annual production of $1x10^{10}$ MT worldwide (Alvira et al, 2010) while total potential bioethanol production from crop residues and wasted crops is 491 GL $year^{-1}$, about 16 times higher than the current world ethanol production (Seungdo and Dale, 2004). However, the bioethanol production from lignocellulosic biomass is still not economically viable using existing technologies in the context of current petroleum price. Unfortunately, this step demands large quantities of energy, water, chemicals and enzymes, and produces large quantities of wastewater that should be purify before discharging back to the nature. Promissing option for meet this challenge, among others, is valorisation and reuse of by-products, especially wastewaters obtained during pretreatment processes. Namely, pretreatment is first step in bioethanol production from lignocellulosic biomass, which makes it susceptible for further steps, enzymatic hydrolysis and fermentation, and removes all substances that could have any kind of negative influence on those processes.

Worldwide (as well as in our country) availability and low cost among with its great potential made sugar beet pulp suitable for bioethanol production. Sugar beet pulp in form of shreds containing pectin (24-32%), cellulose (22-30%), hemicellulose (22-30%) and lignin (1-3%) (Zheng et al, 2011). They could be pretreated in order to remove pectic substances and lignin because of fermentative microorganism's (*S. cerevisiae*) inability to ferment its degrading products. Beside that lignin causes non productive binding of enzymes which increase enzyme consumption and process cost (Börjesson et al, 2007).

The aim of this study was to analyse and, base on that, consider utilisation and treatment of wastewaters obtained after pretreatment of sugar beet pulp shreds. Within pretreatment acid extraction of pectic substances and alkali delignification followed by solid/liquid separation by filtration were done. Obtaned filtrates as well as liquids obtained after washing filter cake are wastewaters that were further analysed.

MATERIALS AND METHODS

Substrate

Sugar beet shreds were kind gift from A.D. Sajkaska factory, Helenic sugars, Serbia, as a dryed. First step in order of preparing the sugar beet shreds for experimental usage was milling on *Miag* laboratory *cone mill*. Sieve analysis was performed on the Bühler laboratory sifter (gyratory in a horizontal plane), model MLU-300 (Uzwil, Switzerland), using the entire milled stock. Samples were sieved and part of the stock having particles in the range 224-400 μm was subjected to pretreatment.

Pretreatment

In order to remove pectic substances sugar beet shreds were suspended in HCl solution having pH 1.5 at 0.81% solids load (w/v dry weight) (Sun and Hughes, 1998). Mixture was heated at 85ºC for 4 hours with occasional stirring. After cooling down mixture was filtered through laboratory filter paper Macherey-Nagel MN 651/120 and filter cake was washed in order to remove residual HCl. Delignification was achieved using 0.1 g $Ca(OH)_2$/g substrate (dry weight) at 90ºC for 3 hours (Chang et al, 1998). After that mixture was cooled down, filtered through mentioned laboratory filter paper and washed. Obtaned filtrate and water from washing filter cake were further analyzed separately, while filter cake was used as substrate for enzymatic hydrolysis.

Analytical methods

A wastewaters that obtained during the pretreatment of sugar beet shreds were analysed. Wastewater from pectin removal and wastewater from washing were analysed separately. After that the wastewaters from delignification and washing were analised. Dry matter, ash, pH, chemical oxigen demand (COD) and total nitrogen were determined according to Standard Methods (APHA, 1989.).

RESULTS AND DISCUSSION

Wastewater analyses

The amounts of wastewaters obtained during pectin removal, washing after depectination, lignin removal and washing after delignification, calculated on 1 T of sugar beet shreds, are about: 124 m^3, 84 m^3, 360 m^3 and 120 m^3 respectively. As can be seen this pretreatment require large amounts of water which is followed by generation of large volumes of wastewaters. In order to reduce wastewater volume we tried to decrease water volume required for pretreatment. However, that changed physical properties of substrate and negatively reflected on the enzymatic hydrolysis. Due to this, method proposed by Sun and Hughes (1998) was retained and carried out.

Wastewaters were analysed separately. Additionaly, parameter values for mixed wastewater were calculated in order to determine if it is better to process each water separately or as mixed wastewater. Results of analyses of wastewaters obtained after the pectin removal are presented in Table 1.

Table 1: Results of analyses of wastewaters from pectin removal

Parameter	Wastewater from pectin removal	Wastewater from washing after depectination	Mixed wastewater
pH	1.49	2.34	
Dry matter (mg/l)	3 740	530	2 442
Ash (mg/l)	330	150	257.2
Organic dry matter (mg/l)	3 410	380	2 185
% of organic dry matter ($\%_{DM}$)	91.2	71.7	83.3
COD (mgO_2/l)	4 880	655	3 172
Total nitrogen (mg/l)	70	35	55.85

As can be seen from Table 1, wastewater from pectin removal is acidic. Dry matter is high with large percentage of organic matter, as evidenced by high COD value. Also total nitrogen content is high. Based on shown results it can be said that these wastewater is middle contaminated. Dry matter content in the wastewater from the washing was lower by about 85% in comparing with wastewater from the pectin removal. As well as COD, total nitrogen content in this wastewater is lower only twice. Except acidity, the wastewater from washing is pretty similar to urban wastewater.

Results of analyses of wastewaters from lignin removal are shown in Table 2.

Table 2: Results of analyses of wastewaters from lignin removal

Parameter	Wastewater from lignin removal	Wastewater from washing after delignification	Mixed wastewater
pH	6.99	6.89	
Dry matter (mg/l)	1875	170	1 449
Ash (mg/l)	325	40	253
Organic dry matter (mg/l)	1550	130	1 195
% of organic dry matter ($\%_{DM}$)	82.6	76.5	81
COD (mgO_2/l)	8572	170	6 471
Total nitrogen (mg/l)	98	49	85.75

As can be seen from results presented in Table 2 wastewater from lignin removal is neutral. The dry matter content is twice time lower than this content in wastewater from pectin removal. Percentage of organic dry matter is slightly lower, but nitrogen content is significantly higher. Dry matter content in the wastewater from washing was lower by about 90% compared to wastewater from delignification. Wastewater from washing is significantly lower loaded compared to wastewater from treatment.

Applied method of delignification did not give considerable results to the point of substrate treatment for enzymatic hydrolysis and therefore is abandoned as method of pretreatment. Because of that, processing of wastewaters from delignification will not be considered. Since that delignification step is abandoned, proposed scheme for pretreatment of sugar beet shreds is shown on Figure 1.

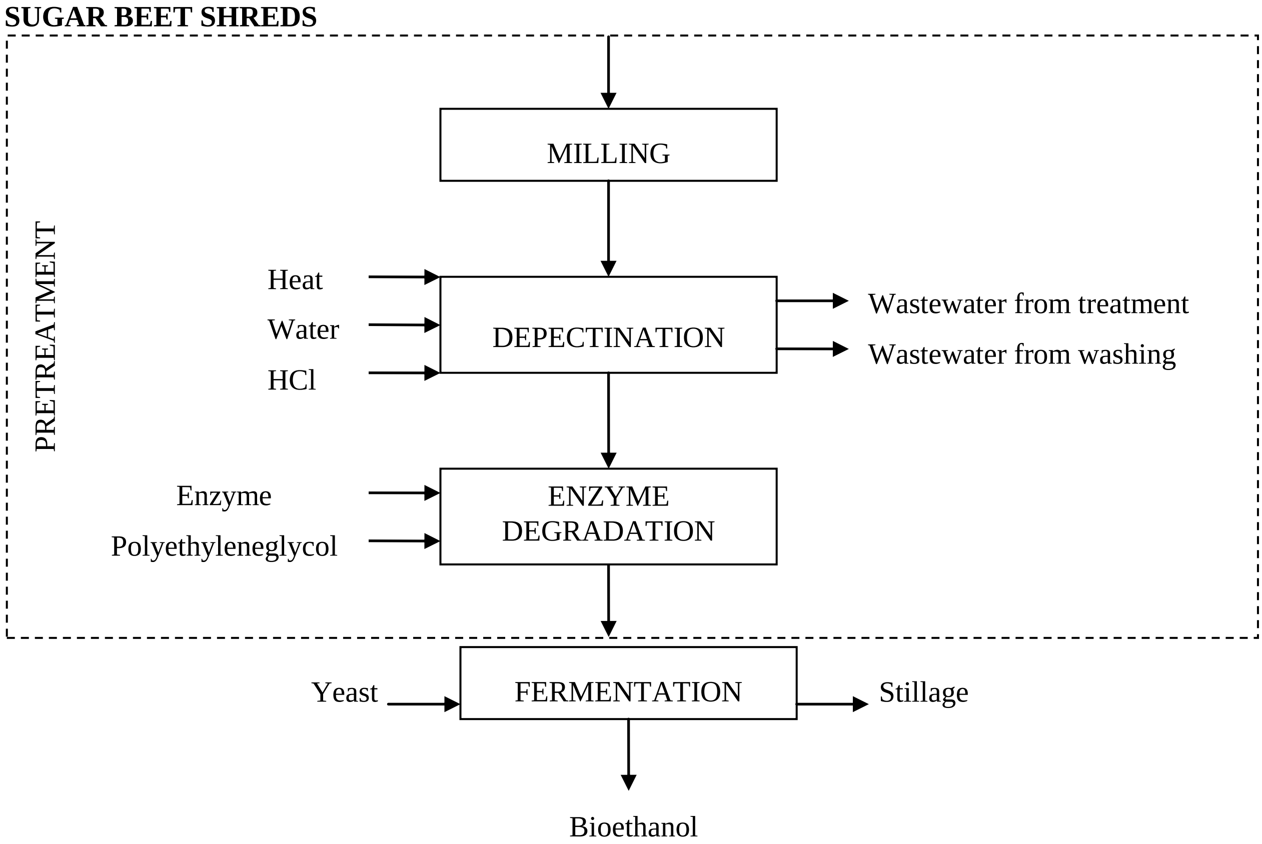

Figure 1. Proposed scheme for pretreatment of sugar beet shreds

Wastewater processing

Considering the results of analyses, it can be said that wastewaters from pretreatment should not be disposed in recipient without previous treatment. On the basis of presented parameter values in wastewaters from pretreatment, from cake washing and mixed wastewater it can be sad that separate processing of wastewaters is better. In order of valorization of by-products and decrease overall process cost, pectin recovery from waste waters should be part of treatment of those waters because of high pectin content in sugar beet pulp (24–32%). Method that is usually used for obtaining pectin from solution, Ca^{2+} gelation, can not be used in case of sugar beet pectins due to its specific structure. Namely, lower molecular mass and presence of acetyl groups in molecule of sugar beet pectins results in low viscosity and poor gelling properties. There are works that indicate that treatment with mono-electron salts (ammonium peroxysulfate), peroxidase/hydrogen peroxide (Oosterveld et al., 1997, Thibault and Rombouts, 1986**)** or enzymes such as laccase and arabinofuranosidase (Micard and Thibault**,** 1999) can induce cross-linking of feruloyl groups of sugar beet pectin and improve its gelling properties. For now most used method for isolation of sugar beet pectin from solution is precipitation with alcohol, especially ethanol. Drawback of this method is volume of alcohol that must be used to precipitate pectin. Namely, amount of ethanol should be four volumes of solution in which pectin is dissolved (Sun and Hughes, 1998). This, with ethanol cost and large amount of wastewater from pectin removal makes this method non viable. This problem might be solved by preconcentracion of this wastewater, for example by employing membrane filtration (Yapoa et al, 2007). Effective filtration through proper membrane will give purified water as permeate and concentrated pectin solution as retentate. For this method it is crucial to determinate type of membrane and process parameters, such as optimal pH of solution, flow rate of feed and volume concentration factor (VCF) in order to prevent leaking of pectin through membrane due to linearity of its molecule. Retentate contains large amount of pectin which could be used after purification.

Obtained wastewater (permeate) should be processed further along with wastewater from washing of filtercake after depectination. Depend on quality and quantity of this mixed wastewater, either convencional method of aerobic biological treatment or membrane technics (nanofiltration or reverse osmosis) could be apply. Waste flows of these processes (surplus of active sludge from aerobic treatment or retentate from membrane filtration) could be treated along with stillage obtained after bioethanol production. Purified water could be discharged in natural recipient or reuse after detailed analyses. On the basis of the above, proposed scheme of wastewaters processing is presented on Figure 2.

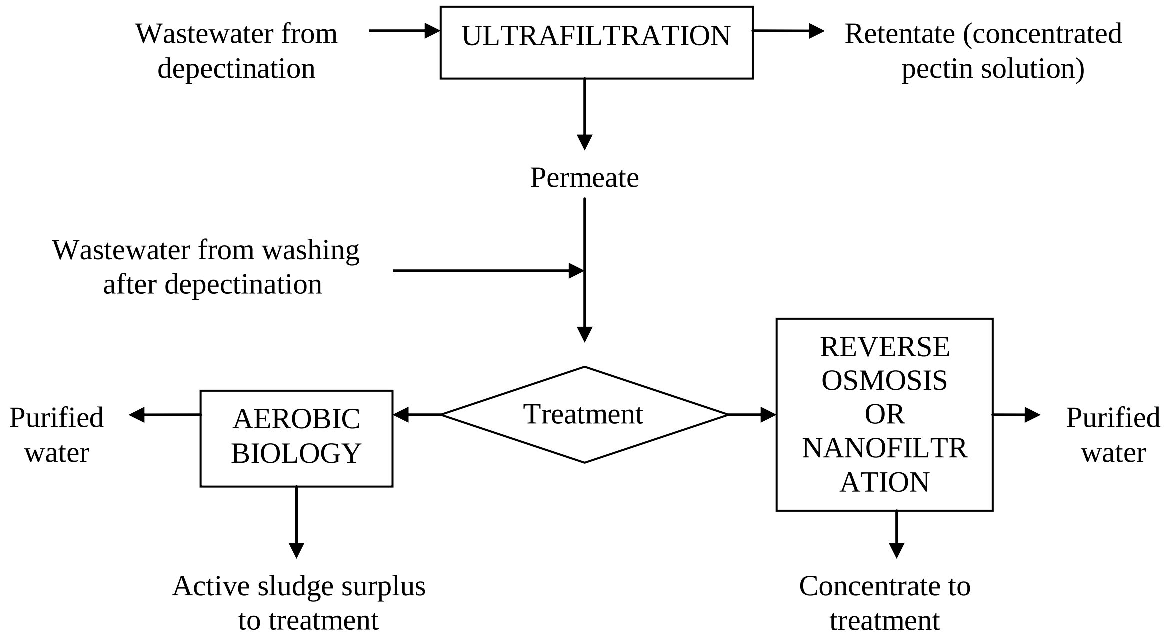

Figure 2: Proposed scheme for wastewaters processing

CONCLUSIONS

Pretreatment of sugar beet shreds which is discussed in this study is very demanding from the aspect of quantity and content of wastewaters regarding following wastewaters treatment as well as spent energy. Obtaining an additional product from the waste flows from pretreatment procedures might be a promising way to reduce above mentioned costs. One of the possible solutions can be the separation of pectin, as valuable product, from wastewater from pectin removal by membrane filtration as it was suggested in proposed scheme.

Acknowledgement

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REFERENCES

Alvira, P., Tomás-Pejó, E., Ballesteros, M., & Negro, M.J. (2010). Pretreatment technologies for an efficient bioethanol production process based on enzymatic hydrolysis: A review. *Bioresource Technology*, 101, 4851–4861.

APHA (American Public Health Association) (1998), *Standard Methods for the Examination of water and Wastewater, 20th ed*., APHA, AWWA, WEF, Washington DC.

Börjesson, J., Engqvist, M., Sipos, B., & Tjerneld, F. (2007). Effect of poly(ethylene glycol) on enzymatic hydrolysis and adsorption of cellulase enzymes to pretreated lignocellulose. *Enzyme and Microbal Technology*, 41, 186-195.

Chang, V.S., Nagwani, M., & Holtzapple, M.T. (1998). Lime Pretreatment of Crop Residues Bagasse and Wheat Straw. *Applied Biochemistry and Biotechnology*, 74, 135-159.

Micard, V., & Thibault, J.F. (1999). Oxidative gelation of sugar-beet pectins: use of laccases and hydration properties of the cross-linked pectins. *Carbohydrate Polymers*, 39 (3), 265-273.

Oosterveld, A., Grabber, J.H., Beldman, G., Ralph, J., & Voragen, A.G.J. (1997). Formation of ferulic acid dehydrodimers through oxidative cross-linking of sugar beet pectin. *Carbohydrate Research*, 300,179-181.

Seungdo, K., & Dale, B.E. (2004). Global potential bioethanol production from wasted crops and crop residues. *Biomass and Bioenergy*, 26, 361-375.

Sun, R., & Hughes, S. (1998). Extraction and physico-chemical characterization of pectins from sugar beet pulp. *Polymer Journal*, 30 (8), 671-677.

Thibault, J.F., & Rombouts, F.M. (1986). Effects of some oxidising agents, especially ammonium peroxysulfate, on sugar-beet pectins. *Carbohydrate Research*, 154 (1), 205-215.

Yapoa, B.M., Watheleta, B., & Paquot, M. (2007). Comparison of alcohol precipitation and membrane filtration effects on sugar beet pulp pectin chemical features and surface properties. *Food Hydrocolloids*, 21, 245–255.

Zheng, Y., Yu, C., Cheng, Y.S., Zhang, R., Jenkins, B., & VanderGheynst, J. S. (2011). Effects of ensilage on storage and enzymatic degradability of sugar beet pulp. *Bioresource Technology*, 102, 1489–1495.

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THERMODYNAMIC ASPECT OF URBAN GROUND WATER PURIFICATION

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ABSTRACT

The row ground water in urban zone in town Kovin containe greater contents of contaminants (0,5-2 mg/l of Fe, 0,5 mg/l of Mn and 0,5-1 mg/l NH_3) and less COD 4 mg/l , compared to Law regulaive defined maximal allowed content (MAC) of iron (0,3 mg/l) , manganese (0,05 mg/l), amoniac (0,1 mg/l) and COD(8). The most economical purification method of raw ground water from urban wells is aeraton. In this paper thermodynamic aspect of aeration of ground water from urban wells enable stationary polarisatuion and depolarisation Gibbs free energy on the contact surface between liquid and gas phase to be determined. The thermodynamic method is usefull for identifying of components which decrease aeration effect in the water with different chemical composition on the base of its Gibbs free energy change.

Key words: Water Purification, Aeration efficiency, Contact surface, Coupled Processes, Polarisation.

INTRODUCTION

The effects of purifications of ground water in aeration plant in the town Kovin is of great interesse for the health of people which consume drinking water, as well as for the other towns which has the same problem. The thermodynamic aspect could be usefuill for identifying the course of decreased aeration effect for the water with other chemical composition in proposing the adequate stages for improved technological process. Microbiological water quality correspond to the MAC, but iron, mangan and amoniac ion has to be purified (acc. to Law regulative) Mean project for purification of groundwater plant in Kovin was realized by Water Technic from Belgrade. By the analysis in laboratoriy of Waterwork in Kovin parameters of rivers water quality are monitored (by Standard methods of drinking water analysis, 1990.). For the each part of aeration plant and for each examined component vant Hoff equation is used the Gibbs free energy of chemical or phase transformation to be calculated, on the base of components contents inclouded in stationary irreversible processes, after chemical potentials between the two phase is achieved.

Figure 1. Aeration in the work, with the one part and with the two parts

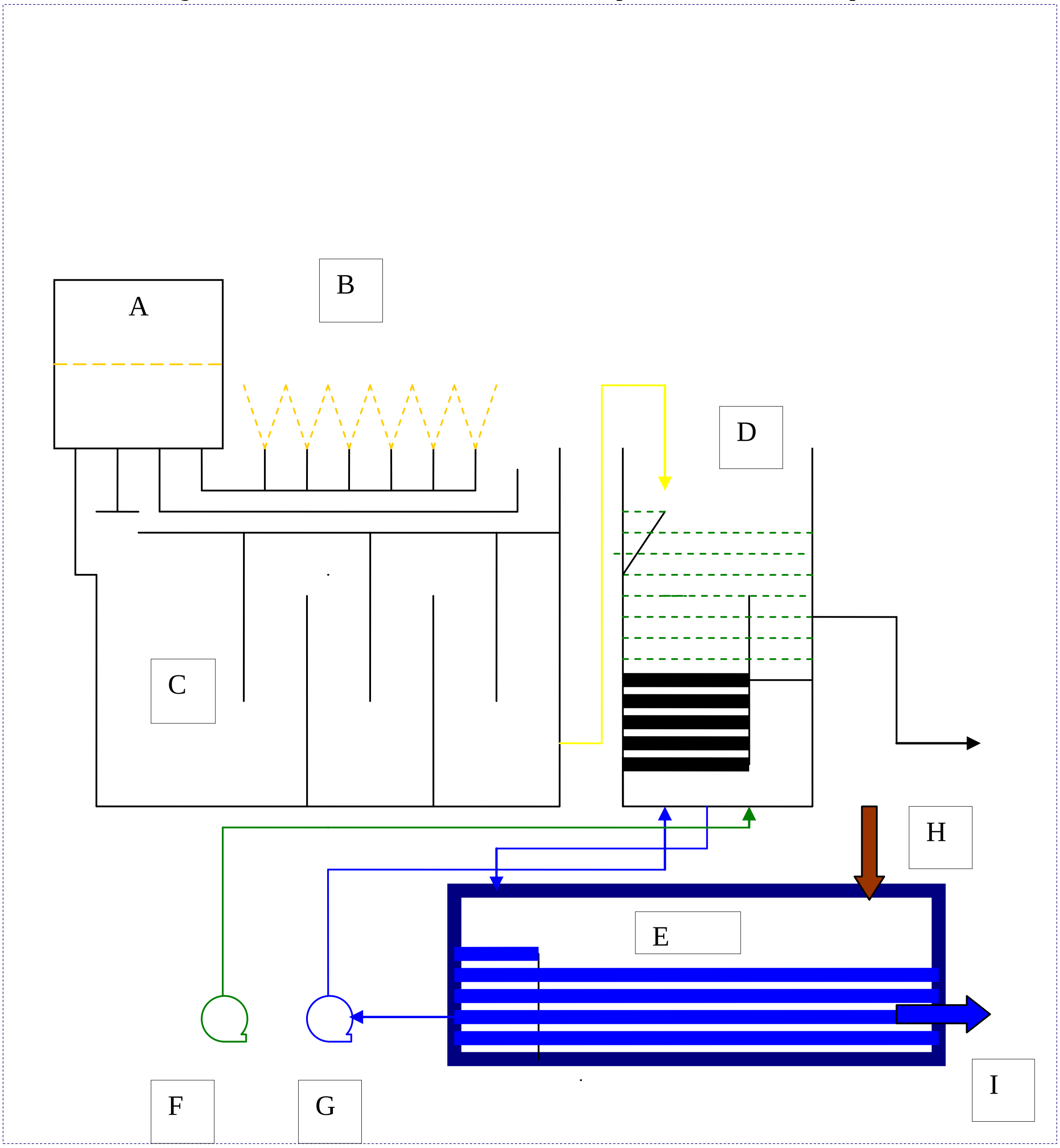

Figure 2. The plan of the aeration plant:

A – *The tower for the raw water distribution from wells*
B - *Aeration,Mixing of water and air, blowing*
C – *retension, aggregation of higher oxyde of iron and mangan*
D – *Filtration and biological degradation of ammonium ion*
E – *Reservoar of the clean water*
F – *blowing pump for filter washing with air*
G – *pump for filter washing with water*

Figure 3. Filter in the work

MATERIAL AND METHODS

The temperature and water quality parameter by Standard analysis methods of drinking water were measured in laboratories of Waterwork in Kovin to found influence of temperature on polutants content in four months, January, April, July and October according to Vant hoff equation for the three parts of aeration plant (fig. 2):
- Aeration basen, prior aeration
- Retention basen after aeration
- After filtration and chlorination

By using By Van' t Hoff equation, standard Gibbs free energy, ΔG^{θ} change of components between two phase in chemical eqiolibrium were determined in this paper. The obtained results show the influenece of water treatment on the Gibbs free energy change of components dissolved in water, as indicators of chemical equilibrium achieved by coupled active and relaxation process prior and after aeration treatment. Examined aerated water contain law organic matter content measured as about 4 mg/l oxygen demand by $KMnO_4$ titration (COD).

RESULTS

The result obtained with the best correlation coefficients enabled the standard Gibbs free energy changes to be calculated in the examined conditions in aeration plant. The calculated sum of calculated Gibbs free energy active in endothermic processes and passive exothermic processes enable the relaxation processe of indicators of coupled processes to be identify which enable thermodynamic equilibrium to be achieved. Measured average values of water quality parameters for the whole year are given in the table 1, as well as the results obtained on the base of thermodynamic aspect, in the table 2.

Table 1: The average water quality parameters in aeration plant period from January to october

Parameter / part of aer,plant	T K	O_2 mg/l	Fe mg/l	Mn mg/l	Cl^- January mg/l	Cl^- April, July, October mg/l	Rez. Cl_2, mg/l	NH_3 mg/l	CO_2 mg/l
Raw water prior aeration	287,5 ±0,3	1,78 ±0,7	1,07± 0,26	0,76 ±0,16	28,8,	16,93 ±0,17	0	0,59± 0,04	26,7 ±3
Clean filtrated water	287,7 ±09	6,99 ±1,1	0	0	25,3	15,8 ±0,5	0	0	19 ±2
After desinfection	287,3 ±1,3	6,96 ±1	0	0	25,8	16,4 ±0,4	0,51± 0,05	0	18,6 ±2,3

Table 2: Total endothermic and exothermic Standard Gibbs free energy changes for analiesed water components and polarisation and depolarisation Standard Gibbs free energy changes

ΔG^θ kJ/mol / part of aer. plant	$T_{average}$ K	El. Cond. µS/cm Jan; the other months	pH	$\Sigma\ \Delta_{end}G^\theta$ kJ/mol	$\Sigma\Delta_{egs}G^\theta$ + kJ/mol	$\Delta_{pol}G^\theta$ (el)
Raw water prior aeration	287,5 ±0,3	705; 662±40	7,70 ± 0,1	545,1	-455,82	89,31
Clean filtrated water	287,7 ±0, 9	722;656±40	7,83±0,05		-228,3	-130,3
After desinfection	287,3 ±1,3	714; 651±40	7,83±0,05	56,03	-33,9	22,13

CONCLUSION

The water aeration enable stationary purification efficiency to be achieved in retention basen and after filtration and chlorination, with 100% removal of iron, manganese and ammoniac and 30 % carbon-ioxide at stationary chloride content, by 300 % forced enhanced stationary oxygen content.

In aeration basen, prior aeration (with 1,8 mg/l O_2), transported raw ground water from urban wells in the tower was analiesed in turbulence state after the chemical potentials equilibrium of the each dissolved component was achieved on the contact surface. By thermodynamic consideration the active surface polarization work was obtained: $\Delta_{pol}G^\theta(el) = 89{,}31$ kJ/mol . Depolarization of active polarized contact surface enable spontaneously dissolution and hydration Fe^{2+} and Mn^{3+} and nitrogen reduction by hydride to gas amoniac.

In retension basen (with 7 mg/l O_2), the passive surface depolarization work was obtained by coupled processes: $\Delta_{dep}G^\theta(el)=-130{,}3$ kJ/mol. The stationary exothermic Gibbs free energy change on contact surface between gas bubble and liquid water enable spontaneously oxydation and aggregation of small soluble hydroxide of iron and manganese.

After equilibrium is achieved in retension basen by gas chlorinator surface polarization work on contact surface between gas phase and water (with 7 mg/l O_2), correspond to the sum of entropy heat changes of component with the most content in liquid and gas phase $\Delta_{pol}G^{\theta}(el) = 22$ kJ/mol.

Thermodynamic aspect of urban ground water purification in adiabatic conditions show the ions content during turbulence of transported un-aerated water as well as flocculation and aggregation effects are dependent on Gibbs free energy change, afterchemical potential equilibrium of components is achieved on contact surfaces between liquid, solid and gas phase.

REFERENCES

Water Technic Belgrade: Purification groundwater plant in Kovin, Mean project.
Law Regulations for drinking water health risk contents : Sl. Glasnik Srbije SRS, august 1998.
NIP”Economical Rewieu” Standard methods for drinking water analysis, Belgrade 1990.

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WATER QUALITY OF THE RIVER IBAR FROM 2000 TO 2009

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ABSTRACT

Using data published by the Republic Hydro meteorological Institute of Serbia from measure stations Raška, Ušće and Kraljevo, there is analyzed the river Ibar water quality in the ten years period, from 2000 to 2009 year. The analysis includes observing different parameters values, frequency of extreme values occurrence and comparing water quality parameters with other river parameters. This work includes considering human activity to the river Ibar water quality change.

Key words: water quality, measure stations.

INTRODUCTION

As the biggest and the most important tributary of Zapadna Morava, quality of the river Ibar is of great significance to the quality Zapadna Morava water as well. The river Ibar comes to Serbia from a neighbor country, there is a “foreign” as well as a “domestic” human but geological impact to its quality too. During the ten year period, according to the data selected and published by the Republic Hydro meteorological Institute of Serbia, there was noticed a big influence of human activity to the river Ibar water quality.

CHARACTERISTICS OF THE ANALIZED AREA

As it was previously said, the river Ibar is the largest and the most important tributary of Zapadna Morava. The surface of the area covered with this river is 8.059 km^2 and its length is 276,0 m up to the mouth to Zapadna Morava by Kraljevo. Average flow of Ibar is 60 m^3/s that indicates that the river is not navigable. Ibar rises in Monte Negro at 1.360,0 m.a.s. The river basin width is 12,0 m in the higher region up to 30,0 m in its middle streaming.

Ibar has very developed hydrographic basin. It collects water from very high mountains like Kopaonik, Čemerno, Rudna Glava, Golija which provides Ibar and to its tributaries torrential mountainous character (http://sites.google.com). Ibar has a plenty of water rich tributaries, whirlpools and cascades and is famous for its rich fish stock. Slopes of the Ibar’s gorge are steep, often exposed. The largest right tributaries of Ibar are Gvozdačka river and Maglasica and the left are Studenica, Dubočica, Pivnica and Lopatnica (http://sr.wikipedia.org).

In this work are used results of measuring from 3 measuring stations placed at the river Ibar: Raška, Ušće and Kraljevo. Raška is a small city situated where the river Raška flows into to the river Ibar. This dense water flows network is consisted of Raška, Jošanica, Rudnička river, Radošićka river, Trnavska river and Brvenička river. One of the main industrial branches for this municipality is agriculture. Ušće is a settlement placed in wooded area, in the middle region of Ibar valley, at 335 m.a.s, where the river Studenica flows into Ibar. There is a still active coal mine and a privet economy „Ekofarm“. Even though relatively small settlement, Ušće has constructed water supply and sewage system. Kraljevo is a city of Raška region placed where Ibar flows into Zapadna Morava. It is situated at 206 m.a.s., in a valley surrounded with mountains. It lies at three rivers: Ibar, Zapadna Morava and

Ribnica. The city has developed industry, and its wider region is famous for agricultural production (http://www.kraljevo.com/kraljevo/geografija).

DESCRIPTION OF THE APPLIED METHOD AND MEASURING STATIONS

The analyzed area is placed along the river Ibar and in this work are used results from three measure stations at this river: Raška, Ušće and Kraljevo. Distance of these three measure stations from the river Zapadna Morava mouth is 93,3 km, 58,0 km and 0,0 km, respectively.

All data used in this work were published annually by the Republic Hydro meteorological Institute of Serbia as a part of their reports (Republic Hydro meteorological Institute of Serbia Annual reports from 2000. to 2009. year). In this work are analyzed hydrological and water quality parameters and they were tried to be correlated, as well as to be correlated with known human impact to water quality of the river Ibar.

The measure station Raška (47260) is placed 93,3 km distant from the mouth of Zapadna Morava. The river basin area up to this measure stations is 6.270 km^2, and the place of the water sampling is positioned at the left side in the profile. The measure station Ušće (47290) is 58,0 km distant from the mouth of Zapadna Morava, the river basin area is spread up to 6.883 km^2, and the location of water sampling is at the right side of the profile. The measure station Kraljevo (47299) is placed right at the mouth of the river Zapadna Morava and at this point water sampling is done at the left side of the profile.

RESULTS

For the river Ibar basin there is typical for flow to achieve maximal values in March that is common for all measuring profiles, while the minimal value is typical for summer months. While the period of the maximal flow is the same for all three measure stations, while the minimal values for the MS Ušće is July and for other stations later months (august, September). In the following graphs there are shown values of flow along the river Ibar in 2001. and 2009., according to the data from the mentioned three measure stations (See Figure 1).

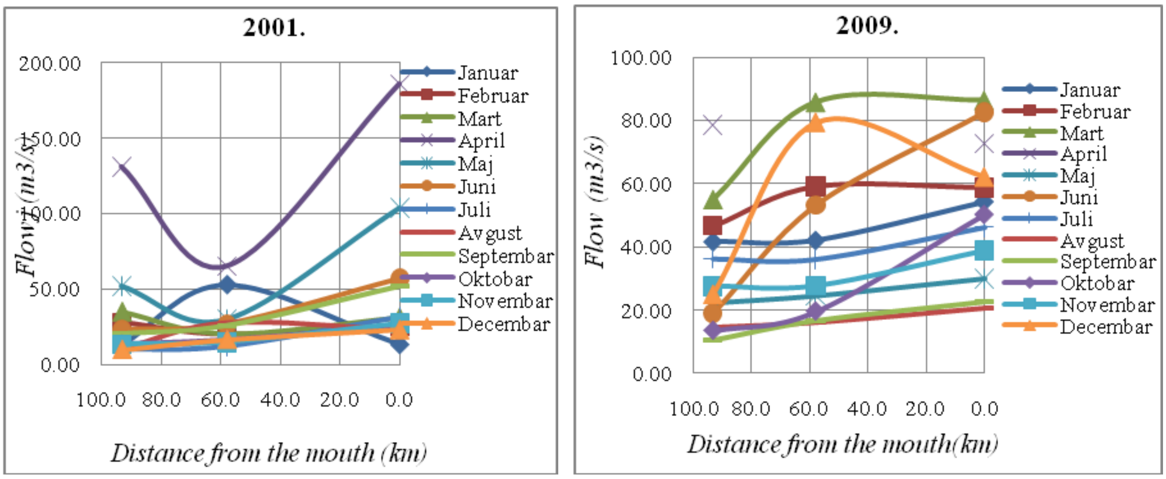

Figure 1. Flow values at the measure stations Raška, Ušće and Kraljevo in 2001. and 2009.

The parameter dissolved oxygen is required not to be under value of 5,0 mg/l (the Regulation on water classification of inter-republic water flows, interstate waters and waters of Yugoslavian coastal sea) for the required category of water II. This parameter, in the referent period, was never measured under 6,8 mg/l (July 2005., measure station Raška). Generally, maximal values of this parameter in 87% of analyzed samples was registered during winter period (December – February), while the summer period is typical for the smallest concentration of dissolved oxygen.

In general, for all measure profiles (Raška, Ušće, Kraljevo), there is typical occurrence of minimal values of dissolved oxygen at the same period when there are minimal flows (usually period from June to September). But comparing these two parameters values at the measure stations Ušće, there is a significant number of cases (usually in march) when even though there were great values of water flow, the concentration of dissolved oxygen was less than average.

According to the Regulation on water classification of inter-republic water flows, interstate waters and waters of Yugoslavian coastal sea, concentration of suspended matters in water of the second class should not exceed 30 mg/l (IIA: Ušće, Kraljevo) or 40 mg/l (IIB class: Raška). But this GRANIČNA values were exceeded several times, most at the measure station Ušće. At the measure station Raška, in more than 15% of samples the concentration of suspended matters was above the maximal recommended. These samples were usually taken in March, April, September and October. There is obvious that during minimal flows in autumn, there are maximal concentrations of suspended matters, but during summer period when flows are small, samples of water contain very high concentrations of suspended matters. The suspended matters content monthly values during ten years period at the MS Raška, is shown at the Figure 2.

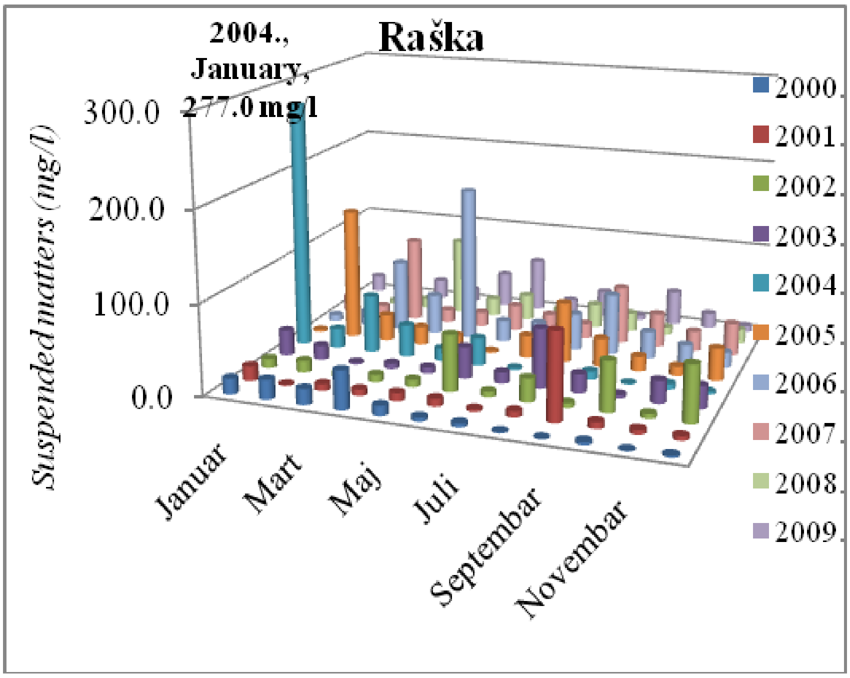

Figure 2. Monthly values of suspended matters concentration in period 2000 – 2009 at the measure station Raška

The measure station Ušće is typical because there were more than one third of samples of water in which the concentration of suspended mater was over the recommended value. The river Ibar at this profile is obviously very often overloaded with suspended matters of different origin. Also there was noticed that the average value of this parameter from 2000. to 2009. was increased and the percentage of samples with exceeded content of suspended matters was bigger as well. The suspended matters content monthly values during ten years period at the MS Ušće, is shown at the Figure 3.

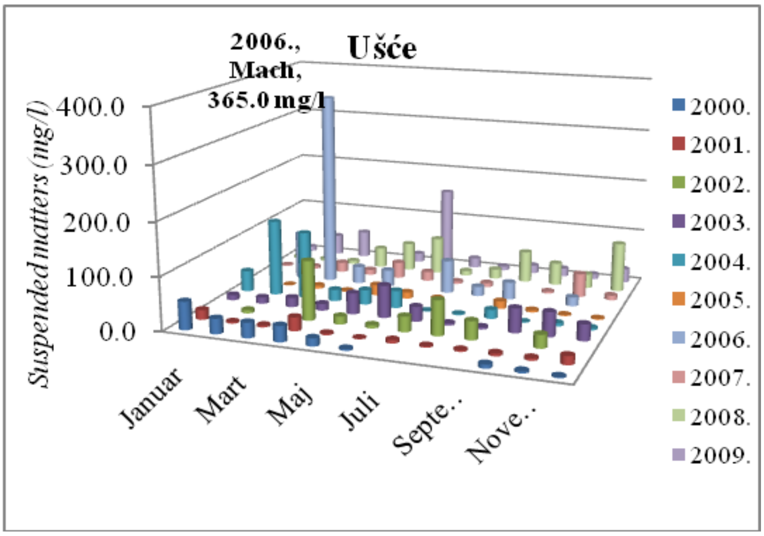

Figure 3. Monthly values of suspended matters concentration in period 2000. – 2009. at the measure station Ušće

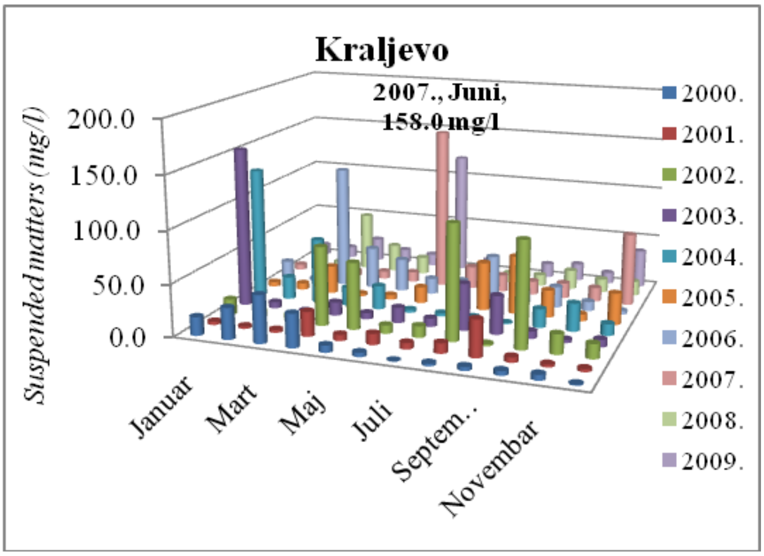

Figure 4. Monthly values of suspended matters concentration in period 2000. – 2009. at the measure station Kraljevo

For the water quality of river Ibar at the measure station Kraljevo during summer period, there is typical occurrence the greatest number of water samples with extremely high concentration of suspended matters. Comparing values of flow and suspended matters content there was noticed that the period of maximal flow values is the same with the period of maximal concentrations of suspended matters occurrence. The suspended matters content monthly values during ten years period at the MS Kraljevo, is shown at the Figure 4. For this profile is typical matching of extreme values (low or high) of flow and suspended matters content which can help in this pollution origin determination. This could be applicable to the whole river Ibar. The suspended matters content monthly values during ten years period at the MS Kraljevo, is shown at the Figure 4.

In the following graphs there are shown values of suspended matters concentration along the river Ibar in 2003. And 2008., according to the data from the mentioned three measure stations (See Figure 5).

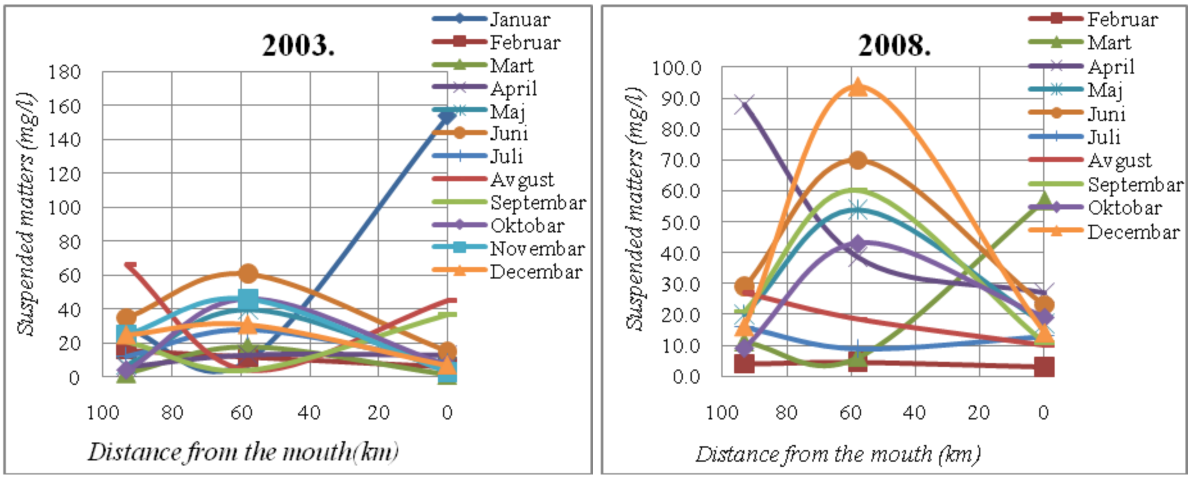

Figure 5. Suspended mater concentrations at measure stations Raška, Ušće and Kraljevo in 2003. and 2008.

Chemical oxygen demand (COD), according to the Regulation on water classification of inter-republic water flows, interstate waters and waters of Yugoslavian coastal sea is recommended not to exceed 12,0 mg O_2/l for the required class of water and this value was never exceeded during the referent ten years period. According to COD, quality of the river Ibar is satisfactory, but from 2000. to 2009. there was noticed that the average value of this parameter was increased.

Biological oxygen demand (BOD) in the river Ibar was exceeded several times during the referent period. The recommended value that should not be exceeded, according to the legislative is 4 mgO_2/l. The greatest percentage of samples with exceeded COD was at the measure station Raška. The highest values of this parameter are typical for February and March. During small waters there is small COD and there was noticed that during winter period and presence of dissolved oxygen, very often COD reached extremely high values. This parameter is not determined regularly, so there are periods of a few months without data about COD value. According to this and to significant number of cases with exceeded value of this parameter, there is reason to assume that this parameter value was exceeded even more often. Values of COD at measure stations Raška, Ušće and Kraljevo, for a several months during the referent period, are shown at the figure 6.

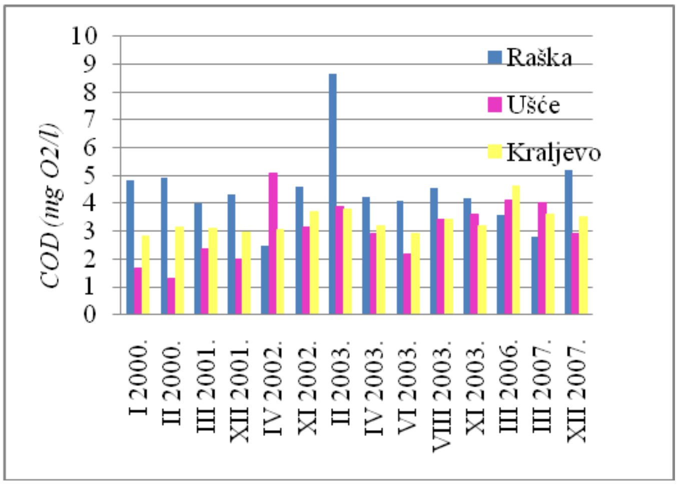

Figure 6. COD at measure stations Raška, Ušće and Kraljevo

According to the values of nitrogen parameters (ammonia, nitrates, and nitrites), quality of the river Ibar at measure stations Raška, Ušće and Kraljevo is adequate to the required quality. MAC for ammonia is and the II class of water id 1 mg/l, and this value was exceeded only once - December, 2002., measure station Raška, 1,55 mg/l. MAC for nitrates and nitrites is 10,0 mg/l and 0,05 mg/l respectively, and these values were not exceeded in the examined samples of the river Ibar during the referent period. The highest concentrations of nitrates and nitrites were most often in September and October. All three measure profiles have in common the same period of extreme values of nitrogen parameters occurrence, during the year (nitrates during winter months). Nitrate concentrations in the river Ibar for a several months during the referent period are shown at the figure 7.

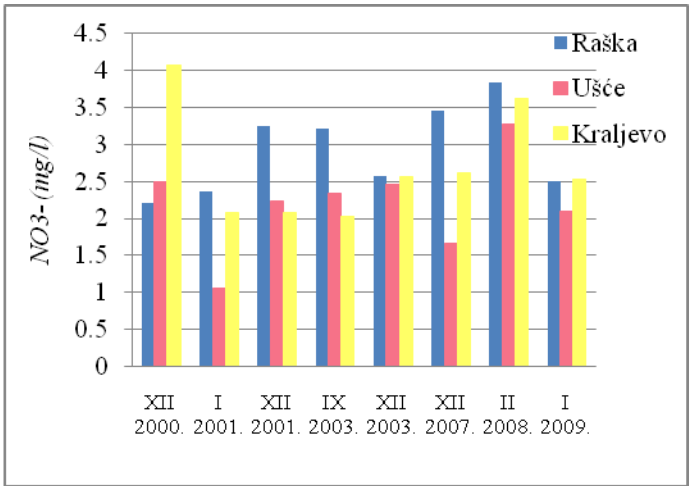

Figure 7. Nitrates concentration at measure stations Raška, Ušće and Kraljevo

Heavy metals are not determined regularly at these three observed measure stations at the river Ibar.

Iron was determined very rarely (three to four measuring during the year) and there are a few years when there is no result about the dissolved iron concentration. According to the The Rules book o dangerous matters in water ("Sl. Glasnik SRS", br. 31/82), the maximal allowed concentration (MAC) for the iron is 0,30 mg/l for the II class of water and it was exceeded in several samples. The highest charge with this contaminant is at the profile Raška where the MAC was exceeded in 7% of examined samples, plus there were approximately one fifth of all samples in which this parameter value was much closed to the MAC. The least concentrations of dissolved iron were noted at the measure station Ušće. Comparative review of iron concentration in Ibar, for a several months during the referent period, is shown at the figure 8.

Manganese was determined at these three observed measure stations as often as iron. Maximal allowed concentration of dissolved manganese for drinking water is 0,05 mg/l, was exceeded in greater percentage of samples than iron. While for the water at the measure station Raška there is typical that high concentrations o iron occurred at the same period as high concentrations of manganese, for the river Ibar water quality at the measure station Kraljevo there is a significant number of samples with high concentrations of iron but manganese presence was not detected.

Copper was determined very rarely and MAC that is 0,1 mg/l for the first class of water and 0,2 mg/l for the second class of water, was exceeded only once at the measure station Kraljevo (August, 2009. 0,114 mg/l).

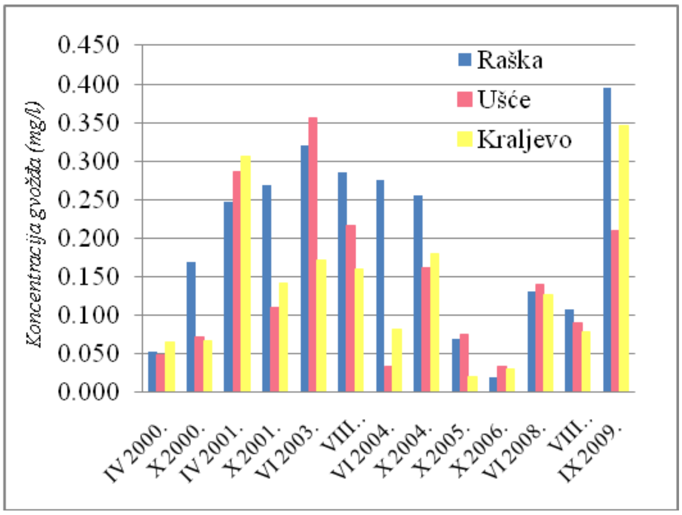

Figure 8. Iron concentration at measure stations Raška, Ušće and Kraljevo

Mercury in Ibar, at the observed measure profiles, was determined four times during a year, but there are some years completely lacking in these data. Beside a few samples with concentrations of mercury close to MAC (0,001 mg/l), there were not cases with this parameter value over MAC. Similar to mercury, zinc was determined very rarely and there is hard to determine eventual regularity of extreme concentrations occurrence. MAC for this metal is 0,2 mg/l according to the valid legislative and this value was exceeded in two samples (March, 2009., MS Raška, 0,274 mg/l and august, 2009., MS Kraljevo, 1,000 mg/l). Even though the cadmium concentration in the river Ibar was not determined very often during the referent period, there was noticed that at the measure station Ušće in 2008. in 5 of 11 samples there were measured concentrations of dissolved oxygen over MAC (0,005 mg/l).

DISCUSSION

On the included three measure stations at the river Ibar – Raška, Ušće and Kraljevo, there is organized analyzing of water quality parameters, but sampling and analyzes are not undertaken regularly. There are even whole years without information about some parameter value at the measure profile. Hence it is hard to notice and confirm eventual regularity among different parameters of water quality, hydrological parameters and climate conditions.

According to available data, there is obvious that the river Ibar is often charged with high concentrations of pollutants of different origin and type. There are several hundred of industrial plants, smaller or larger, and even 40 cities and settlements that pollute the river Ibar with sewage, heavy metals, oils etc. There are only a few factories with proper plant for waste water purification.

Phenols, that haven’t been observed in this work, since there are no official results about this parameter values, but represent a serious pollutant, are very often present in the river Ibar. Namely, there are a numerous sawmills all along the river bank, from Kosovo area to Kraljevo, which release waste water with saw dust that contain phenols. There are several tailings disposal in Kosovo that represent enormous sources of phenols as well.

Fortunately, thanks to a great number of tributaries that come from high mountainous and are rich with great amounts of fresh water, dissolved oxygen and aerobic organisms, the river’s Ibar water quality is still not irreversibly impaired. The highest water flows are typical for winter and spring periods during the year and in the same samples there were detected the highest concentrations of dissolved oxygen. In more than 30% of samples, minimal flows match with minimal concentrations of dissolved oxygen. It is normally, according to the fact that mountainous tributaries of Ibar bring more fresh water after the snow periods. Only the measure profile at Ušće had the characteristic, usually in spring, that even flow was very high, the concentration of dissolved oxygen was minimal, which can be a result of uncontrolled releasing of some waste water, probably charged with organic pollutants somewhere above Ušće. These contaminants can also come from a numerous wild landfills at river banks.

To all profiles observed in this work there can be noted that extremely high concentrations of suspended matters occur when there are the greatest values of flow – it is typical for the period March – May. That fact can indicate what the origin of such contaminants is and that they are perhaps the result of the torrential flow of rivers, main stream and tributaries as well. Suspended matters in water can derive from the river bed, as a result of strength of water in Ibar as well as in its tributaries, but they can get into the main stream from the river bank as well. They usually care organic matter on themselves.

According to values of nitrogen parameters, water quality of the river Ibar at all analyzed measure stations is adequate to the required quality for determined class of water, according to the valid legislative. The greatest source of nitrogen pollutants in rivers, in general, as well as in Ibar are slaughterhouses and plants for textile treating that are present in a huge number in Novi Pazar and Raška at first. Highest concentrations of nitrates are typical for winter period, period of big waters and large amounts of precipitations, but they can derive from a numerous farms and cultivated areas placed along river banks (Ibar and its tributaries).

For all three measure stations Raška, Ušće and Kraljevo there are small flows usually followed with small values of COD. The extent of organic pollution, which is specially emphasissed in water at the measure station Raška, is represented with extremely high values of COD even when there are high concentrations of dissolved oxygen. At the same time, COD at the measure station Raška during the referent period was usually greater than at the measure station Kraljevo, but other circumstances and water conditions contribute to the general impaired quality of the river, even thoug values of COD didn’t exceeded MAC. BOD determined in the river Ibar was several times detected in concentrations over MAC and the most often it was registered at the measure station Raška. COD and BOD, as parameters that represent the organic type of pollution, can be increased in water samples as a result of enormous number of households, even whole settlements and cities, that release their sewage water directly to the river Ibar, or to some of its tributaries. Very high concentrations of organic pollution, implied through COD and BOD are matched with periods of high flows during cold period of the year (autumn, winter, early spring) since low temperatures contribute to more slowly organic matter decomposition.

Water of Ibar at the measure station Raška is the most charged with pollution with dissolved iron. The fact that the most often occurrence iron concentrations over MAC for dissolved iron was registered at Raška and Kraljevo measure stations, and that the river Ibar water quality at the measure station Ušće was not loaded in that high extent with iron, indicates that this contaminants come from above parts of Ibar stream, then are diluted to Ušće, but then are fed from some new source of pollution. Dissolved manganese concentrations were detected over MAC in more samples of water than iron, and often extremely high concentrations of iron are matched with high concentrations of manganese. Only at the measure station Kraljevo there were samples of water from Ibar with very high concentrations of iron, but there was no manganese at the same time. Iron can be a result of anthropogenic impact to the river Ibar quality, but can be of geological origin as well.

Copper, mercury, zinc and cadmium probably derive from the coal mine. Since their presence was not determined regularly and their concentration exceeded the maximal allowed concentration in a few samples, it is hard to confirm such assumption about their origin as the only one, because they can derive from some other sources like various chemical plants, municipality plants for waste water treatment, plants for sewage deposing, landfills, plants for incineration of municipal waste. Also farms and economies with intense breeding poultry and pigs, as well as intense fishing, can be a cause of high concentrations of copper and zinc.

CONCLUSION

The Republic Hydro meteorological Institute of Serbia measuring results about water quality of the river Ibar indicate that this great river is under permanent danger of pollution, primary as a result of human activities along its stream. In purpose to conserve its current state, to prevent potential pollution in the future and to protect the river in general, there are many serious steps needed to be undertaken. All effluents from different plants should be purified prior to their discharging to the river stream, all wild landfills should be cleaned up and conserved etc. Prior to all that, people consciousness should be increased and penalty policy should be equally and fairly implemented. The river Ibar is contaminated permanently and enormously, and only thanks to the nature of its mountainous aerobic tributaries, its water quality is not completely destructed.

REFERENCES

http://sites.google.com
http://sr.wikipedia.org
http://www.kraljevo.com/kraljevo/geografija
Republic Hydro meteorological Institute of Serbia Annual reports from 2000. to 2009. year
The Regulation on water classification of inter-republic water flows, interstate waters and waters of Yugoslavian coastal sea (“Službeni list SFRJ”, br. 6/78)
The Rules book o dangerous matters in water (“Sl. Glasnik SRS”, br. 31/82).

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ANALISYS OF SURFACE WATER BY ROUGH SET THEORY

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ABSTRACT

This paper represents the feasible surface water analysis, through Rough Sets Theory. One of the practical results of rough sets theory application is the generation of if-then rules from tabular data. These can be obtained by measuring the surface waters, and it is possible to generate decision rules in if-then form. Those rules can depict the relations existing between various measured water parameters. It is possible to predict the value of still unmeasured water values based on these relations, with calculated probability. This would ease the monitoring of certain impact factors on the surface water condition. As the example, surface water parameters measured on the territory of Zrenjanin municipality have been monitored, as well as the opinions of the Centre for Hygiene and Human Ecology, in the Department of Public Health Zrenjanin. Based on Serbian Water Quality Index, parameters viable for rule generation have been extracted. This was shown how to be done using software based on the rough sets theory.

Key words: Surface Water, Zrenjanin, Rough Set Theory, If-Then rules.

INTRODUCTION

Today's state of surface waters is extremely alarming. It is the everyday fact of every one of us, regardless of our profession. Surface waters are clearly visible pollution part. According to the Report on Environmental State in the Republic of Serbia for 2009, written by Agency for Environmental Protection and Ministry of Environment and Spatial Planning (Ministry of Republic of Serbia, 2010), our country sees the wastewater discharge in watercourse without prior treatment. Analytic study conveyed by the Institute of Public Health of Serbia 'Dr Milan Jovanovic Batut' (Analytic study Batut, 2008; Statistical Office of the Republic of Serbia, 2010) in the period 1997-2007, shows that the period 1999 – 2005 recorded the settlement and industry wastewater quantity increase. Mechanical purifiers are present only the small percentage. The biggest centers, Belgrade and Novi Sad, did not have the wastewater treatment plants (EPR, 2007). In the region of cities, where there are several rivers, lakes, ponds and sand ponds, the need to control the surface waters is big. Numerous measurements conveyed daily indicate the polluted water. The data are stored and tracked, and are publicly available (Ministry of Republic of Serbia, 2010; Statistical Office of the Republic of Serbia, 2010; Report on Environmental State, 2010; Monitoring, 2010).

In Agency for Environmental Protection and Ministry of Environment and Spatial Planning (Ministry of Republic of Serbia, 2010), were defined parameters that describe the condition of surface water. This paper presents the possible analysis of surface waters based on the rough sets theory.

Section two gives the review of the basic definitions which the Theory of Rough Sets is based upon. The basic set features and the correlation between the theory and developed rules are given. Various software tools, enabling automatic rule generation, were developed based on rough sets theory. Section three reviews the SSCO system.

Section four represents the material obtained through measuring the surface waters on the territory of Zrenjanin municipality (Monitoring, 2010). According to the results from Chemical laboratory and the Hygiene Specialist opinion, Centre for Hygiene and Human Ecology in the Department of Public Health Zrenjanin, and based on Serbian Water Quality Index (Report on Environmental State, 2010), the measuring parameters were shown. A certain number of parameters, important for water classification into categories, were extracted.

Based on these extracted parameters of measured values of surface waters, Section five addresses the ways of rule generating by SSCO system. It has been shown how the prediction can be made.

The conclusion is in Section six, while the References are at the end of the paper.

ROUGH SET THEORY

Rough Set Theory (Pawlak 1982, see Pawlak et al., 1995; Pawlak, 1997) was developed as the result of analysis and presentation of data in various domains. In order to obtain data from large databases, it was necessary to develop the tools which would automate this task. “A significant advantage of methods that yield decision trees or if–then rule sets is that the models are directly inspectable and interpretable, and the results of decisions are explainable” (Komorowski and Øhrn, 1999). This is the exact reason for utilizing Rough sets theory in various domains, in order to cope with problems of uncertain, incomplete or approximate data, especially in conducting analyses of unknown phenomena.

Every object of the universe is described by certain amount of information expressed by means of some attributes used for object description.

The indiscernibility relation

The indiscernibility relation is the mathematical basis of Rough sets theory. Formally, as in [4], let U be a universe (finite set of objects), $Q=\{q_1,q_2,...,q_m\}$ is a finite set of attributes, V_q is the domain of attribute q and $V=\bigcup_{q\in Q}V_q$.

An information system is the 4-tuple $S=\langle U,Q,V,f\rangle$ where $f=U\times Q\to V$ is a total function such that $f(x,q)\in V_q$ for each $q\in Q, x\in U$, called information function. To every non–empty subset of attributes P is associated an indiscernibility relation on U, denoted by I_P:

$$I_P=\{(x,y)\in U\times U : f(x,q)=f(y,q), \forall q\in P\} \tag{1}$$

The relation (1) is an equivalence relation – reflexive, symmetric and transitive. The family of all the equivalence classes of the I_P is denoted by $U|I_P$ and class containing an element x by $I_P(x)$.

Set approximations

If there is (usually) one attribute called decision attribute while other attributes are called condition attributes, an information system is called decision system. Let X be a non–empty set of U and $\varnothing\neq P\subseteq Q$. Set X is approximated by means of P–lower (2) and P–upper (3) approximations of X:

$$\underline{P}(X)=\{x\in U : I_P(x)\subseteq X\} \tag{2}$$

$$\overline{P}(X)=\bigcup_{x\in X} I_P(x) \tag{3}$$

The P–boundary of X is denoted by $Bn(X)$:

$$Bn(X) = \overline{P}(X) - \underline{P}(X) \tag{4}$$

Reducts

Another issue of practical importance in reduction is to keep only those attributes that preserve the indiscernibility relation and consequently, set approximation. The rejected attributes are redundant (superfluous) since their removal cannot worsen the classification. Let $\emptyset \neq P \subseteq Q$ and $a \in P$. Attribute a is superfluous in P if $I_P = I_{P-\{a\}}$, otherwise it is indispensable attribute. The set P is orthogonal if all its attributes are indispensable. The set $P-\{a\}$ is a reduct of P if it is orthogonal and $I_P = I_{P-\{a\}}$.

An example

In the Table 1, there is a universe of six objects $U = \{x_1,...,x_6\}$ and each object is described by means of four attributes: pH value, oxygen saturation, Escherichia coli and Pollution.

Table 1: Simple example of information system

Object	pH value (pH)	Oxygen saturation% (O%)	Escherichia coli (Esch)	Pollution (D)
x_1	low	high	low	Low
x_2	high	medium	low	High
x_3	high	medium	low	Low
x_4	medium	medium	low	High
x_5	high	high	high	High
x_6	low	medium	high	Low

In this particular case, the object x_1 is described by: pH=low, O%= high, Fat%=low, Esch=low and so on. If $P = \{pH, O\%, Ecsh\}$ then, by (1), we have:

$I_P = \{\{x_1, x_1\}, \{x_2, x_2\}, \{x_2, x_3\}, \{x_3, x_2\}, \{x_3, x_3\}, \{x_4, x_4\}, \{x_5, x_5\}, \{x_6, x_6\}\}$,

$U | I_p = \{\{x_1\}, \{x_2, x_3\}, \{x_4\}, \{x_5\}, \{x_6\}\}$.

Let us consider a case when set X contains only those elements where Leptin Level is low: $X = \{x_1, x_3, x_6\}$, (see Table 1). Now, we can approximate set X using only the information contained in P by constructing the P–lower (2) and P–upper (3) approximations of X: $\underline{P}(X) = \{x_1, x_6\}$, $\overline{P}(X) = \{x_1, x_2, x_3, x_6\}$. The P–boundary (4) of X is: $Bn(X) = \{x_2, x_3\}$. The reader may notice that objects x_2 and x_3 (P–boundary of X) have exactly the same values of condition attributes but different value of the decision attribute. If R={ pH, O%}, S={pH, Esch}, and T={O%, Esch}, then it is obvious that $I_R = I_P$ and $I_S = I_P$ while $I_T \neq I_P$. This means that R and S are reducts of P, while T is not. Attribute pH is indispensable, but attributes O% and Esch may be mutually exchanged.

SSCO SYSTEM

According to the rough sets theory the software tools enabling automatic rule generation were developed. One of them is SSCO system. This system was developed in the period 2007-2008 as the result of Vladimir Brtka's research (Brtka et al,, 2007; Brtka, Stokic et al., 2008). His theoretical foundation is based on rough sets theory and the classical state space search. SSCO system is based on original algorithm, giving the results similar to the systems solely based on the rough sets theory (Brtka, Berkovic et al., 2008).

There are several versions of SSCO system. This paper presents the version 3.4. Apart from the versions developed for single-computer use, SSCO method was used with the aim to create and achieve functionality of web portal for data analysis and consulting (www.tfzr.uns.ac.rs/dawp).

SSCO system – version 3.4

The main menu of this program is divided into four parts: File, Task, Output and About. File display option can be seen on Figure 1, offering the ability to download entire databases, as well as rules for the training set.

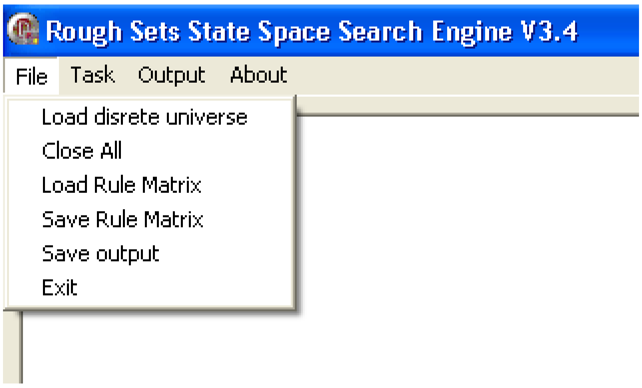

Figure 1. SSCO system – File option

A special feature offered by SSCO system is generating a smaller number of rules, which enables faster and easier work in practice. This was especially successful in working with medical data [2, 5]. Task option, depicted in Figure 2, enables the choice of generation of desired results.

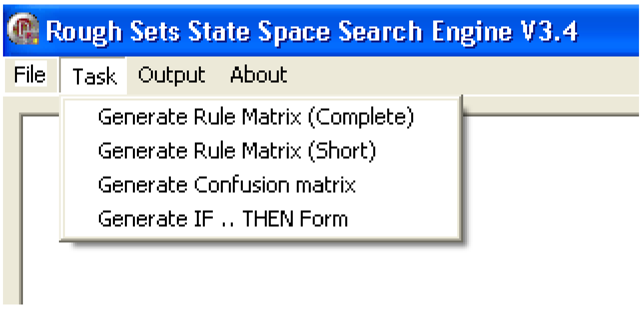

Figure 2. SSCO system – Task option

SSCO system – IF THEN rules

The system generates the results with probability display, hence the reliability of the obtained data can be clearly followed. Within the generated IF THEN form:

```
[4,0.75]    IF  (a1,1), (a2,6), (a3,4), (a4,1) THEN (a6,1)
```

beginning [4,0.75] represents the number of objects supporting the rule and accuracy probability of the rule itself. Conditional attributes and their values are listed within the IF part, while after THEN part there is the decision attribute with its own value.

SSCO system – Confusion matrix

The previously described rule set is accompanied by so called confusion matrix. Confusion matrix C is a $|V_d| \times |V_d|$ matrix, where V_d is the set of possible values of decision attribute. This matrix with integer entries summarizes the performance of rule set while classifying the set of objects. Entry:

$$C_{i,j} = \left|\left\{x \in U : d(x) = i, \overline{d}(x) = j\right\}\right|,$$

where $d(x)$ is the actual decision and $\overline{d}(x)$ is the predicted decision, which counts the number of objects that really belong to class i, but were classified to class j. Classification percentage can be calculated based on total amount of the diagonal matrix, compared to the total number of objects. It is important to notice that confusion matrix SSCO system was formed without any voting system so that one object could be classified to more than one class by some inexact rules.

SURFACE WATER MEASURING PARAMETERS

Surface water analysis depends on measured parameters. As the example, results of surface waters measuring conveyed on the territory of Zrenjanin municipality will be given.

Example: Surface water measuring reports on the territory of Zrenjanin municipality

Apart from the developed monitoring system, Zrenjanin municipality has the developed system of public information through the official web portal: (Monitoring, 2010). The data on state of surface waters in 2009 and 2010 can be found at this portal. Complete reports are given, based on the results of Chemical laboratory and the opinion of the Hygiene specialist, working for Centre for Hygiene and Human Ecology in the Department of Public Health Zrenjanin. The reports contain the microbiology laboratory results, chemical laboratory results, as well as the Hygiene specialist's opinion and interpretation of specific values of measured parameters. The Hygiene specialist gives his opinion by classifying the water into one of five categories.

Since the reports have to be reproduced in their total, for easier tracking of the monitored parameters, one day's completed report (4th August 2010 was chosen) is presented on Figure 3 – Figure 6 string: Figure 3 shows the Microbiology laboratory result, Figures 4 and 5 results of Chemical laboratory, while the Figure 6 gives the Hygiene specialist's opinion and interpretation of specific measured parameter values.

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Centar za mikrobiologiju

REZULTATI MIKROBIOLOŠKE LABORATORIJE

PROTOKOL: **II 285**	MIKROB. BROJ **197**		*Tražena analiza:*
DATUM UZORKOVANJA	**04.08.2010**	**9:20**	MIKROBIOLOGIJA ☑
VRSTA UZORKA: **POVRŠINSKA VODA**	RECIPIJENT:		HEMIJA ☑
VLASNIK:	**OPŠTINA ZRENJANIN**		
MESTO	**ZRENJANIN**		
MESTO UZORKOVANJA:	**KUPALIŠTE TISA - TALPA**		
UZORAK DOSTAVLJA: **RADNIK ZAVODA**	UZORAK UZEO: **MILOŠ SRDANOV**		
OSTALI PODACI:	**SM 1**		

PROTOKOL: **II 285** MIKROBIOLOŠKI BROJ: **197**

Parametar	*Rezultat*	*Jedinica*	*Metod*	*Klasa I*	*Klasa II*	*Klasa III*	*Klasa IV*
MPN	24000	U 1000 ml			do 20000		
Esherichia coli	POZITIVAN						

Rezultate izdao:

DR PREDRAG RUDAN

Rezultate odobrio
Načelnik centra za mikrobiologiju
Dr Predrag Rudan
Spec. mikrobiologije sa parazitologijom
10-avg-10 12:18:21

Napomena: Izveštaj se može kopirati i reprodukoviti isključivo u celosti. Rezultati ispitivanja se odnose na ispitivani uzorak. *Strana 1 od 1*

Figure 3. Microbiologic laboratory results

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Centar za higijenu i humanu ekologiju
Odeljenje hemijske laboratorije

REZULTATI HEMIJSKE LABORATORIJE

PROTOKOL: **II 285**	HEMIJSKI BROJ: **170**		*Tražena analiza:*
DATUM UZORKOVANJA	**4.8.2010**	**9:20**	MIKROBIOLOGIJA ☑
VRSTA UZORKA: **POVRŠINSKA VODA**	RECIPIJENT:		HEMIJA ☑
VLASNIK:	**OPŠTINA ZRENJANIN**		
MESTO	**ZRENJANIN**		
MESTO UZORKOVANJA:	**KUPALIŠTE TISA - TALPA**		
UZORAK DOSTAVLJA: **RADNIK ZAVODA**	UZORAK UZEO: **MILOŠ SRDANOV**		
OSTALI PODACI:	**SM 1**		

PROTOKOL **II 285** HEMIJSKI BROJ: **170**

Parametar		*Rezultat*	*Jedinica*	*Metod*	*Klasa I*	*Klasa II*	*Klasa III*	*Klasa IV*
Temperatura vazduha		21,2	°C					
Temperatura vode		22,3	°C					
Boja		svetložućkasta		MHI-06-003	Bez	Bez	Slabo primetna	/
Miris		bez		MHI-06-004	Bez	Bez	Slabo primetan	/
Vidljive otpadne materije (prozirnost)		mutna		MHI-06-005	Bez	Bez	Bez	Bez
pH vrednost		7,71		MHI-06-006	6.8 – 8.5	6.8 – 8.5	6.0 – 9.0	6.0 – 9.0
Sušeni filtrirani ostatak		241	mg/l		350	1000	1500	1500
Suspendovane materije		238	mg/l	MHI-06-007	10	30	80	100
Hemijska potrošnja kiseonika	(HPK iz $K_2Cr_2O_7$)	13,5	mg/l	MHI-06-009	10	12	20	40
Biološka potrošnja kiseonika	$(BPK_5)^{20}$	3,25	mg/l		2	4	7	20
Rastvoreni kiseonik		8,9	mg/l		8	6	4	3

Napomena: Izveštaj se može kopirati i reprodukoviti isključivo u celosti. Rezultati ispitivanja se odnose na ispitivani uzorak. *Strana 1 od 2*

Figure 4. Chemical laboratory results - page 1

PROTOKOL **II 285** HEMIJSKI BROJ: **170**

Parametar	*Rezultat*	*Jedinica*	*Metod*	*Klasa I*	*Klasa II*	*Klasa III*	*Klasa IV*
Zasićenost kiseonika u procentu	102	%		90 - 105	75 - 90	50 - 75	30 - 50

Rezultate izdao:

VESNA MAKSIMOVIĆ, spec.dipl.ing.tehnologije

Rezultate odobrio
Šef hemijske laboratorije

Mr Ph Olivera Grozdanović,
Specijalista ispitivanja i kontrole lekova

D. Grozdanović

13-avg-10 13:51:46

Napomena: Izveštaj se može kopirati i reprodukoviti isključivo u celosti. Rezultati ispitivanja se odnose na ispitivani uzorak.

Strana 2 od 2

Figure 5. Chemical laboratory results - page 2

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Izjava o ispunjenosti zahteva / specifikacija
Mišljenja i tumačenja

NALAZ BROJ: II 285

Vode koje se u prirodnom stanju mogu uporebljavati za kupanje i rekreaciju građana, sportove na vodi, gajenje drugih vrsta riba (ciprinida) ili koje se uz uobičajene metode obrade-kondicioniranja (koagulacija, filtracija i dezinfekcija i sl.) mogu uporebljavati za piće i u prehrambenoj industriji moraju da ispunjavaju zahteve II klase (Sl. List SFRJ br. 6/78).

Ispitani uzorak ne odgovara uslovima za klasu II (dva) u pogledu tzv. "najverovatnijeg broja" koliformnih klica (MPN).

Napomena:
Neophodan je nadzor nad merama lične i kolektivne higijene (tuširanje pre i posle kupanja, dispozicija otpada i sl.).
Preporučuje se periodična inspekcija kupališta u pogledu ispunjenja sanitarnih uslova, kao i sagledavanje optimalnog broja korisnika imajući u vidu kapacitet kupališta.

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Načelnik Centra za higijenu i humanu ekologiju

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Figure 6. Opinions and interpretations

Serbian Water Quality Index

Agency for environmental protection has developed the environment indicator called Serbian Water Quality Index (SWQI). According to (Report on Environmental State, 2010), it is aimed to inform the publicity, experts and political decision makers (local self-government, state authorities). The indicator is based on Water Quality Index method (Development of a Water Quality Index, Scottish Development Department, Engineering Division, Edinburgh, 1976.), according to which ten parameters of physical-chemical and microbiological quality are monitored:

1. oxygen saturation
2. BPK_5
3. ammonium ion
4. pH value
5. total nitrogen oxides
6. orthophosphates
7. suspended matters
8. temperature
9. conductivity
10. coliform bacteria

These ten parameters are aggregated in a composite indicator of surface water quality. Since all these parameters are not equally significant, they are described with weights (w_i) and the points assigned according to the share in their quality jeopardize. Sum of the product ($q_i \times w_i$) gives the index 100 as an ideal sum of quality shares of all the parameters. Apart from the classification, values for descriptive indicator of the quality has also been adopted. These are shown in Table 1.

Table 2: Surface water classification by Serbian Water Quality Index method

WQI-MDK I class		WQI-MDK II class	WQI-MDK III class	WQI-MDK IV class
85 - 84		78 - 72	63-48	38-37
100 - 90	89 - 84	83 - 72	71 - 39	38 – 0
Exceptional	Very good	Good	Poor	Very bad
Serbian Water Quality Index (SWQI)				

According to the Serbian Republic Hydrometheorogical Service data and the Serbian catchment area analysis, including 16745 samples from 143 measuring points in the period 1998 – 2009, the worst quality of waters are in the canals and rivers in Vojvodina. The profince has 47% samples in the 'poor' and 'very bad' category, which are III, IV and outside of the class.

SURFACE WATER RULES

According to parameter analysis shown within the monitoring example in the Zrenjanin municipality, as well as the Serbian Water Quality Index parameters, the following can be noticed:

All ten parameters (oxygen saturation, BPK_5, ammonium ion, pH value, total nitrogen oxides, orthophosphates, suspended matters, temperature, conductivity and coliform bacteria) have their numeric values, but the parameter 'coliform bacteria', apart from the numeric value (number of bacteria in 1000ml) has its descriptive value (bacteria name) as well. Therefore, the condition attributes should, apart from these first nine parameters, be extended with each bacterium individually. Their number could be limited to a smaller number of important bacteria (such as Escherichia Coli). In order to facilitate the rules, the decision attribute should be descriptive, based on Serbian Water Quality Index: Exceptional, Very good, Good, Poor, Very bad.

The Example of the Rules Based on Chosen Parameters

According to already presented rule entry obtained through SSCO system, the following entry:

```
[89,0.73]    IF (a1,102),(a2,4),(a4,8),(a10,30000) THEN (ad,2)
```

would mean:

I. 89 measurements confirm this rule with the probability 0.73.
II. If the oxygen saturation is 102%, BPK_5 = 4 mg/l and pH value = 8 and if there is Escherichia coli in quantity of 30000/1000ml, then the quality of water is good (II class).

Surface Water Rule Interpretation

Compared to the total number of parameters, the previous example contains only four of them: oxygen saturation, BPK_5, pH value and Escherichia coli. This means that the rule with the probability of 0.73 offers the possibility to monitor only these four parameters, regardless the rest of them. The rest do not have to be measured in case of such values of these four parameters. In this way the rules could facilitate decision making and reduce the number of measuring. Interrelation between certain parameters could be tracked thanks to these rules.

CONCLUSION

The paper presented the rough sets theory application in assessment of surface waters. Based on the theory, it has shown the possibilities offered by the software developed by one of the paper's authors. The ways of measuring the surface waters have also been shown, as well as the way of determining the parameter set for SSCO system (on the example of monitoring in Zrenjanin municipality and Serbian Water Quality Index)

Specific surface water can be described more precisely with the if-then rules. They would enable decision making on water classification with less measuring and thus enable to save money and other resources. This paper showed just the basic application of rough sets theory. The rules could be checked by testing the same water. In case of missing data, the rough set theory could give the result. Generating if-then rules on the large database would create actual rules.

REFERENCES

Analytic study 1997-2007. - Institute of Public Health of Serbia ‘Dr Milan Jovanovic Batut’ (2008). http://www.batut.org.rs/

Brtka V., Berkovic I., Brtka E., Jevtic V. (2008). “A Comparison of Rule Sets Induced by Techniques Based on Rough Set Theory”, SISY 2008, 6th International Symposium on Intelligent Systems and Informatics, September 26-27, Subotica,Serbia, IEEE Catalog Number: CFP0884C-CDR, ISBN: 978-1-4244-2407-8, Library of Congress: 2008903275.

Brtka V., Berkovic I., Stokic E., Srdic B. (2007). “Automated extraction of decision rules from medical databases - A rough sets approach” (Proceedings Paper), 2007 5TH INTERNATIONAL SYMPOSIUM ON INTELLIGENT SYSTEMS & INFORMATICS, (2007), vol. br. , str. 27-3

Brtka V., Stokic E., Srdic B. (2008). “Automated extraction of decision rules for leptin dynamics—A rough sets approach”, *Journal of Biomedical Informatics* 41, pp. 667 – 674.

EPR (2007).– Republic of Serbia – *Second Review Ministry of Natural Resources and Environment in collaboration with the UE European Commission Committee on Environmental Policy*, Belgrade. http://www.ekoplan.gov.rs/src/index.php

Komorowski J., Øhrn A. (1999.) “Modeling prognostic power of cardiac tests using rough sets”, *Artificial Intelligence in Medicine*, 15, pp. 167–191.

LEAP Zrenjanin (2003). Zrenjanin Municipality Website / E-Administration / Document: http://www.zrenjanin.rs/1-146-0-0/Dokumenta-za-preuzimanje

Monitoring (2010). Zrenjanin Municipality Website / E-Administration / Environmental Protection / Monitoring: http://www.zrenjanin.rs/1-295-294-0/Monitoring.

Pawlak Z. (1997), "Rough set approach to knowledge-based decision support", *European Journal of Operational Research*, 99, pp. 48-57.

Pawlak Z., Grzymala-Busse J., Slowinski R. and Ziarko W. (1995). "Rough sets", Association for Computing Machinery. *Communications of the ACM,* 38.

Report on Environmental State in the Republic of Serbia for 2009 (2010). Agency for Environmental Protection and Ministry of Environment and Spatial Planning,: www.sepa.sr.gov.yu

Statistical Office of the Republic of Serbia (2010). http://webrzs.stat.gov.rs/WebSite/

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APPLYING OF THE “RADIJAN 2001 SF” METHOD OF EOCHEMICAL PROSPECTION IN LYTHOLOGICAL PROFILE AND ROUNDWATER QUALITY DETERMINATION IN INDUSTRIAL AREA OF NOVI SAD

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ABSTRACT

The non invasive method of geochemical prospection „RADIJAN 2001 SF“ is applied at four measure points at the location of the chemical industry of Novi Sad HINS. There were determined lythological layers and detected different pollutants. Along the profile line, parallel with the channel Dunav-Tisa-Dunav, there was determined the geochemical profile, in overall length of 250 m, defined with four measure points, positioned at 25 to 125 m from each other. The obtained results indicated that there was a crashed ground object from which there was leaking oil, lead, ammonia, nitrates and arsenic.

Key words: geochemical prospection, lythological profile, ground water

INTRODUCTION

All previously obtained results with standard methods of sampling and samples analyzing, indicate that there is a significant extent of ground water pollution in Serbia. Simplicity and fastness in providing results of the here applied method, as well as its friendly ecological impact to environment, have specific significance in those parts of Serbia, where ground waters represent the main source for drinking water supplying.

The subject of this paper is determination of lythological profile and identification of present pollutants in ground water, with the new method of geochemical prospection „RADIJAN 2001 SF“ in industrial area of Novi Sad.

Increased content of specific pollutants can be correlated with vicinity of the source of pollution (factories, plants, experimental farms, etc.) or just with a lythological profile.

CHARACTERISTICS OF THE ANALIZED AREA

In alluvion of the river Danube, based on hydrogeological criteria, according to Vilovski and Andric (1982) there are two basic hydrogeological categories:

1) Water bearing layers of good filtration characteristics – they are usually consisted of sands and gravels of which there are formed compact type aquifer with free levels or partially under pressure during some period of the year.
2) Weakly permeable or impermeable layers represented with all variation of powdery-clay or loess sediments.

At some of explored locations within the area of Novi Sad, alluvial sediments have depth from 17,0 to 38,0 m, depending on erosive impact of river and development of bed facies or backwater as it is claimed by Rakic (1998).

According to lythological profiles along the left and the right bank of the river Danube, obtained with geophysical methods and exploration bores, there are three media with different functions: a hanging wall, a water bearing layer and a lying wall. The hanging wall of depth 3,0 to 6,0 m, is weakly permeable and contains mainly different aleurit varieties and loess. Water bearing layers are usually developed in bed facies and consisted of grey-greenish powdery to fine grained sands, partially gravelly sands. They have depth from 10,0 to 20,0 m. Hydrogeological function of the aquifer depends on type of the facies (bed, backwater, ait). The third lythological element is the impermeable lying wall consisted of gray-blue lean carbonated clay.

Referring to existing and available results of chemical analyses of ground water of Danube alluvion, anayzed in the period from 1986. to 2004. ground waters are of hydrocarbonated type according to the dominant cation and calcium-magnesium type according to the dominant anion. Zrnic and Stojiljkovic (2005) findings indicate that there are some parts of Novi Sad where ground water contains heavy metals, hazardous and cancerogenic materia, naphtha and mineral oils, detergents etc., which depends on technological process and way of purification and releasing of industry waste waters. But, results of chemical analizes of ground waters, sampled using piezometers during 1988. and 1989. year indicates that there are some pollutants over maximal allowed concentration in ground waters (ferrum, manganese, ammonia, phenols and mineral oils).

DESCRIPTION OF THE APPLIED METHOD

The basic equipment implemented in this work is a device named „RADIJAN 2001 SF“, where the implemented method’s name derives from. This method includes generation of electromagnetic vawes at thr earth surface. When such vawes, emitted from the mentioned device, penetrate through the ground and face to some conductive formation or some ore body, they induce currence in conductors which then become a source of new vawes that are discharged from the conductor. These vawes are detected at the surface with proper part of the implemented instrument (http://www.maden.hacettepe.edu.tr).

As it is said by Stojiljkovic (2009), there are two phases of the method. First phase includes horizontal geochemical prospection that understands detection of pollutants and direction of water streams flows. After these two issues are defined, on those measure points where type of ground water streams as well as pollutants content is found interesting for further examination – there is used the device „RADIJAN 2001 SF“ for vertical geochemical prospection. Results of the vertical geochemical prospection provides information about lythological profile, depth of lythological elements, presence of water, depth of water bearing layer, presence of contaminants and extent of their presence, as well as direction of their possible sourcing.

„RADIJAN 2001 SF“ is the device used for determination precise location of ores, minerals, water, hidden objects and explosive. This device provides determination of chemical composition of some ore / mineral / compound, on the basis of the size of an inferrent field created around the sampled material. Measuring is done separately, particularly for each element of which the material is made of.

MEASURING POINTS

The experimental part of this work took place along the left side of the channel Dunav-Tisa-Dunav, in industrial area of Novi Sad. The whole experiment included 40 measuring points of which four of them are presented in this work. A map of a wider area of Novi Sad with marked locations of exploration is presented at the picture 1.

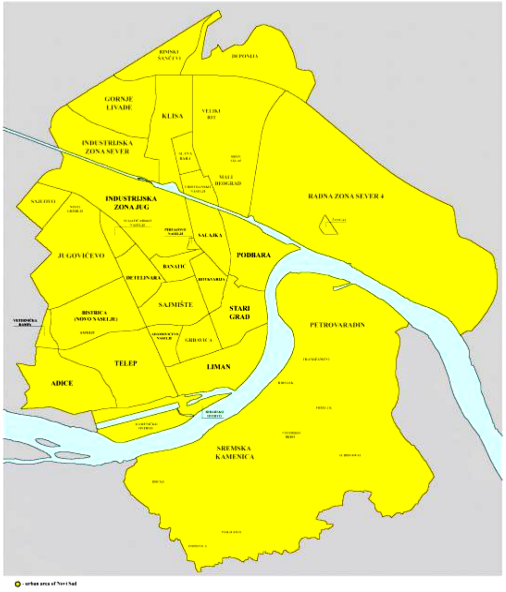

Figure 1. A reference map of measure points at explored locations in industrial area of Novi Sad

Horizontal geochemical prospection was used first for pollutant detection. At those points where the pollutants were detected, there was also done the vertical geochemical prospection. In order to determine lythological profile up to the first water impermeable lying wall occurence, direction of contaminants moving, depth of pollution and the strength of the signal frequence for each pollutant.

Here in this work are presented lythological profiles and detected pollutants, determined with the implemented method of geochemical prospection „RADIJAN 2001 SF“.

Four measure points that this work includes, are placed in area of Chemical Industry of Novi Sad (HINS). This factory began its work in 1925. positioned in Radnicka street. First this factory produced creams for shoes, various chemicals for leather conservation, lubricants, ink, sealing wax, terpentine and other similar articles. After 1960. HINS introduced some new articles in its production process: urea based glues, polyester resins, crystals, separators etc. Beside the plant for formaline production, there is constructed a new plant for production of commodities. The basic activity of this factory today relies on: production of chemicals for cleaning and washing in households, production of chemicals for leather treathing, cosmetic for cars, industrial auxiliary chemicals, production of unsaturated polyester resins, production of urea-formaldehyde based glues, formaline production and service charging of aerosol products (http://www.hins.co.yu).

Geochemical profile, in total length of 250,0 m, is defined with 4 measure points (MP7 – MP10), distant form each other 25,0 to 125,0 m along the profile line prallel to the channel Dunav – Tisa – Dunav. In the table 1, there are presented measure points with the depth to which the prospection were done.

Table 1.A: scope of the exploration with vertical geochemical prospection at the location of Chemical Industry of Novi Sad

Location: HINS	
Measure point	Depth of prospection (m)
7	23,0
8	22,0
9	21,0
10	21,0

RESULTS

Measure point 7: It is placed parallel to a fence of the plant of the chemical industry of Novi Sad and this mesure point is the last one in the profile line. At the surface there is a layer of humus and yellow sandy clay under it. The water bearing layer is determined with yellow sands at the depth of 4,5 to 5,3 m. These sands are polluted with oil (strength of the RADIJAN signal frequency 1) and with lead (strength of the RADIJAN signal frequency 10). The other water bearing layer consisted of gravelly sand and gravel, at the depth of 11,0 to 18,0 m – is not polluted (See pictures 2a and 4).

Measure point 8: This point belongs to the same profile line as the MP7. The first two lythological elements from the surface are humus and yellow sandy clay. At the depth of 3,5 to 5,4 m there is a first water bearing layer consisted of sands where was detected pollution with: oil (strength of the RADIJAN signal frequency 40), iron (strength of the RADIJAN signal frequency 20) and nitrates (strength of the RADIJAN signal frequency 25). In the interval from 8,0 to 8,6 m in depth, there is a sandy intercalations where was detected arsenic in traces. This pollutant seems not to be infiltrated vertically from the HINS waste waters, but from some shallower polluted sand zone which comes a side at this location. Since there was a limited number of measure points, there is not possible to claim that this arsenic came from direction of the plant „Koteks produkt“. The other layer of gravelly sands at the depth of 12,3 to 17,0 m – is not polluted (See pictures 2b and 4).

Measure point 9: It is positioned above a drain and a precipitator of the HINS waste waters. Under rhe surface there is a layer of yellow sandy clay under which there is a water bearing layer of sand, from 3,1 to 4,1 m in depth. In this interval there was detected a pipe of the precipitator. There in the waste water were detected the following pollutants: oil, nitrates, ammonia, manganese (strength of the RADIJAN signal frequency 15, 10, 60, 10, res1pectively). There was also detected contamination with lead (strength of the RADIJAN signal frequency 40) that is poured up to the depth of 6,5 m under the precipitator and the drainage manhole. After a layer of plastic clay, at the depth under 11,5 m there is determined another water bearing layer of sand that is not polluted (See pictures 3a and 4).

Measure point 10: This measure point is located close to the beginning of the industrial ring. After the layer of humus and yellow sandy clay at the deph of 4,1 m there was determined a water bearing layer consisted of sand, to the depth of 6,7 m. There was detected pollution with naphtha (strength of the RADIJAN signal frequency 15) and sulphur (strength of the RADIJAN signal frequency 25), while a gravelly sand layer, at the depth of 12,0 to 15,7 m – is not polluted (See pictures 3a and 5).

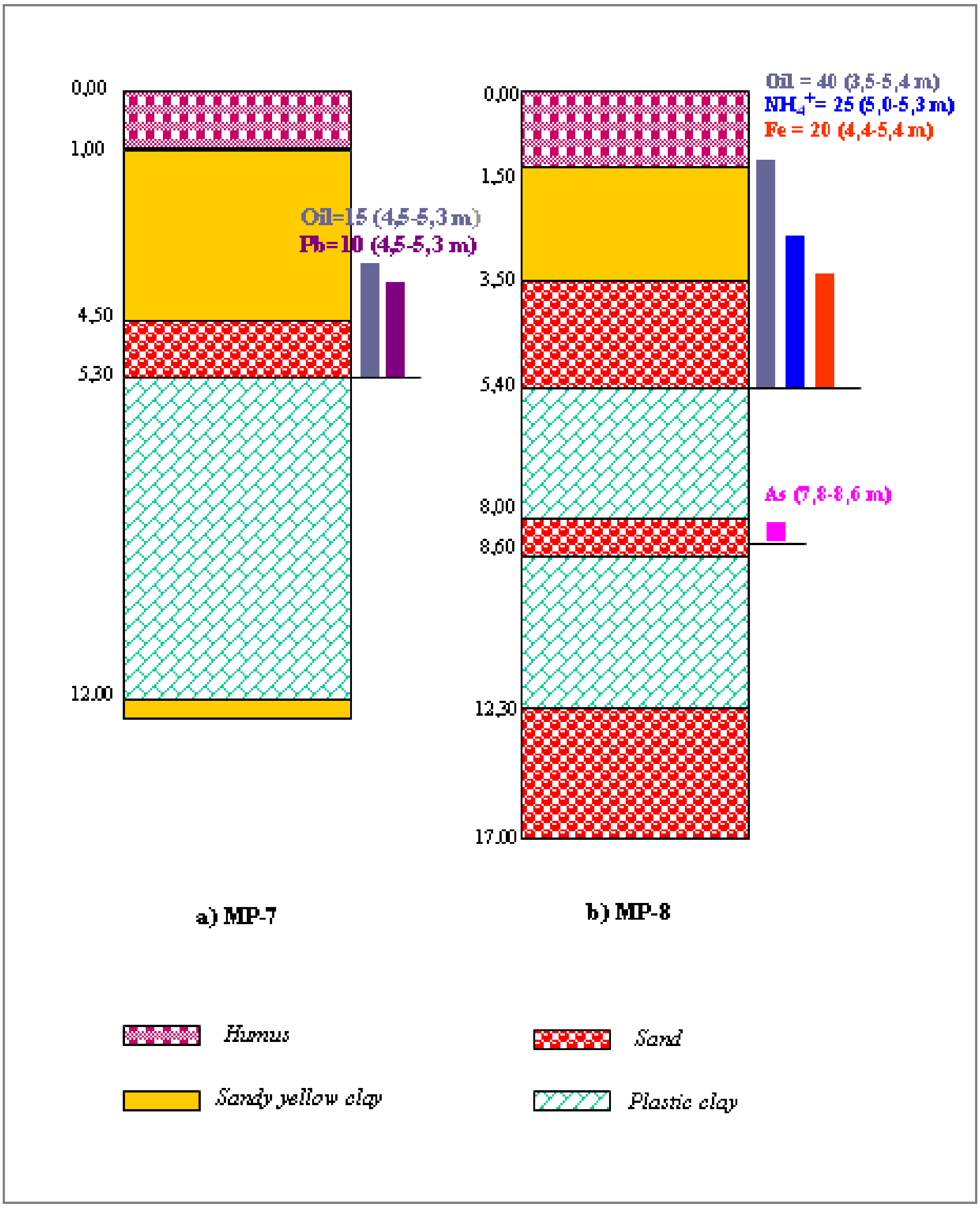

Figure 2. Lythological profile as a result of vertical geochemical prospection at MP7 and MP8

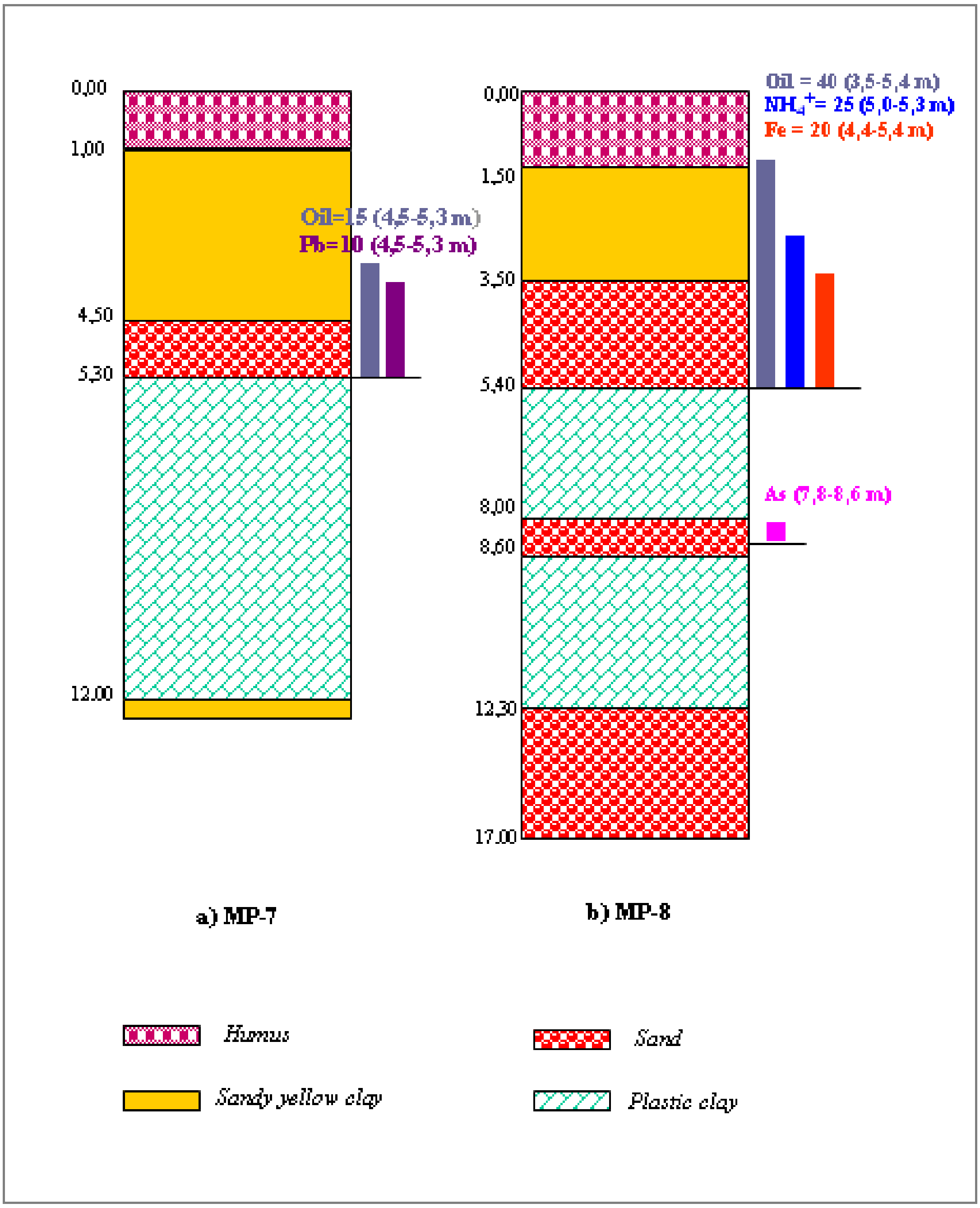

Figure 3. Lythological profile as a result of vertical geochemical prospection at MP9 and MP10

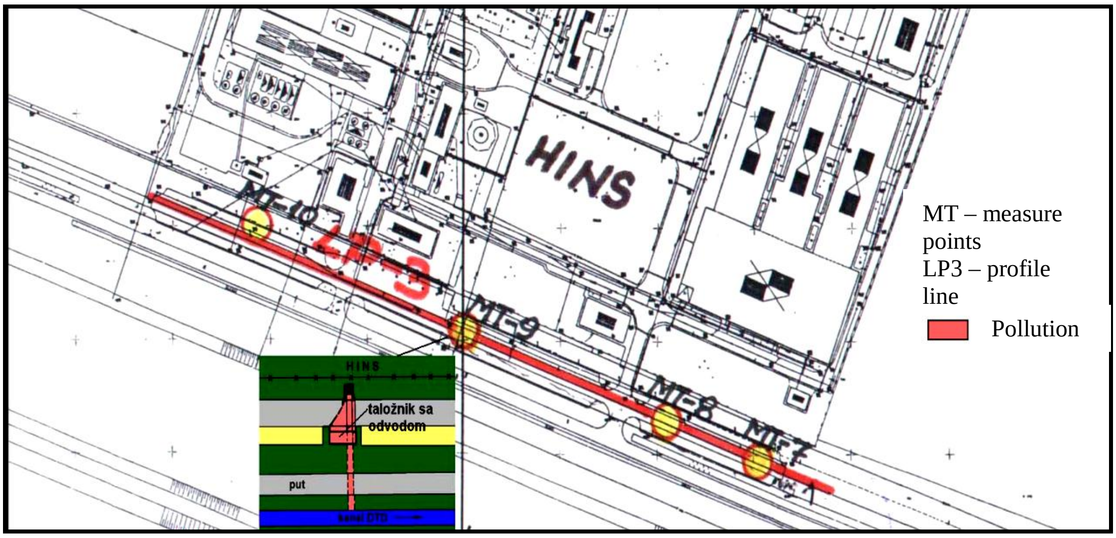

Figure 4. A reference map of measure points MP7 to MP10, as a result of horizontal geochemical prospection

DISCUSSION

For the whole explored area of Novi Sad, there were some typical and for all mesure points common lythological elements determined. First from the surface, there is a mound or a layer of loess yellow clay which, in hydrogeological meaning, represent a semipermeable hanging wall. The next lythological layer is represented with yellow sands, fine grained or powdery, of variable depth that are spread from the hanging wall to the water impermeable layer of clay / sandy clay / clayey sand. The other part of water bearing layers, spread under 20,0 m in depth up to the lying wall of alluvial sediments, consists mainly of fine grained sand, gravelly sand and sandy gravel.

At the HINS location there was determined a crashed underground object from which leaks oil, lead, naphtha, ammonia, nitrates and arsenic. The total geochemical profile of 250,0 m in length, there was determined with 4 measure points, at the distance between each other from 25,0 to 125,0 m, along the profile line prallel to the channle Dunav – Tisa – Dunav. These 4 measure points have in common occurence of humus layer of various depth, after which there are layers of plastic clay and sand interchanging. Manganese, nitrates and oil were detected there in approximately same quantities (according to the RADIJAN frequency signal strength). Lead and ammonia were detected in much greater quantities, according to the significantly greater RADIJAN frequency signal strength.

CONCLUSION

There are a plenty of methods for identification of pollutants in soil and ground water, usually applied during hydrogeological, geological, engineering exploration etc. All those methods understand presence of water intake facilities or building new objects in purpose to be used for sampling soil and water for laboratory analyzes (drilling wells, piezometers,...).

In this work, the applied method „RADIJAN 2001 SF“ is a method of geochemical prospection which is simple, non invasive, non-destructive, environmental friendly method that provides information about lythological elements and their nature, while the whole process lasts short and the results are provided immediately.

With the new method, in part of the industrial area of Novi Sad, there were determined lythological profiles of alluvial sediments, occurence of ground water and flow direction of the dominant water stream, underground objects for waste water storage, precipitators, pools (depth and technical correctness), type of present pollutants, depth of pollutants infiltration, width of the contaminated area etc. Quantitative interpretation of data obtained with the new method „RADIJAN 2001 SF“ is not possible jet, but there is a possibility to correlate such gethered data with standard physical values.

Comparing previously gathered results provided with verified standard methods about lythological profile of the refferent terrain and ground water quality, with the results obtained with the method „RADIJAN 2001 SF“, there is rasonably to have optimistic attitude related to the new method reliability. The method „RADIJAN 2001 SF“ is very practical and useful for fast terrain measurings and can represent a good basis for forming ground water cadastres.

REFERENCES

Vilovski, S., Andric, B. (1982). Organized water supplying of settlements along the river bank by Novi Sad, Novi Sad

Rakic, M. (1998). Sedimentary cycle of quarters in parts of Panonian basin, The Geological society of Montenegro and The Union of Yugoslavian geological societies, XIII Congress of geologists of Yugoslavia, Book II, Herceg Novi, 426 - 451

Zrnic, Z., Stojiljkovic, D. (2005). Characteristicf of public wells and springs in paleolandslides of Danube type Dunavskog tipa, Monography „Cities and suburban settlements environment protection“, EKO association of the city of Novi Sad, Book I, Novi Sad

http://www.maden.hacettepe.edu.tr

Stojiljkovic, M. (2009). Ground water pollutants determination with non invasive method „RADIJAN 2001 SF“, Master thesis, University of Novi Sad, The faculty of agriculture, Department for water managing, Novi Sad, 2009.

http://www.hins.co.yu

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SEASONAL KINETIC ASPECT OF PURIFICATION OF URBAN ATMOSPHERIC WATER IN PETROCHEMICAL REFINERY

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ABSTRACT

Laboratorycal information and menagement system, LIMS in Refinery Pančevo is used also in control of the atmospheric waste water purification. The measured contents of contaminats for 20 samples from january to september were lower than maximal allowed contents (MAC) 2 mg mineral oil /l, pH 6,5- 9, and less than 0,0002 mass % of sulphides, 0,0002 mass % of mercaptane and 30 mg/l suspended matter. After gravitational sedimentation and water clarification, in prior examination the correlation between water pH and turbidity were found. In this paper by the seasonal kinetic aspect, dominant influence of hydrolysis kinetic of sorbed water , on turbidity and motor oil content was found.

Key words: Seasonal temperature, Sorbed water hydrolysis, pH relaxation kinetic, Atmospheric waste water, Petrochemical reafinery.

INTRODUCTION

The atmospheric water in Petrochemical refinery in Pančevo (Fig 1.) were purified by gravitational treatment. The results from laboratorycal information monitoring system, LIMS for purified atmospheric waste water for 20 samples from january to september in 2008. year were less than maximal allowed contents (2 mg oil /l; pH 6,5 – 9; 0,0002 mass % of sulphides; 0,0002 mass % of mercaptane and 30 mg suspended matter /l). In this paper were examined seasonal kinetic of pH relaxation in depndence of oil content, on the base of monitoring data.

Figure 1. Petrochemical Refinery in Pančevo

Figure 2. The plant for sedimentation and clarifications of un-oiled water of Petrochemical Refinery in Pančevo

Figure 3. The retension reservoars

In periods with great atmospheric water is accumulated retension reservoars (Fig 3) as well as for water with the bad quality from canalisation system for egalisation of water quality and direction between the two system for oiled API separator with oil scrimers or for un-oiled waters in the plant for sedimentation and clarification (Fig. 2)

In ther plant for sedimentation and clarification dominant contaminats, suspended matter and seasonal motor oil from: a) un-oiled atmospheric water from petrochemical refinery, earth except process plant b) the cooling water, and technological waterr and c) water from energy plant, waste water from sedimentation and sand filter. Mechanical purification of oil drops and suspended particles of the earth in industrial around on two-comores for sedimentation and clarification sometimes with scrimers for oil removal and with swimming barriers is moved to system with two packet of coalescent filters. Purified atmospheric water with pumps and pipe is transported in HIPP industry canal of waste water and then in river Dunav after controlled contamination by LIMS.

In prior examination (Minić, M 2008) the correlation between pH and turbidity as well as between oil content and turbidity. In this examination the oil content change rate constant were compared with pH change rate constant and turbidity cvhange rate conastant.

MATERIAL AND METHODS

The data obtained from LIMS in our prior examination of water quality of spontaneously sedimented atmospheric water (Fig 2) were obtained by standard methods analysis (Minić. M., 2008) are used in first order kinetic examination in this paper (the Table 1.).

According to literature (Mabey, W. and Mill, T.,1978 and Mill, T., Bawol, R., et al.,1981), hydrolysis kinetic of organic chemicals follows a simple kinetic relations if parallel processes define organic mater hydrolysis rate constant, $k_h= k_{pH}+k_B+k_N$, by kinetic of first order, where:
k_{pH} - pH relaxation rate constant ,
k_B - base content change rate constant of sorbed water hydrolysis, with week organic acid soaps with strong bases (Al^{3+}, Ba^{2+}, Li^{+}, Cs^{+} and Na^{+})
k_N – turbidity change rate constant due discharged organic macromolecules hydration or dehydration

According to literature (Amamy, M. and Mill, T. 1984.) the presence of inorganic clay in water suspension had a small effect on the organic matter hydrolysis process ($k_h \approx 0$), but the adition on moisture to oven dried clays up to limits of sorbed water resulted in an increase in the rate of hydrolysis of the organic epoxide molecules (0,04 day $^{-1}$). When the moisture content exceeded the limit for sorbed water, the hydrolysis rate constant increased to 0,136 day $^{-1}$ (Amamy, M. , Mill, T. 1984.) . The addition of humic acid to the clay minerals in about a 40 % show reduction the epoxyde hydrolysis rate constant (to 0,11 day^{-1}).

RESULTS

In this work on the base of monitoring data from LIMS (Table 1and Fig. 4.), the kinetic parameters were calculated and presented in *Tables 2.and 3* .

Table 1: The results of monitoring of purified atmospheric waste water from petrochemical industry Pančevo before flow in the river Dunav

Examined parameters	pH	Oil content	Suspended matter	Turbidity	Sulfide	RSH
Meтhod	SRPS H.Z1.101/87	ASTM D 3921	DM 03019	ISO 7027	API 313	API 313
Unit		mg/l	mg/l	NTU	mass%	mass %
MAC to Law Reg.	6,5 – 9,0	2,0	30,0		≤ 0.0002	≤ 0,0002
The number of the sample						
1.	7,79	1,61	14	11	< 0,0001	< 0,0001
2.	7,95	1,45	9	7,5	< 0,0001	< 0,0001
3.	7,93	1,96	12	8	< 0,0001	< 0,0001
4.	7,68	2,1	15	9	< 0,0001	< 0,0001
5.	7,41	1,13	15	12	< 0,0001	< 0,0001
6.	7,35	1,66	5	3,9	< 0,0001	< 0,0001
7.	7,99	1,12	23	21	< 0,0001	< 0,0001
8.	8,05	0,85	14	11	< 0,0001	< 0,0001
9.	7,59	0,81	18	15	< 0,0001	< 0,0001
10.	7,68	1,74	14	12	< 0,0001	< 0,0001
11.	7,85	1,96	17	9,3	< 0,0001	< 0,0001
12.	7,95	1,54	18	22	< 0,0001	< 0,0001
13.	7,98	0,65	13	14	< 0,0001	< 0,0001
14.	7,51	0,8	16	11	< 0,0001	< 0,0001
15.	7,57	0,71	16	13	< 0,0001	< 0,0001
16.	7,98	1,73	39	33	< 0,0001	< 0,0001
17.	7,7	3,1	20	21	< 0,0001	< 0,0001
18.	7,77	0,2	5	4	< 0,0001	< 0,0001
19.	7,66	0,45	23	15,3	< 0,0001	< 0,0001
20.	7,75	0,76	4	11	< 0,0001	< 0,0001
Мин.	7,35	0,2	4	3,9	< 0,0001	< 0,0001
Max.	8,05	3,1	39	33	< 0,0001	< 0,0001
Sped.	7,76	1,32	15,5	13,2	< 0,0001	< 0,0001

The results obtained on the base of kinetic of first order are given in the table 2 , 3 and Fig 4.

Table 2: Calculated data for the seasonal average oil contents and pH relaxation rate constants

The period of acid or base hydrolysis	c_{oil}, mg/l	k_{pH},day^{-1}
17.01. -14.02. 2008.	1,67±0,3	-0,013
21.02.-7 .03.2008.	1,63±0,5	-0,017
4.04 - 1.05.2008.	1,34±0,5	-0,033
17.05. - 22.05.2008.	0,75±0,95	-0,077

Table 3: Data for the seasonal average oil contents and pH relaxation rate constants

The period of acid or base hydrolysis	Calculated rate constants day^{-1}	Sorbed water hydrolysis rate constant, k_B day^{-1}
17.01. -14.02. 2008.	$(k_N + k_{pH})/2 = -0{,}0145$	$k_B = 0$
21.02.-7 .03.2008.	$k_{pH}/3 = -k_N/3 = -k_B = 0{,}017$	$k_B = k_N/3 = k_{pH}/3$
4.04 - 1.05.2008.	$k_{pH} = (k_N + k_B)/2 = -0{,}033$	$k_B = k_N = 2k_{pH}$
17.05. - 22.05.2008.	$k_{pH} \approx -k_B \approx -k_N = -0{,}077$	$k_B \approx -k_N = k_{pH}$
25.08-4.09. 2008.	$k_{B.} = k_{pH} = -0{,}1301$	$k_N=0$

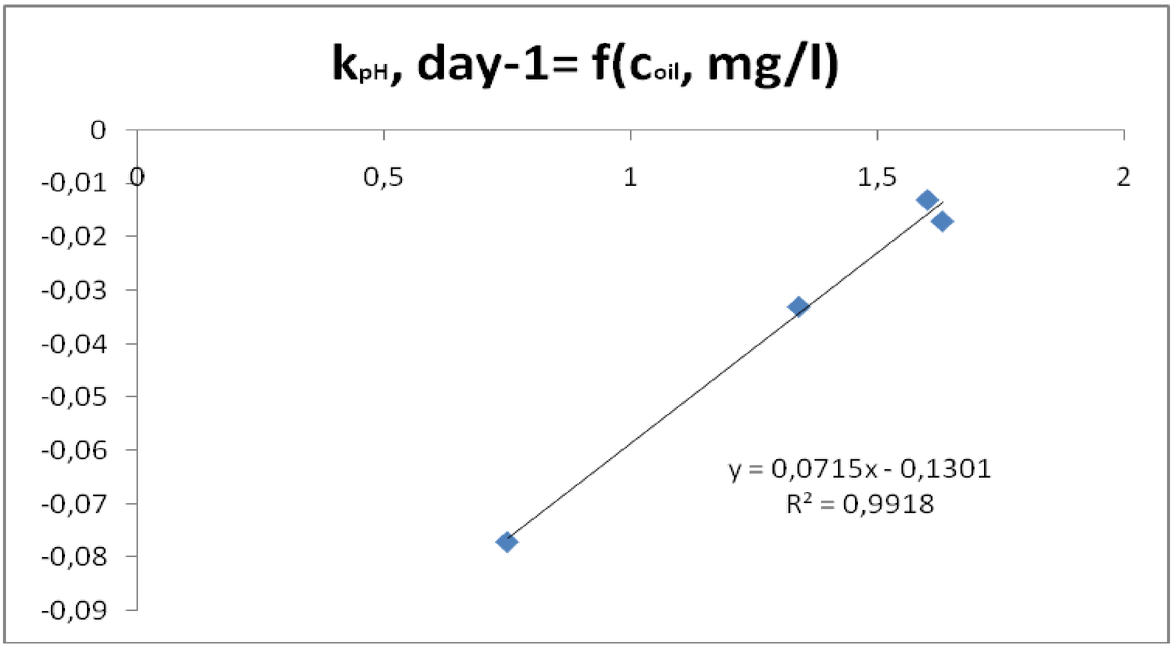

Figure 4. Functional dependence of seasonal pH change rate constant on the average oil content in the range of 0,8-1,7 mg/l

On the base of experimental data in period from January to May stationary oil contamination influenced catalytic on pH change rate constant, in the range 0,75 - 1,67 mg/l:

$k_{pH} = 0{,}0715 \cdot c_{oil} - 0{,}1301$

1. From January to May stationary oil contamination in the range 0,75 - 1,67 mg/l, less compared to MAC, motor oil content change, rate constant increased from zero in January to twice greater compared to pH relaxation rate constant in May, in the range of oil content 0,75 - 1,67 mg/l, less compared to MAC:
   - from beginn of water molecules titration by sorbed on motor oil molecules, $k_B \approx 0$ ($k_N = k_{pH}$),
   - in equivalent point ($k_B = k_N/3 = k_{pH}/3 = -0{,}017$ day^{-1})
   - in titration end point ($k_B = k_N = 2k_{pH} = -0{,}066$ day^{-1})

   In literature (Amamy, M. and Mill, T. 1984.) with the adition on moisture to oven dried clays up to limits of sorbed water, hydrolysis rate constant on organic acid, base and neutral clay particles was measured: $k_h = 0{,}04$ day^{-1}

2. In June , pH relaxation rate constant $k_{pH} = - k_B = -0,077$ day $^{-1}$, correspond with successive coupled process rate constant of oil content change rate constant which is parallel and resonance turbidity change rate constant, $k_B = k_{N\ during}$ i ncreased turbidity 20 NTU and oil content 3,1 mg/l.

3. In August / Septembar resonance of hydroxide content change rate constant and pH relaxation rate constant at hydration rate constant zero decrease turbidity up to 4 NTU. pH relaxation rate constant $k_B = k_{pH(stac)} = 0,1301$ day $^{-1}$ (Fig.4) favored purifying (oil content 0,2 -0,76 mg /l was found.

   In literature (Amamy, M. and Mill, T. 1984.) where the moisture content exceeded the limit for sorbed water , hydrolysis rate constant on organic acid, base and neutral clay particles was measured: $k_h = 0,136$ day $^{-1}$

CONCLUSION

The results of examination of the kinetic of purification of urban atmospheric water in petrochemical refinery are obtained.

It was obtained *the agreement between results for the experimental measured water hydrolysis rate constant* on organic acid, base and neutral clay particles in literature, with our results obtained for seasonal hydrolysis kinetic dependent on oil and turbidity content *during gravitational separation influenced by seasonal water temperature change*:

- up to the limits of sorbed water on dried clay in literature, with our results obtained in period from January to May
- where saturation of sorbed water is achieved in literature, with our results obtained in beginn of summer for favored hydration of organic turbidity with equal pH relaxation processes rate constant at increased stationary oil content
- where the moisture content exceeded the limit for sorbed water in literature, with our results obtained for beginn of autumn where is pH relaxation rate constant equal with oil content change rate constant.

The examination of kinetic aspect of urban atmospheric water purification in petrochemical refinery show that mass transport during gravitational separation and clarification is coupled by water sorption and water hydrolysis rates on suspended particles, in dependence of seasonal water heating rate.

REFERENCE

Minić, M., “Determination of oil and petrochemical carbohydrate in waste water optimization by using laboratoric information monitoring system”, Ending work, VTŠSS, Zrenjanin, 2008.

Mabey, W. and Mill, T.,”Critical revieu of hydrolysis of organic compounds in water under environmental conditions” ; J.Phys. Chem. Ref. Data 27, (1978), pages 383-915.

Mill, T., Bawol, R., Patrige, I., and Mabey, W., Validation and optimization of Hydrolysis Screening Test: Final report, Batelle Columbus Laboratories, contact T-6416 (7197) -030 (1981) page 86.

Amamy, M. and Theodore Mill,” Hydrolysis kinetics of organic chemicals on montmorilonite and caolinite surfaces as related to moisture content, Clay and Clays Minerals” , Vol.12 No1, (1984), page 67-73.

Sl. Glasnik R. Srbije br. 31/82, “The maximal allowed contents of hazardous substances in water”.

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INFLUENCE OF URBAN ZONE ON THE RIVER WATER QUALITY

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ABSTRACT

The water quality of urban river Begej in town Zrenjanin is of great interest for the town’s development. In this work, the physical, electrochemical and spectrochemical methods were used to determine the changed of rivers water quality in urban zone of Zrenjanin: the surface tension, pH, conductivity, phosphate, nitrite, nitrate, natrijum content, as well as some organic polutatnts on five locations through town. The classes of river water on five, different locations were calculated, as wella as the degree of self-purification degree of urban contamination degree. The obtained results are better after contact with water cane on the Begej’s coast.

Key words: River water quality, Urban zone, Influence of water cane, Influence of primary purification of PPW „Begej’s loop” in Zrenjanin.

INTRODUCTION

The water quiality of river Begej in town Zrenjanin is of great interest for the town’s development. To low regulations, quality can be defined as I, II , II and IV class of quality in dependence of phisical, chemical, physico-chemical and biological poarameters (Law regulative). In this paper on the base prior obtained results (Simić, S. 2007) by phisical, electrochemical and by spectrochemical methods (Jahić, M., Mišović, J. and standard methods, 1990)] in laboratories of High technical school, the parameters of rivers water quality were determined: the surface tension, pH and conductivity inorganic polutants phosphate, nitrite, nitrate, natrijum content, as well as organic polutatnts, fat acids, oil content, aromatesas (benzene) on five locations through town. Between five different locations degree of urban contamination and of self-purification were calculated to equation:

$$\mathbf{SP = (1 - \frac{C_1}{C_2}) \cdot 100\,\%} \qquad (1)$$

SP – The degree of water selfpurification
$\mathbf{C_1}$ **–** Pollutant concentration in the river input in the town
$\mathbf{C_2}$ **–** Pollutant concentration in the river output from the town

Figure 1. The part of river Begej after milk and oil industry, ship transport factory and beer industry location prior primary purification station PPW ”Begej’s loop”

Figure 2. The part or river Begej after location PPW”Begej’s Loop” and prior Railway Bridge

EXPERIMENTAL

The Standard method were used (Suzana Simić, 2007), chemical, physical, electrochemical and spectrochemical methods were used in laboratories of High technical school to determine the parameters of rivers water quality: the surface tension, pH and conductivity inorganic polutants phosphate, nitrite, nitrate, natrijum content, as well as organic polutatnts, fat acids, oil content, aromatesas (benzene) on five locations of river flow through town. The water quality was examined (tables 2-5) in the five locations of urban zone of Zrenjanin: Motel, Hat industry, Primary water purification plant PPW „Begej’s Loop“, Railway bridge, Lake 3 by comparing with maximal alloved contents for classes of water quality (Table 1) as well as according to equation (1).

Table 1: Maximal allowed contents for classes of the surface waters according to according to [4]

Red. br.	Parameters	Class of water, **I**	Class of water, **II**	Class of water, **III**	Class of water, **IV**
1	COD, **mg / l**	8	-	-	-
2	**pH**	6,8 - 8,5	6,8 - 8,5	6 - 9	6 - 9
3	Natrijum**, mg / l**	150	-	-	-
4	Nitritei**, mg / l**	0,05	0,05	0,5	0,5
5	Nitrate**, mg / l**	10,0	10,0	15,0	15,0
6	Phosphate**, mg / l**	0,15	-	-	-
7	Oil, **mg / l**	0,05	1	10	100
8	benzene**, mg / l**	0,5	0,5	0,5	0,5

Table 2: The river water surface tension, γ, pH, conductivity, κ values and nitrite, nitrate and phosphate content in dependence of locations in urban zone [1]

The location	**γ (mN/m)**	**pH**	**κ (mS/m)**	**Na^+ (mg/l)**	**NO_2^- (mg/l)**	**NO_3^- (mg/l)**	**PO_4^{3-} (mg/l)**
Motel	65	6,8	62	29	0,051	3,14	0,46
Hat industry	69	7	70	24	0,46	3,85	0,68
PPW”Begejs loop”	72,75	7,2	59,4	22	0,088	3,42	0,72
The railways bridge	72,75	7,2	62,1	24	0,065	3,42	0,51
The lake 3	72,75	6,9	97,6	41	0,017	2,28	0,073

Table 3: The organic matter content in river' s water in dependence of locations in urban zone [1]

The location	**Oil (mg/l)**	**Aromate(benzene) (mg/l)**	**Fat acids (mg/l)**	**Fats (mg/l)**
Motel	7,8	0,012	432	0
Hat industry	24,7	0,04	590	461
Begejs loop	600	0,92	558	343
Railsway bridge	10,4	0,016	307	103
The lake 3	23,5	0,036	630	0

Table 4: The classes of river water on examined locations in urban zone [1]

The parameters of waters quality	Motel	**Hat industry**	**PPW"Begejs loop"**	**The railwas bridge**	**The lake 3**
pH	**I**	**I**	**I**	**I**	**I**
Na^{+}	**I**	**I**	**I**	**I**	**I**
NO_2^{-}	**I , II**	**III , IV**	**III , IV**	**III , IV**	**I**
NO_3^{-}	**I , II**	**I , II**	**I , II**	**I , II**	**I , II**
PO_4^{3-}	**I , II**	**I , II**	**I , II**	**I , II**	**I**
Oil	**II**	**IV**	**IV**	**III**	**IV**
Aromate (benzene)	**I**	**I**	**IV**	**I**	**I**

The I and II class of water quality on town input, at Motel was worsed in industrial zone, for nitrite and oil, by waste water of milk and oil Industry located between Motel and Hat industra (and sheep transport factory).

At location PPW "Begejs Loop", aromate content was increased (IV class for aromate and oil) by waste water from ships transport factory.

The water quality was improved by achieving I class in the lake 3 after treatment in PPW "Begeys loop" for nitrite, phosphate and aromate. Water cane located on the river coasts after location at PPW "Begejs Loop" improved water quality up to location at Railsway Bridge, up to prior water quality of river on input in the town at Motel, by decreased oil content (I and II class, respectively).

Table 5: Calculated self-purification degree of river water between examined locations as negative value and degree of contamination as positive value, according to equation (1)

SP,% on parts of river between examined locations	Na^+	NO_2^-	NO_3^-	PO_4^{3-}	oil	aromate	fat	Fat acids	Surface tension N/m□	Disscusion
motel - Hat industry	-17,24 %	+801,96 %	+22,61 %	+47,83 %	+216,67 %	+233,33 %	0 *	+36,57 %	od 65 do 69	Contamination with inorganic and organic matter
Hat industry - PPW ”Bewgejs loop”	-8,33 %	-80,88 %	-11,17 %	+5,88 %	+2329,15 %	+2200 %	-25,6 %	-5,42 %	od 69 do 72,75	Contamination with organic matter
PPW” Begejs loop” - . Railways	+9,09 %	-26,14 %	nema prom-ene konc.	-29,17 %	-28,27 %	-98,26 %	-69,97 %	-44,98 %	72,75	Self--purification of mineral oil and fat
PPW” Begejs loop” - Lake 3	+70,83 %	-80,68 %	-33,33 %	-89,86 %	-96,08 %	-96,09 %	-100 %	+12,90 %	72,75	Self--purification of inorganic and organic contaminats

CONCLUSION

On the base of obtained results it can be concluded:

- Increased technogenic contaminate with fat acid and organic matter decreased surface tension and natrijum content on part between Motel and Hat industry, with increased waste water content from milk and edible oil industry. Increased mineral oil content on the part between Hat industry and PPW”Begejs loop” after location with ship transport factorty was found.
- Contact of contamined water with the water cane improved self - purification effect in removal of aromate, oil and fats in zone between PPW ”Begejs Loop” and Railways Bridge in presence of water cane
- Primary purification in PPW “Begejs Loop” improved about three times removal of nitrite and phosphate, compared to water self-purification processes in contact with water cane.

REFERENCES

Suzana Simić, the end graduate: “Physical Chemical examination of Begejs water quality in urban zone of Zranjanin”, High Technical School in Zrenjanin, 2007.
Jahić B dr Munir: " Purificartion of contamined water " , Novi Sad, 1990.
Mišović Jelica, Teodor Ast:" Instrumental methods of chemical analysis " Belgrade, 1994.
Officiall papers SFRJ, regulative for surface and drinking water, may 1987.
Standard Metods of Drinking Water Analysis, Economical Reviewu, Belgrade 1990.

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INFLUENCE OF WASTEWATERS OF LIVESTOCK FARMS

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ABSTRACT

There are numerous water pollutants which can be divided into:
- concentrated, and
- dispersed pollutants.

Concentrated pollutants are various premises where some kind of human activity takes place and human settlements.

Wastewaters of livestock farms contain organic substances which are subjected to the activity of microorganisms, so their chemical composition continuously changes. Testing of wastewaters before their discharging into a recipient is aimed at protection of rivers. The paper shows the results of a livestock farm waste water testing.

Key words: wastewaters, organic substances, livestock farm

INTRODUCTION

Manure is the main by-product of cattle production. Depending on the type of cattle breeding, there are two types of manure:
- Solid manure
- Liquid manure (slurry)

Manure is a biologically active matter and from the moment it is produced, it is a subject to constant change. Manure constantly changes its chemical and physical features, mostly as a result of microbiological influence. Microorganisms turn complex organic compositions into more simply forms. In the process of anaerobic metabolism compositions like amin, skatol and fatty acids are produced. Most of these compositions have unpleasant smell which causes pollution of the atmosphere, and can be conveyed into surface waters. Liquid manure presents a mixture of urine and feces and is stored in tanks which are built near the barns. The overflow system transports all manure into a concrete pit where it is pumped into tanker trucks and taken away. Daily production and a content of manure are given in the tables 1 and 2.

Table 1: Daily production of feces and urine by a cattle

Category	Amount (l/day)	Feces (kg/day)	Urine(l/day)
Calf 6 months 10 5kg	7	5	3
Cattle1 years 250 kg	13	13	6
Cattle 1−2 yers 440 kg	26	22	14
Cattle 550 kg	32	28	17

Table 2: Content of liquid manure

Macro-elements	N_2	NH_3	P_2O_5	K_2O	Ca^{+2}	S^{-2}
Amount (kg/m^3)	2,76	1,13	1,68	2,52	1,2	0,37

In the sense of pollution, liquid manure production presents bigger problem than the production of solid manure. Liquid manure is treated in many ways which include aeration, separation, anaerobic fermentation and chemical additives addition. Concerning what is stated above, during the work on the farm, some negative side effects on surface waters and ground waters are possible.

While depositing waste on cropland, it can easily come into contact with surface watercourses and ruin their ecosystems. If the waste comes into contact with ground waters, they can be polluted which can ruin the quality of drinking water. If a great amount of waste is used on cropland there is a possibility of soil pollution and ground waters pollution. Disinfectants which are used for barn disinfection can affect surface and ground waters quality.

Certain parameters are tested on waste which is run off into waterways. If the quality of waste water (clarified manure) satisfies the standards, i.e. if the quality of the waste waters matches the quality of the waterways, it can be run off into it.

MATERIAL AND METHODS

Laboratory studies are carried on waste waters from a cattle farm. All the analyses are done in accordance with Standard Metods for Examinination of Water (1995).

RESULTS AND DISCUSSION

A unique scheme for measuring waste waters pollution can not be set. Which parameters will be used as a pollution criteria, primarily depend on the nature of water pollution. Water pollution can be defined according to: color, smell, amount of suspended particles, ash content, pH, active acidity, content of certain chemicals etc.

Organic and inorganic matters which can be oxidized present the major waste waters danger. Content of the matters which can be oxidized presents the basic and almost the only general criteria for polluting waste waters. Content of these matters can be presented via different types of indicators: permanganate number, ultimately use of oxygen, chemical use of oxygen, biochemical use of oxygen and direct use of dissolved oxygen.

Quality of surface waters is defined in Regulation (1978) of water classification , according to which, surface water can be divided into four classes depending on the level of pollution and its use.

Table 3: Water classification

Nmb.	Indicator	Class I	Class II	Subcl. Iia	Subcl.Iib	Class III	Class IV
1.	Suspend.particles	10	30	30	40	80	/
2.	Dry residue(mg)	350	1000	1000	1000	1500	/
3.	pH	6.8−8.5	6.8−8.5	6.8−8.5	6.5−8.5	6.0−9.0	/
4.	Dissolved Oxygen	8	6	6	5	4	0.5
5.	BPK5	2	4	4	6	7	/
6.	Degree sapr.	Oligosa pr.	Betamezos apr.	Betamez os.	Betaalfa.m ezosapr.	alfamez o	
7.	HPK		12			20	

Results of the research of waste waters on a cattle farm, as well as MDK values from the Regulation (1982) of wastewater quality and the ways of their run off into the public sewer and natural recipient are given in the table 4.

Table 4: Results of research

Compound name	Number 1	Number 2	Number 3	Number 4	Subclass IIb
Nitrite(mg/l)	0.19	0.20	0.185	0.19	0.5
Nitrates(mg/l)	0.5	0.48	0.40	0.45	40
phosphates (mg/l)	13	12.7	12.4	13.2	1.0
PAM cation.	0.19	0.18	0.16	0.20	0.5
PAM anion.	0.25	0.30	0.21	0.35	0.5
Sulfides(mg/l)	0.5	0.65	0.55	0.69	0.1
NH_4^+	14	11	15	13.7	0.5
Total N_2	22	19	27	21	/
HPK(mg O_2)	204	195	253	224	45
BPK(mgO_2)	45	35	52	48	30
Total fat	5.4	4.9	5.8	5.2	5.0
Iron	0.5	0.54	0.63	0.48	1.0
pH	8.32	8.28	8.15	8.41	6.5−9
Dry residue	1182	1413	1276	1083	1000

According to the received results, it is concluded that waste waters can be run off into the recipient, DTD canal (the quality of the recipient is IIb category).

Value of HPK in mg/l goes from 195 to 253 which is considerably more than the quantity given in the Regulation (1968) as permissible limit. Load index, allowed HPK and measured HPK, is from 4.33 to 5.62.

Value of BPK in mg of oxygen/l goes from 35 to 52 which is more than the allowed value. Comparing the permissible limit given in the Regulation of waste water classification (1978) which is 6mg of oxygen, the found value is 6 to 9 times higher oxygen consumption.

Content of the dry residue is from 1083 to 1413 mg/l. comparing the quality of the water of the recipient, the amount is from 8 to 41% higher. Content of the dissolved substances is harmful in two ways.

They use oxygen dissolved in water for the oxidation which increases pollution, and in the case of oxygen scarcity anaerobic processes are activated and they produce compounds with unpleasant smell and pollute the atmosphere.

Mineralization of organic matters in the anaerobic process can be presented with the given scheme:

$$\text{Organic matter} \rightarrow CH_4 + CO_2 + H_2S + Q$$

Content of sulfides is five times higher than the permissible limit. Sulfides are undesirable in water especially because of the stench and because they use dissolved oxygen of the recipient in the process of oxidation.

Formation of ammonia out from complex organic compositions, primarily from proteins can be presented with the reaction:

$$R{-}NH_2 + H_2O \rightarrow NH_3 + ROH$$

Presented reaction is the first step in the process of mineralization of the organic matter which reacts with water creating ammonium ion. In the second step ammonium ion is transformed into nitrite by the process of nitrification, and nitrates are created in the process of nitration. All the presented forms of Nitrogen are easily absorbed by plants. Release of ammonia as a gas depends on temperature. In summers, evaporation is greater which contributes the atmosphere pollution.

The concentration of ammonia exceeds the permissible limit by many times. Water with a high content of ammonia has base character (www.cecra.dh.pmf.uns.rs). As well as sulfides, ammonia uses dissolved oxygen in the process of oxidation. Reduction of the content of dissolved oxygen increases pollution of waterways. There is a danger of eutrophication, enrichment of nitrogen compounds, which causes accelerated growth of algae and higher plant species which disturbs natural equilibrium (www.regjeringen.91/676EEC).

Content of nitrite and nitrates is within the permissible limits.

Total fat go from 4.9 to 5.8 which, according to the Regulation (1968), is a non permissible limit, from 8 to 16% higher. Increased content of fat is non desirable because it floats on the water surface and reduces oxygen production in water.

Amount and quality of liquid manure depends on the amount of water used for shed cleaning and on a diet. Dry matter in manure in EU is 6-7%, and in Serbia is 1-5% which is a result of high water consumption.

CONCLUSION

In the work are presented results of the research of some of the parameters of the waste water quality on a cattle farm. Results showed a huge organic load presented in BPK5, HPK indicators and a content of dry residue. Content of ammonia and sulfides are above the permissible limits.

Content of phosphates also exceeds permissible limits.

Content of iron and detergents (PAM) is within the permissible limits.

From the presented results, it is obvious that water should not be run off into the recipient, i.e. the treatment was not implemented all the way.

Beside industry, agriculture can have negative impact on the environment. The greatest level in the sense of industrialization within the agriculture, is made in the field of animal husbandry (cattle breeding). Increasing the number of cattle, brought a new problem of adequate storage and use on the existing cropland. Because of the stated above, the pressure on the environment and its pollution is increasing. Use of manure is limited to 170 kg of nitrogen per acre annually. This raises a new question, the need for storage and keeping manure without any bad influence on the environment.

REFERENCES

http:/ www.Istokar.bg.ac.rs

Odluka o maksimalno dopuštenim koncentracijama radionukleotida i opasnih materija u međunarodnim vodama i priobalnom moru Sl. List SFRJ br. 8/78.

Pravilnik o opasnim materijama Sl. Glasnik SRS br. 31/82.

Standard Metods for Examinination of Water and Wasrerwater- In: M.H. Franson (Ed.), 19th Editrion. American Public Health Association, Washington (APHA), Dc 20005, 1995.

Uredba o kategorizaciji vodotoka Službeni Glasnik SRS br.5/68.

Uredba o klasifikaciji voda međurepubličkih vodotokova, međudržavnih voda i voda obalnog mora Jugoslavije Sl.List SFRJ br.6/78.

www.cecra.dh.pmf.uns.ac.rs

www.regjeringen.91/676EEC

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SEASONAL TEMPERATURE INFLUENCE ON PRIMARY PURIFYING OF URBAN RIVER WATER

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ABSTRACT

Primary purifying of urban river water by primary purifier of water PPW enable to improve quality of Begejs water in urban zone of the town Zrenjanin, by purified water accumulation containing three lakes with name “Begej's loop”, from 1987. The intention of examination in this paper is to explaine by the seasonal temperature influenece, why satisfying purification efficiency by the treatment in beginn of autumn by much more chemicals consumption can be achieved, compared to treatment in beginn of summer.

Key words: Primary purifying, Raw water temperature, Oxygen adsorption affinity, Relaxtion processes.

INTRODUCTION

Though the industrial production in the town Zrenjanin (with more than 100 years developed industry) was from 1989. in decreasing trend, it made negative effects on environment so on the urban river Begej. In the town from 1987., accumulation were made “Begejs loop” with three lakes which were supplied with dirthy begej's river water after purifying by primary treatment of water in primary purification plant (Fig 1 and 3), PPW with automatic controll of added chemical (Fig 2).The best effecs are achieved in the phosphate and nitrite purifying and the worse in organic matter purifying , according to lit (Simić S., Ševaljević, M., 2011).

According to literature (Brewer, R. 1979), liquid water temperature is dependent on: absorption of the sunn light, season, water deepness , width and volume, vegetation on the coasts, industrial effluents. After winter stagnation with ice on surface, water temperature on the bottom is 4 ^{o}C and in spring water with less density above more compact layers force mixing of the whole mass water and achieving stationary temperature 3-10 ^{o}C in the whole lake. Increasing surface temperature rate in begin of summer (or by human activities) make faster heat energy input rate in one layer, in comparison with heat conduction rate in other layers. Result is stratification in three layers of water in lake , with different stationary layer temperatures: 22-25 ^{o} C in epi-limnion on surface; (10-20 ^{o} C in meta-limni or termo-clima in the middle and 4-5 ^{o} C in hipo-limnion on bottom ofr lake. In autumn the slower surface heating rate achieve heat transport rate in water which enable mixing between layer up to the stationary layers temperature 3-10 ^{o} C, in the whole lake, up to November and winter stagnation.

The intention of this work is to examine seasonal temperature change influence on primary water purification efficiency. In our examination the seasonal temperature were monitored as well as the water quality parameters at beginn of summer and in beginn of autumn. Understanding of the seasonal temperature change dependent processes enable to choose the purifying regime with better economical efficiency. The examination of kinetic aspect of urban atmospheric water purification in petrochemical refinery (Ševaljević, M; Minić, M., 2011) show that mass transport during gravitational separation and clarification is coupled by water sorption and water hydrolysis rates on suspended particles, in dependence of seasonal water heating rate. Thermodynamic aspect of urban ground water purification in adiabatic conditions show the ions content during turbulence of transported un-aerated water as well as flocculation and aggregation effects are dependent on Gibbs free energy change achieved on contact surfaces between liquid, solid and gas phase in dependence of surface chemical potential equilibrium of components (Joža, R.; Ševaljević, M, 2011).

Figure 1. Begej's river water, Dozier pumps for chemicals in PPW, Reactors 1 and 2 in PPW and lake 3

MATERIAL AND METHODS

By primary treatment the water quality has to be achieved according to the regulative, EU 98/83/EC by adding of chemicals, dosed by jar test: $Al_2(SO_4)_3$, $Ca(OH)_2$, anjonic polielektrolyte (110), with automatic control (Fig. 2).

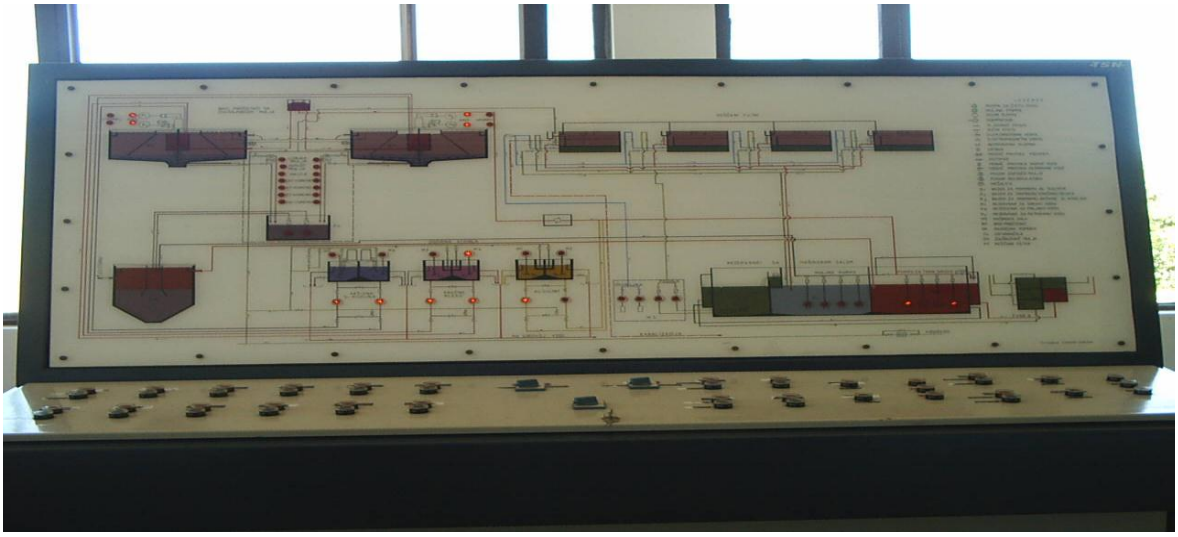

Figure 2. Control Table of PPW »Begejs loop« in Zrenjanin

Figure 3. Reactor in work

According to conservation law (Gilbert, M. Masters, M., 1995), in un-stationary sistem stationarycontent of nitrite, organic matter, and phosphate neutralisation in purified water in PPW determine kinetic aspect (transport, accumulation and degradationa rate constant) also:

$$d(cV_L)_{out.}/d\tau - d(cV_{in})/d\tau + d(cV_L)_{acc.}/d\tau - k_{degr}V_L c = 0,$$

where:

$$c - c^* = (c_0 - c^*) \cdot e^{-(k + q_G/V_L)\tau}$$

Prior successive adding of chemicals (optimized by jar test) on 5 locations: input of raw water signed as (1.1), reactor 1 (1,2), reactor 2 (1.3), basen prior filtration (1.4) basen after filtration (1.5). in equal time intervals.

Monitoring in the laboratory of "Waterwork", Zrenjanin, by Standard Methods was carried after stationary state was achieved of the water quality parameters*:*

- $\Delta G^{\theta}(O_2)$, kJ/mol, oxygen Gibbs free energy change
- COD, mg/l , organic matter content, as consumed oxygen demand, by kalijum permanganate
-$[NO_2^-]$, nitrite conten and $[PO_4^{3-}]$ phosphate content, mg/l
- $\Delta Y_{1.x}$, % = $(Y_{1.x}.-Y_{1.1.})/Y_{1.1.}$, purifying efficiency Y (PO_4^{3-}, NO_2^- and COD, mg/l), x= 2., 3., 4., 5.
- temperature, t ^{o}C
- TSM, mg/l, total soluble matter content
- κ , µS/cm, conductivity
- $[O_2]$ oxygen content, mg/l
- pH , negative logaritm of oxygen ions concentration

RESULTS

The monitoring results in Fig. 3 are interpreted from kinetic aspect, in the two treatments of water in PPW:

- by temperature increasing from 21,7 - 24 ^{o}C, in beginn of summer from June 22 – July 14, 2009,
- and temperature decreasing 18,5 - 14 ^{o}C, in beginn of autumn from September 24 - October 19, 2010.

The relaxation periods of gradients between parts of purification system of temperature, pH , conductivity, TSM,and Oxygen content were found on the base of monitoring data:

Temperature gradient relaxation enable pH gradient and oxygen gradient relaxation processes with equal rate constants $k=1/\tau$ (Fig. 4 and Fig. 5):

- in summer treatment at pH 7, after 15 days from treatment beginning (July 6), by pH gradient relaxation processes, $k_T = k_{pH}$, where the peak of oxygen content with rate constant 0, 66 day^{-1} was detected in water input during decreased content in other parts of the purifying system. The resonance with activation rate constant processes of successively increased TSM and conductivity is found: $k_\kappa = - k_{pH} = 0{,}066$ day $^{-1}$
- in autumn at pH 7,2; pH 7,6 and pH 7,4 after 7 days from treatment beginning and successively two times, with rate constant, $k_T = k_{pH}$ in resonance with conductivity gradient successively activated relaxation processes: $k_T = k_{pH} = k_\kappa = 0{,}14$ day $^{-1}$
- in autumn after processes of flocculation and aggregation , stationary oxygen content, conductivity and TSM, without gradient between parts of system is achieved.

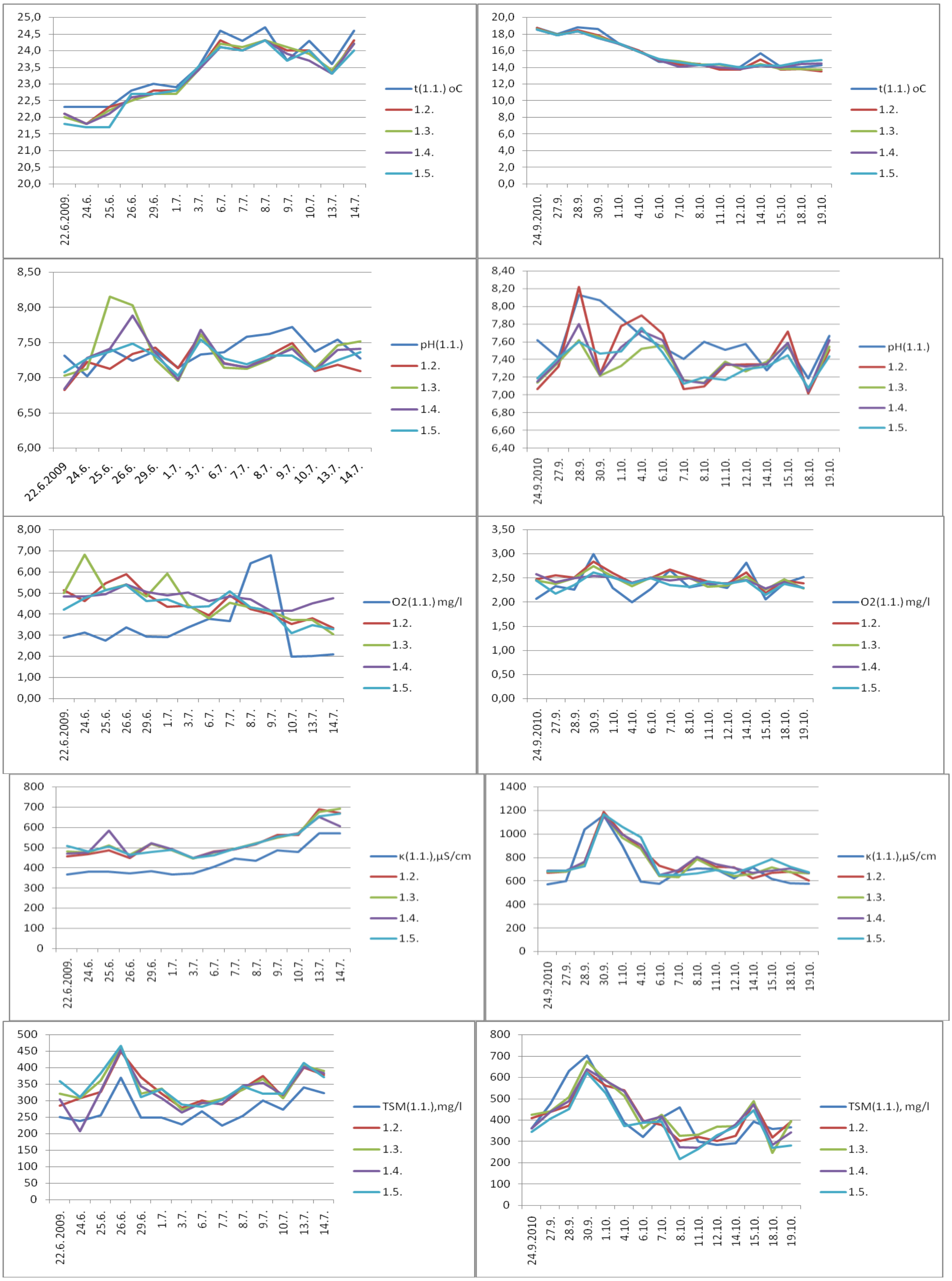

Figure 4. The monitoring results of water temperature, pH, conductivity, total soluble matter, content TSM and oxygen content in water in summer and autumn on 5 locations: input of raw water signed as (1.1), reactor 1 (1,2), reactor 2 (1.3), basen prior filtration (1.4) basen after filtration (1.5).

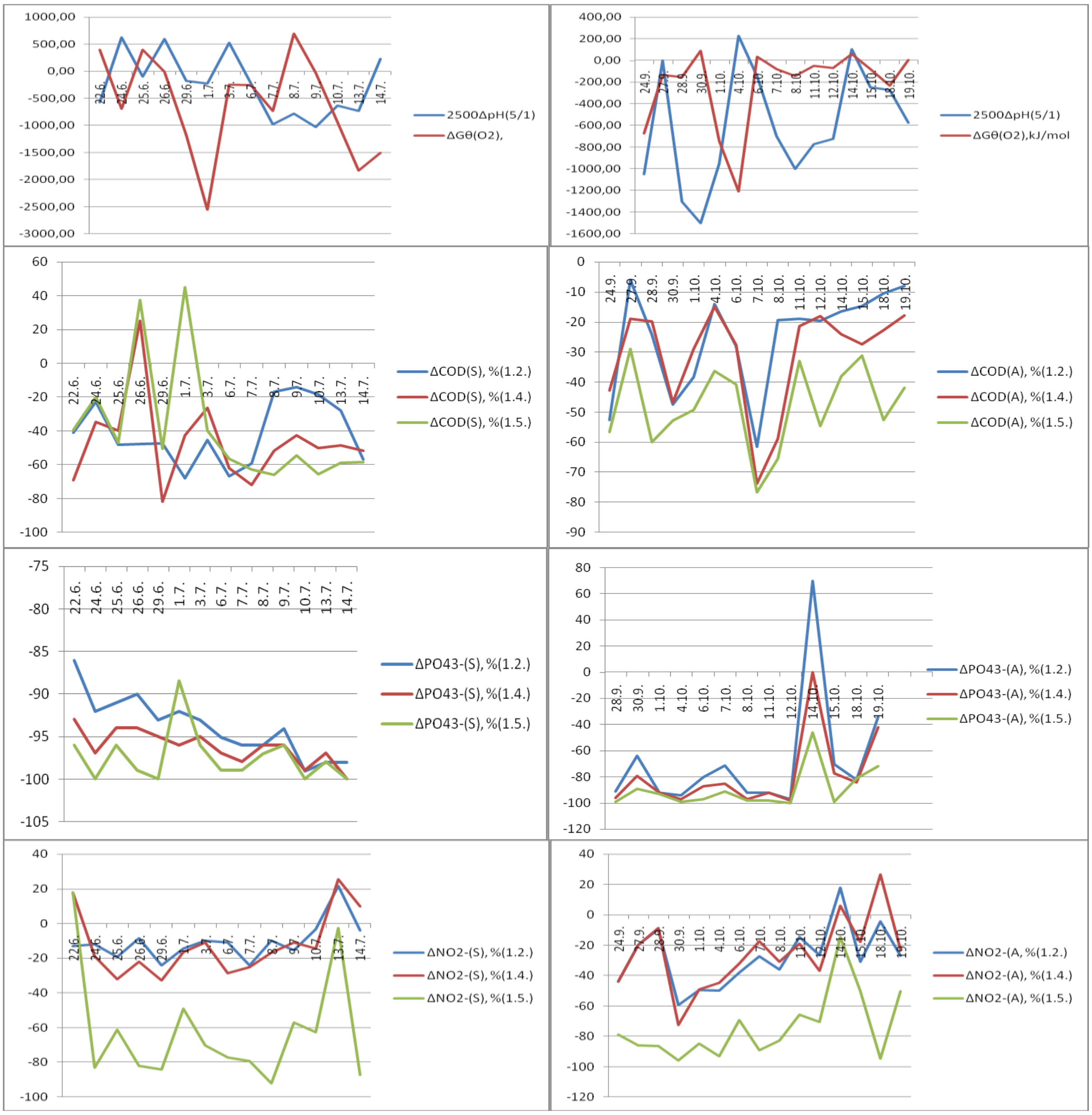

Figure 5. The monitoring results of oxygen adsorption affinity and pH gradient between input and output of river water, COD, nitrite and phosphate purifying efficiency, on ocations in reactor 1 (1,2), basen prior filtration (1.4) basen after filtration (1.5), in summer and autumn treatment

The monitoring results in Fig. 5 are interpreted from thermodynamic aspect on the base of contact surfaces between floccules/gas oxygen/ liquid water polarisation, by negative Gibbs free energy change in beginning and positive in the end point of oxygen gradient content, during oxygen gradient relaxation processes, influenced on reach of indicators of relaxation procesases:

$R\text{-}COOH = R\text{-}COO^{-} + H^{+}$,
$H_2PO_4^{-} + OH^{-} = HPO_4^{2-} + H_2O$
$NO_2^{-} + 2OH^{-} = NO_3^{-} + H_2O + 2e$

1. In summer treatment maximum of oxygen adsorption affinity change (equal with Gibbs energy of ions exchange reaction, between Al-sulphate and Ca-hydroxide -2555 kJ/mol)

oxygen adsorption is not influenced by *sorbed water production and hydrolysis.* Organic matter, phosphate and nitrite neutralisation are indicators of end points *of saturation state of sorbed* water during oxygen gradient content in water input relaxation processes.

2. In autumn, maximum of oxygen adsorption affinity change is indicator of beginning of stationary conductivity period where *the moisture content exceeded the limit for sorbed water* and relaxation enable Gibbs energy of Al-sulphate hydrolysis, -1834 kJ/mol). Produced water consumption during pH relaxation processes favor organic matter, phosphate and nitrite removal as indicators of end point of gradient temperature and pH relaxation neutralisation titrations at stationary conductivity.

CONCLUSION

Seasonal temperature influence on primary purifying efficiency of urban river water. Greater purifying efficiency of phosphate, nitrite and organic matter (100, 80 and about 60 % respectively) was achieved in summer *by less consumed chemical during treatment,* compared to autumn (80, 50% and about 50% respectively).

By detailed understanding influence of kinetic and thermodynamic aspect of thermal and mass transport of contaminants during relaxation processes in water purification based on surface polarization with added chemicals, forced (in summer) or spontaneously (in autumn), optimized purification regimes could be choose.

REFERENCES

Directive EU 98/83/EC.

Standard Metods of Drinking Water Analysis, Economical Reviewu, Belgrade (1990).

Brew er, R., Principes of Ecology, W.B.Saunders Company, Philadelphia, London, Toronto, 1979.

Ševaljević, M., Tošić, D. , Manigoda. T. The 40th Annual Conference of the Serbian Water.

Polution Control Society , “WATER “2011”, Zlatibor 7.- 9. Jun.”Determination of the Gibbs free Energy of dissolved Oxygen in the water of Begejs loop system in Zrenjanin”.

Mabey, W. and Mill, T.,”Critical revieu of hydrolysis of organic compounds in water under environmental conditions”; J.Phys. Chem. Ref. Data 27, (1978), pages 383-915.

Mill, T., Bawol, R., Patrige, I., and Mabey, W., Validation and optimization of Hydrolysis Screening

Test: Final report, Batelle Columbus Laboratories, contact T-6416 (7197) -030 (1981) page 86.

Gilbert M. Masters.M, Introduction to Environmental Engineering and Science, CRC Press 1995.

Ševaljević, M. M., Minić, M, Seasonal kinetic aspect of purification of urban atmospheric water in

Petrochemical refinery, I International Conference ECOLOGY OF URBAN AREAS 2011, Zrenjanin, 30th September 2011.

Joža , R, Ševaljević, M,., Thermodynamic aspect of urban ground water purification, I International Conference ECOLOGY OF URBAN AREAS 2011,Zrenjanin, 30th September 2011.

Simić, S., Ševaljević, M., 2011, Influence on urban zone on the river water quality, I International Conference ECOLOGY OF URBAN AREAS 2011, Zrenjanin, 30th September 2011.

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„ECOLOGY OF URBAN AREAS“ 2011

IN SITU REMEDIATION WITH OIL/WATER MICROEMULSIONS

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ABSTRACT

Microemulsion is widely used for extracting pollutants from contaminated soil. We studied oil/water microemulsions of the rape oil (RO) and rape oil methyl ester (RME) as oil components and alkyl polyglycol ethers $C_{12/14}EO_7$ as a surfactants. Our specific goal was extraction experiments of pyrene from highly contaminated fine soil fraction. These experiments were characterized by various extraction parameters. Here we found that rape oil methyl ester accelerates the extraction and leads to higher equilibrium concentration of pyrene and it is meaningful to wark by lower surfactant concentration, not higher than 5%.

Key words: microemulsion, polycyclic aromatic hydrocarbon, non-ionic surfactant, extraction.

INTRODUCTION

Industrial processes often generate environmental hazards. The contaminants can be transported from the upper to the lower levels of the soil. Especially when contaminants reach an aquifer a danger for the groundwater quality arises as the contaminants can be distributed by the groundwater flow. Depending on the species and the distribution of contaminants in the soil different remediation principles are possible. In situ remediation the soil matrix is not moved. Polyciclyc aromatic hydrocarbons are organic contaminants. They are no movable as phase. They are adsorbed contaminants. Polyciclic aromatic contaminants can only be extracted from the soil by insertion into surfactant micelles (solubilisation).

Microemulsions are thermodynamically stable, fluid and macroscopically homogeneous, optically isotropic dispersions of two or more immiscible liquids which are stabilized by an interfacial film of surfactant molecules. Microemulsions have been an interesting subject for the past decades. They have been successfully applied to separation, chemical reactions, and materials synthesis, M. Ilic et al. (2005).

The extraction of organic pollutants like polycyclic aromatic hydrocarbons from fine soil fractions with bicontinuous microemulsions has already been investigated by several autors, Clements et al. (1993), Bankhoff et al., (1994a). This bicontinuous microemulsios with a high amount of surfactant and oil show good extraction behavior. By reducing the temperature after the extraction step these microemulsions separate into an oil phase enriched with the pollutants and a surfactant rich water phase can be used again for the next extraction step. The oil phase with the contaminants and small amounts of surfactant can be biologically degraded or thermally treated.

An oil/water microemulsion consists of water, oil and surfactant. The concentration of surfactant can be low, but celles are expanded to a certain limit by must exceed the critical micellar concentration (c.m.c.), to form micelles. The inner core of these micelles is expanded to a certain limit by added oil. Additional oil would lead to phase separation. Oil/water microemulsions are low-viscous and exibit good wetting behavior besides small surface and interfacial tensions.

Oil/water microemulsions can be applied to in situ soil remediation. Organic pollutants such as polyciclyc aromatic hydrocarbons can be solubilize by bicontinuous microemulsions, Bankhoff et al. (2004b).
For the soil remediation experiments alkyl polyglycol ethers (C_nEO_m with n = number of C-atoms in the alkyl group and m = number of exthoxy groups) were therefore chosen as surfactants and rape oil as oil componentes. These substances were determined to be non-toxic and biodegradable.
The actual research programme has so far been focused on polycyclic aromatic hydrocarbons as contaminants.

BATCH EXPERIMENTS AND DISCUSSION

Experiments were performed with a highly contaminated fine soil fraction. C 12 and C 14 alkyl polyglycol ethers with 7 ethylene oxide units are a commercial nonionic surfactants from BASF AG Ludwigshafen, Germany. Rape oil and rape oil methyl ester are from Zrenjanin, Serbia.

In most cases the extraction solutions were analysed by UV-derivate spectroscopy to determine the concentration of pyrene as one representative of the polycyclic aromatic hydrocarbons groups. The initial concentration of pyrene in the soil fraction was analysed by HPCL or GC after extraction with hot toluene.

In figure 1 is shown critical micellar concencentration (c.m.c.) for $C_{12/14}$ EO $_7$.

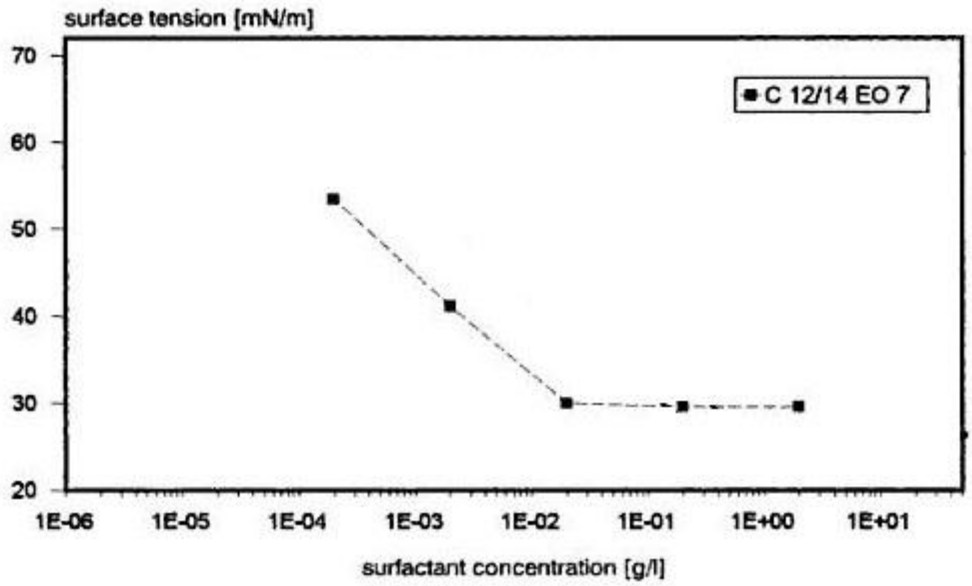

Figure 1. Critical micellar concentration for surfactants $C_{12/14}$ EO_7

The maximum solubility for pyrene in the surfactant solution is shown in figure 2. The surfactant solution samples were shaken with excess pyrene for 48 h and allowed to settle for 24 h.

Kinetic measurements with oil/water microemulsions and two surfactant solutions were performed with the surfactant $C_{12/14}$ EO_7. Experiments were performed with a highly contaminated fine soil fraction. The o/w microemilsions consisted of 5% surfactant and 0.5% oil. By the use the rape oil the equilibrium concentration of pyrene is lasse then for the pure surfactant systems. Rape oil methyl ester, hoewer, always accelerаters the extraction and leads to higher equilibrium concentrations of pyrene. The mass ratio of extractant/soil was 6/1.

Figure 3 shows kinetics of the pyrene.

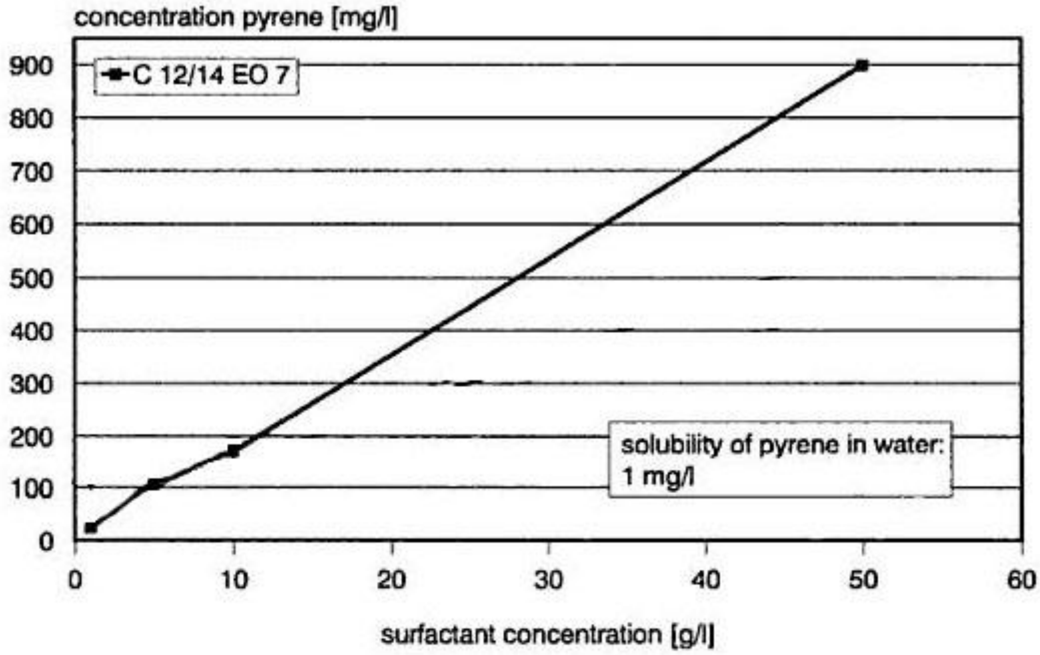

Figure 2. Solubility for pyrene in the $C_{12/14}$ EO_7 surfactant solutions

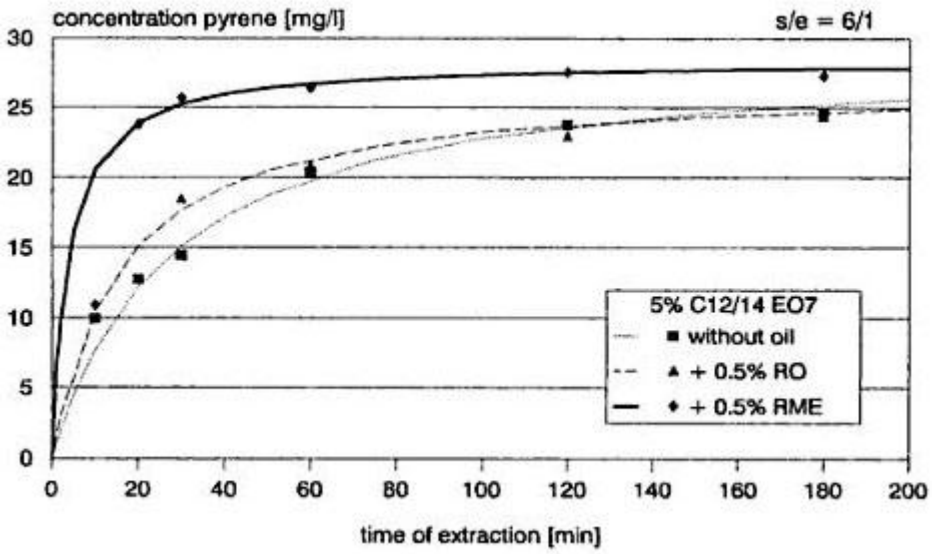

Figure 3. Kinetics of the pyrene uptake from a fine soil fraction with pure surfactant and oil/water microemulsions systems

In order to discover the suitable amount of surfactant and oil the surfactant concentration was varied from 0.1% to 10% showing a non-linear rise of the extraction result with increasing $C_{12/14}$ EO_7 content in figure 4. In the case of the o/w microemulsion the ratio of oil/surfactant was kept at 1/10. It is not meaningful to work with higher surfactant concentrations then 5%.

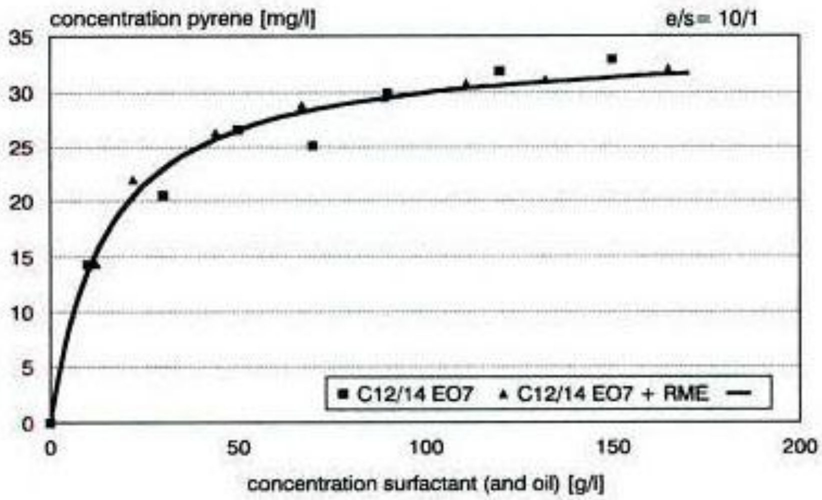

Figure 4. Pyrene uptake from soil fraction as a function of surfactant (surfactant + oil) concentration

1% and 5% solutions as well as o/w microemulsions with 5% surfactant and 0.5% oil were selected for the systematic extraction experiments. In figure 5 the extraction results for the 1% and 5% surfactant solutions show differences in efficiency with increasing surfactant concentration.

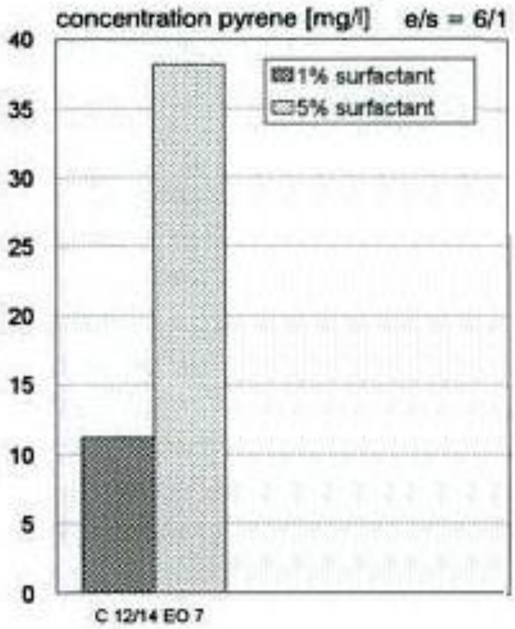

Figure 5. Pyrene extraction with surfactant solution

Use of rape oil methyl ester improves the uptake of pyrene. This is shown in the figure 6.

In comparison to pure surfactant solutions these oil/water microemulsions show a higher solubilization capacity for pyrene.

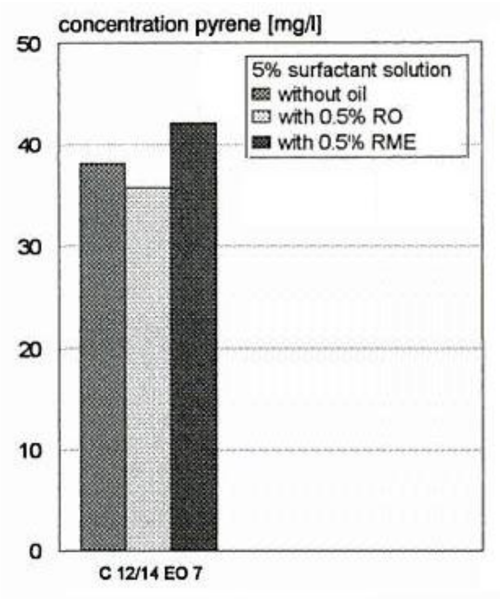

Figure 6. Pyrene extraction with surfactant solutions and oil/water microemulsions

SUMMARY

Polycyclic aromatic hydrocarbons in contaminated soil can extracting bay oil/water microemulsions. Oil/water microemulsions have high solubilization capacity for polycyclic aromatic hydrocarbons. They are very suitable for in situ soil remediation. None-ionic surfactants, alkyl polyglycol eters, $C_{12/14}$ EO_7 and natural oils were tested for the selection of oil/water microemulsions.

The results are basic investigation for in situ soil remediation with oil/water microemulsions and illustrate the advantages of these extraction media. In comparison to pure surfactant solutions these oil/water microemulsions show a higher solubilization capacity for for oganic pollutants like pyrene.

REFERENCES

Ilic M., Haegel F.H., Zlatanovic S., Potkonjak N. and Simonovic B. (2005). Microemulsion with aromatic oil as cleaner media for electropolymerisation, *Environmental Chemistry Letters*, , Vol. 3, 82-85.

Clements, W. D., Haegel, F.H. Schwugwer, M. J., Stickdorn, K, Subklew, G., Webb, L. (1993). *Contaminaited Soil ‘93*. Vol. II, Kluwer academic Publischers, Dordrecht, 1315-1323.

Bankhoff, K., Clemens, W. D., Haegel, F., H. and Subklew, G. (1994). Proceedings of the International *Conference and Course on Cost efficient acquisition and Utilization of data in the Management of Hazardous waste sites*, Waste Policy institute, Herdon , Virginia.

Bankhoff,K., Wittmann, M., Haegel, F.H. and Subklew G. (1994). Fremdstoffe in Boden, Bonn-Bad Godesberg.

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ECOLOGICAL MANAGEMENT IN ENVIRONMENTAL PROTECTION

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ABSTRACT

The determination of the ecological situation in different countries and regions is a result of lack of concern for a healthy environment. Most of the global ecological problems associated with air pollution. It turned out that acid rain may fall, and far from sources of pollution. Parallel to the increase of energy consumption, industry development, growth, followed by air pollution emissions that form acid gases (sulfur dioxide and nitrogen oxides) - this issue is gaining a global character. Anthropogenic chemical substances into the environment due to different routes. By the ecological complex situation and therefore there is, which has long considered that the basic natural components, which man uses in its production activities, practically inexhaustible. This explained the complexity it is necessary to introduce environmental management as a separate discipline that will manage environmental resources.

Key words: management, ecology, environment.

INTRODUCTION

Careful examination of the current content can be seen that no objects with the name of "ecology" or "environmental protection". Furthermore, if the analyzed curriculum, the impression would be disappointing. Taking into consideration real need of man for the environmental achievements of the sign, it opens a serious question of innovation of existing curricula in terms of introducing environmental content, as a separate subject, "modules" inserted in the programs of individual subjects. Managers are in position to make decisions in the field of technological and economic development, based on the concept of stable and harmonious - sustainable development, taking into account the social, health, political, ethical and cultural factors. Sustainable development takes into account the cross-border spread of air pollution, climate change, protection and management of natural resources, protection of oceans and coastal areas, the quality of drinking water supply resources and waste management. Global risks in the field of genetic and biological resources are forced to switch to a balanced development, which must necessarily be accompanied by incentives and regulatory measures.

ECOLOGICAL MANAGEMENT

Term definition and management

Environmental management is a young scientific discipline emerged in the ecology of the end of the last century with the aim of reducing the impact of the minimum dimensions of technological development on the biosphere and the survival of living beings.

The word 'management' means management, leadership, management, and when it comes to the environment, would mean the environmental management of various forms of pollution. [3]

The subject of environmental management would be the comprehensive result of the study of anthropogenic impact of economic and technological development on ecosystems.

The goal of environmental management is to change the current state of pollution and environmental degradation, using methods of ecological engineering, legal and economic instruments.

The main objectives of environmental management

Environmental management based on fundamentally new concepts for solving environmental problems at the time of frequent and numerous local and global environmental catastrophes. As a subject, environmental management includes knowledge about the impacts anthropogenic impact of economic and technological development on the environment. Environmental management in industry involves the management of industrial enterprises with the acceptance of environmental requirements and standards (ISO 14000). This, at the micro level, scope, and highlights: [6]

1. Strategic planning and management
2. Implementation of environmental surveillance and control of all business activities and actions
3. Absolute control and external verification of environmental performance of companies
4. Acceptance of environmental responsibility

Ecological management, with its functions, part of the overall enterprise management system that includes organizational structure, processes, procedures, resources for implementing environmental policy and responsibility in an organization. The task of environmental management is to ensure the availability of environmental issues when making business decisions at all levels of management.

Application of environmental management that allows businesses to plan and economically solve environmental problems, with emphasis on prevention. In this way, reduce environmental costs and reduced environmental risk and risk of incident. Without such a structured management, environmental costs incurred as a result of the incident, are much higher. Although at first the introduction of environmental management systems seems costs are high, long-term measured results (increased efficiency, more efficient use of raw materials, energy and waste) show savings.

ENVIRONMENTAL PROTECTION

Environment as a system

Environment as an area of research at the beginning of XXI century, attracting the attention of scholars and practitioners from different professions. They often explore in detail the various subsystems of the spatial environment, which reflect and concretize the scope and objectives of their study. The environment is often considered as a system of interconnected systems: the natural environment, social environment, housing, environment, cultural environment, information environment. Depending on the scope and objectives of the research, it is possible to observe the environment of each person (etc cabin astronaut), family (etc flat, detached house with associated), a group of people (etc. population urban districts), of all mankind. Practical need to observe and concretize the scale and objectives of their study: Anthropogenic environment, which is seen as a natural environment with changes conditioned by human activities, quasi-natural protection as a system converted by the human (cultural), the natural landscape created by man, including planting of park type, urban environment as a combination of natural conditions and construction of architectural forms, creating conditions for economic activity and life of man and with her influence on the social organization of man - Housing environment consisting of living conditions in residential areas, a complex that includes physical, chemical, biological, social and psychological factors. It is formed by outside influences, in relation to the room, The impact of building construction and safety of their treatment, environmental factors, activities and social factors (refers to the family, between neighbors, tenants, etc.), cultural environment that makes the conditions for the existence of materially and spiritual spheres of human life, which includes the subject results human activities, national and ethnic characteristics established for centuries, as well as human strength and ability shown by human activity. Environment settlements, urban environment, urban and rural, as a combination of man-created conditions of life: roads, sidewalks, houses, sanitary infrastructure, climate the city and the like, - a working environment consisting of physical, chemical and biological conditions at production facilities. Form the external natural and anthropogenic impacts, impacts the entire industrial zone, traffic, etc., Conditions in the workplace, the conditions in the community with social and psychological environment in the collective you - Socio-psychological environment consisting of relations between people, which include the degree of attention one another, mutual respect or, conversely, lack of respect, interest, or indifference in relation to the common cause and the success of each staff member, the unity or diversity of tastes, aspirations, priorities - Socio-economic environment made up of relations between people (and their groups), and between them and they created the material and cultural values that affect humans. It includes social, psychological, sociological, demographic, cultural, ethnic, economic and other factors.

Table 1: Global air pollution and ecological problems [1]

Type of economic problems	**Pollutants**	**The main sources**	**Impact on Environment and Health people**
Global warming and climate change	Carbon - dioxide	Fuel combustion	The increase in high temperatures, rising sea levels, rainfall asymmetry, increasing the number of cyclones, hurricanes, typhoons, Tsunamis, floods. Reduction of potable water (melting glaciers, mountains and polar winter). The increase in anemia and other Hematological contribution charge icon.
	Carbon - Monoxide	Incomplete combustion of fuel	
Reduction of the ozone layer	Freon	Devices for COOLS, sprays	The increase in the intensity of ultraviolet radiation, reducing crop productivity, increase the number of cancerous diseases
Acid rain, increased acidity of the environment	Sulfur - dioxide	Fuel combustion	Chronic disease of plants, reducing yields in agriculture, deforestation. Respiratory diseases
	Nitrogen oxides	The oxidation of atmospheric nitrogen and nitrogen from high temperature fuel	The absorption of sunlight, creating the photochemical fog - smog. The destruction of a number of materials, reducing the yield Agricultural crops, deforestation, threat to biodiversity. The reduction in blood hemoglobin content.
Radioactive, chemical and bacteriological contamination	Chemical, bacteriological and active polluter	Petroleum and chemical industry, nuclear accidents and chemical plants, explosion, war actions	Of severe poisoning, burns, infective and other gastroenterological diseases, skin cancer and contribution to the charge icon in the total destruction of the biosphere.

BIOTECHNOLOGY IN THE RESOLUTION OF GLOBAL ENVIRONMENTAL PROBLEMS

Despite many uncertainties in the scientists and the wider layers of population on food security with genetically modified components, the problem of rapid population growth and hunger in the underdeveloped countries of the world and the transition to macrobiotics using large quantities of cereals in many countries raises the need for increased production of soybeans, corn, wheat and other genetically modified plants. At the beginning of XXI century world population exceeds 6 billion and the UN estimates that by 2030. reach 10 billion people. Now only 70% of people grow their food, but it will by 2025. half of the population living in cities with the need of the food supply. There are estimates that production will food on existing arable land will have to double over the next 30 years. Many countries now can not produce enough food for its population due to climatic and other conditions that are unfavorable for conventional crops [10]. Increased field, increased flexibility in relation to the environment, less use of chemical pesticides and increased nutritional value are future food biotechnology. In developed countries there are many laboratories in research institutions, technology parks and Insight involved in research and development of biotechnological methods of food production. The largest of these are regions in Canada, USA, Great Britain, Israel and so on. Name just a few: [8]

- Bio NC Bio Canada,
- Bio Forest, Bio Capital,
- Bio Corridor, Bio lsrael,
- Biotech Bay Bio Midwest,
- Biotech Beach was Texas,
- Gene town Bio UK,
- Farm Country Plant Genetic Systems.

Many companies in the world are engaged in research and development in the field of biotechnology applications in agriculture and pharmaceuticals. According estimates in 15 countries (USA, Canada, Japan, Australia, Austria, and many others) is about 5000 companies and other organizations dealing with biotechnological methods (Oliver, 2000). About two-thirds of companies engaged in the commercialization of biotechnological research, while other firms lead scientific research (pharmaceutical companies and organizations for environmental protection). A significant number of large companies such as DuPont, Monsanto, Novartis, is in the process of rapid reorientation of the chemical companies to biotechnology companies. Dow Chemicals, on the other hand, focuses on industrial applications of biotechnology, as well as many pharmaceutical companies, either through their own research or through the establishment of strategic relationships with smaller, research-oriented firms. Biotechnology firms are far from the most intensive research in all branches of non-military industries. Estimates of the current annual amount of research and development are moving up to $ 10 billion. The average biotech firm spent 69,000 dollars per employee on R & D, compared with 7651 dollars in other industries. In relation to total operating costs (on average) for biotech companies, research and development accounts for 36% [4]. The largest market for biotech firms are pharmaceuticals, agriculture and environment with total sales exceeding 15 billion dollars a year. In the next ten years is expected tripling of the market for biotech products. Market size will determine the biotech innovation, and sectors that will be most affected are health, agriculture and environmental protection. It is very important, area in the world is under crops of genetically modified crops, cotton and vegetables (Tables 2, 3, 4).

Table 2: Total area in million hectares of transgenic crops in 1999 and 2000 [11]

Culture	1999	%	2000	%	+/-	Change, %
Soy	21.6	54	25.8	58	+ 4.2	+ 19
Corn	11.1	28	10.3	23	- 0.8	- 7
Cotton	3.7	9	5.3	12	+ 1.6	+ 43
Canola	3.4	9	2.8	7	- 0.6	- 18
Potato	< 0.1	< 1	< 0.1	< 1	< 0.1	-
Gourd	< 0.1	< 1	< 0.1	< 1	(-)	-
Papaya	< 0.1	< 1	< 0.1	< 1	(-)	-
Total	39.9	100	44.2	100	+ 4.3	+ 11

Table 3: Total area in mil/ha and characteristics of transgenic crops in 2000 [9]

Trait	1999	%	2000	%	+/-	Change, %
Herbicide tolerance	28.1	71	32.7	74	+ 4.6	+ 16
Resistance to insects (Bt)	8.9	22	8.3	19	- 0.6	- 7
Bt / Herbicide tolerance	2.9	7	3.2	7	+ 0.3	+ 10
Resistance to viruses / Other	< 0.1	< 1	< 0.1	< 1	< 0.1	
Total	39.9	100	44.2	100	+ 4.3	+ 11

Table 4: The area under transgenic crops in the mill. Ha for the mainstream culture, 2000 [5]

Culture	The total area	The area under transgenic culture	The area under transgenic culture as % of total area
Soy	72	25.8	36
Cotton	34	5.3	16
Canola	25	2.8	11
Corn	140	10.3	7
Total	271	44.2	16

TRAFFIC ONE OF THE BIGGEST ENVIRONMENTAL POLLUTANTS

Transport is of great importance to the economy, and social welfare. He is an essential element in the production and distribution of goods and services without it can not be employed trade and regional development. Traffic enabled production expansion and strengthening of competition.
Modern trends in road and air traffic leading to congestion, pollution, loss of time, health, life and total economic losses.

Traffic is not environmentally neutral, and various types of traffic differently affect the environmental gases middle. Emission traffic is an important part of their overall emissions: over 90% of the total emissions of lead, over 50% of total NOX emissions and over 30% of the total emissions of volatile organic component. In urbanized regions of the traffic originates almost 100% CO, 60% HCL and NOX, 22% CO_2 and 10% SO_2.Osim addition, traffic is heavily in one of the largest sources of noise [9].

It is necessary to limit the impact of infrastructure development on land use, density and reduce the strain on the roads (especially in urbanized regions), or eliminate the risk reduce or transport of hazardous waste.

Effective results in this field will depend on the whole complex of interconnected measures and effort. For example, habits owners of passenger cars in most cases depend on the availability of other forms of transport, quality of infrastructure, parking prices, etc.

Biodiesel-fuel of the future

The idea of getting fuel from plants for the first time a century ago tried to implement the German engineer Rudolf Diesel to start taking advantage of a prototype diesel engine peanut oil, but its function is not achieved due to the appearance of petrol (gas) oil. This time in an accessible and inexpensive petroleum distillate proved to be satisfactory fuel efficient diesel engines, but its widespread use for the first time called into question during the first oil crisis.

Unlike diesel fuel, biodiesel contains no sulfur, thus reducing the possibility for the occurrence of acid rain. The high oxygen content reduces particulate matter (or soot) in exhaust gases while contributing to more complete combustion and reduced emissions of carbon monoxide [2].

Biodiesel is an environmentally friendly energy source, is obtained from rapeseed and sunflower with multiple benefits and advantages compared to conventional fuels. Its use reduces emissions and avoids the creation of the effect of "greenhouse". As for the carbon dioxide is neutral, does not contain sulfur, lead and nitrogen compounds. Better burn in the engine, and its use reduced air and water pollution and the environment as much as 300 percent, because it is biologically degradable. Its positive effects are present in agriculture, because rape succeeds on all soil types.

Based on the experiences of Western countries, notably Germany did the program for this strategic investment and offered it to the Government of Serbia, of course, free. Such a program, for example, Slovakia has paid 100,000 euros [7]. In it are discussed in detail capabilities for the production of oilseeds in the country, climate, and content of the soil, the land fund, and the mode of production, EU standards, human resources, staff education, marketing and tax policy of the country, from the start to be very stimulating.

CONCLUSION

Mankind is only the beginning of XXI century, faced with the problem of their own survival not because of danger of a third world war, but because of the unreasonable profits that the race has caused irreparable damage to nature. Every year in the bosom of the Earth takes out 100 million tons of ores, mineral fuels, construction materials, including 4 billion tons of oil and 2 billion tons of coal. The land is put 92 million tons of fertilizers and 2 million tons of pesticides and herbicides. The atmosphere is removed over 200 million tons of carbon dioxide, 50 million tons of hydrocarbons, 150 million tons of sulfur dioxide, 50 million tons of nitrogen oxide emissions, 250 million tons of dust. In rivers, lakes, seas and oceans removes the 32 billion cubic meters of waste water to 10 million tons of oil. Every year 6-7 million hectares of land becomes unusable for cultivation. All this, obviously, requires a change in behavior of mankind, because many changes in the environment have become irreversible.

The complex of ecological situation, which has long considered that the basic natural components, which a man uses in its manufacturing activities, practically inexhaustible. Nature is equated with the universe: percent of its resources are endless, take the as much as you seem them all you wish - still remain infinitely many, and air and water. In fact it was the policy of undermining the stable long-term balance between economic activity and the biosphere. In order to explain the complexity necessary to introduce environmental management as a discipline to manage environmental resources.

REFERENCES

GH Brundtland, "Our Common Future Revisited", The Brown Journal of World Affairs, No. 3 (2), 1996,

Various authors, "Encyclopedia - Environment and Sustainable Development", Institute for textbooks and teaching aids Serb Sarajevo, Belgrade, 2003,

L. Jovanovic-Kolomejceva, "Environmental Management", University "Braca Karic" Faculty of Management, Belgrade 2002.

SM Lele, "Sustainable Development: A Critical Review," World Development, br. 19, 1994, 604th

Environmental Management Systems, ISO Preliminary First-Sraft, ISO/TC0207/SG-1/WG-1 Document, 1994.

A. Adler ECOLOGICAL fantasies, Delta Book, New York, 1973.

M. Zderic The school and the environment, Thought, Novi Sad, 1983.

D. Markovic et al.: Basic processes and state of the environment, University of Belgrade, 1997.

I. Mrmak (1979): The impact on the development of the school environment, Education Review 40, Belgrade, 1979.

V. Terzija, The protection and improvement of the environment, Education Review 1-2, Belgrade, 1983.

R. Biocanin, The protection and improvement of the environment, Faculty of Uzice, 2000.

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THE NOTION, CHARACTERISTICS AND PRINCIPLES OF ENVIRONMENTAL PROTECTION IN REPUBLIC OF SERBIA

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ABSTRACT

The use of modern technology leads to the general progress of the society, but also to some extent, to the contamination of basic natural resources of the living world. This has created a need to include these changes in the content of a particular system of legal norms as part of the total social system. This system of legal norms will be able to determine the conditions, methods, procedures and criteria for the use of new technologies, without which there is no economic and social development of every country and the mankind, but the one that would lead to a reduction or limitation of forms and ways of pollution or degradation of the environment, in another words, that would lead to "sustainable development". By giving great importance to arranging, developing and protecting the environment as a whole or its parts, the international community has, through several global or regional legal acts which will be listed in chronological order, set the legal standards in this area that many countries, including our country, are obliged to implement into their national legislation. This is the basis for determination of Serbia as a state in which the principle of sustainable development is implemented. The authors, in this paper, illustrate the characteristics of the system of environmental protection that the law which governs the protection of the environment arranges as an integral system of the environmental protection. This law, at one hand, ensures the humans the right to live and develop in a healthy environment, and on the other hand, the balance between economic growth and environmental protection. In the second part of the paper, the authors analyze the principles that are prescribed by the Law on Environmental Protection of the Republic of Serbia.

Key words: environment, law, protection, principles.

INTRODUCTION

The use of modern technologies brings general progress to the society but, on the other hand, these technologies have to be followed by appropriate preventive measures which include removing possibly harmful consequences for the environment. Ecological defense is multi-disciplined and it should represent permanent obligation of all organizations within the society.

In ecological theory protection of the environment is defined as a range of different procedures and measures that have to be taken in order to prevent endangering of the environment aiming at protection of biological balance. (Ninković, 2005) The most important aims of environmental protection are protection of health and life of humans, quality of eco - system, protection of plant and animal species, cultural heritage made by people, protection of balance and ecological stability of nature and rational and appropriate usage of natural resources, etc.

The third generation of human rights is especially dedicated to ecology, health care and culture. However, environmental protection does not imply only protection of life and health of humans but also protection of plants and animal species. Universal Declaration on human rights in the article 31 envisages that « all human beings have the right to maintaining ecological balance in the environment which they share with all other beings, animals and plants whose survival as security of their own survival should be secured.» In this context there is an interesting observation in the theory according to which «the cited requirements are essential for survival of nature and humanity, therefore it is necessary to limit and delegitimate some of the existing human rights – especially incompetent ownership, manufacturing and consumer authority which act as senseless misuse of technological and political power – to avoid ecological disaster and to create a new ecological ethics. For this reason it is necessary to determine new human obligations for maintaining and developing natural living conditions and human life on the Earth as well.» (Ninković, 2005)

Taking into account the necessity of environmental protection it is of crucial significance to arrange, improve and protect the environment as a whole and in its segments: water, air, soil, flora and fauna. International community realized this aim by adopting universal (under OUN) or regional (European Council and European Union) acts in which it postulated legal standards in this field. Individual countries and Serbia among them are obliged to implement these standards in their national legislation. These legal standards were implemented in our country in 2005 by passing a new ecological legislation which represents a base for determining Serbia as a country that firmly protects the principle of sustainable development (Jovašević, 2009). In this way Serbia joined a great number of countries which harmonized their ecological regulations to a series of relevant international acts, first of all, those with universal character and therefore it created foundation for sustainable development of all biological resources in the function of economic development of the country.

International legal protection of the environment is mainly reduced to international legal action oriented against pollution. We will present, here, the most important international legal acts from this field chronologically. Declaration on the environment adopted on the UN World Conference in 1972 emphasized that « man has elementary right on freedom, equality and appropriate living conditions in the environment whose quality enables decent life and welfare». Stockholm conference on the environment held in 1972 attracted attention to these issues and marked the beginning of «ecological era». During the same year Paris conference of presidents and prime ministers from EU countries was held as well. The main aims related to ecology, in the Declaration which was adopted at the conference, were reducing risks concerning living conditions and paying special attention to environmental protection. The public was warned to maintain quantitative level of natural resources because exploitation of natural resources can cause ecological imbalance. Natural resources are limited and they can absorb pollution and neutralize harmful effects only to the certain level. Exceeding the level can cause quantitative and qualitative changes and natural imbalance which, as a consequence, causes disturbance of elementary ecological processes. European Charter on the environment and health adopted by EU Council in 1989 emphasizes that people are guaranteed the right to live in clean and healthy environment.

It can be concluded from everything said before that environmental protection policy is not limited only to pollution control on the local level but it has a global character as well. In other words, global ecological balance is becoming more significant which makes the necessity for applying appropriate measures and instruments which are active on the market. Although global pollution represents the world problem primary responsibility for its solution is on developed industrial countries. This is confirmed by the fact that participation of USA in global emission of carbon-dioxide is 23%, EU 13%, Japan 5%, while the ex-Soviet Union countries and Eastern European countries participate with 25% (Ninković, 2005). For this reason and in order to alleviate global climatic changes Kyoto Protocol was adopted. The Protocol numbers different gases which cause pollution of the atmosphere (carbon-dioxide, methane and etc.), but carbon-dioxide was emphasized as a gas which individually contribute to Green House effect in greatest extent because it participates with 60% in total quantity of all dismissed harmful gases. Provisions of Protocol demand from developed industrial countries to reduce emission of harmful gases below the level from 1990. These emissions should be reduced from 2008 to 2012 for about 5%, precisely EU countries should reduce the emission for 6%, USA for 7%, Japan for 6%, etc. In 1992, Basel Convention was adopted aiming at reducing substances determined as dangerous waste. According to Basel Convention, mobile phones were identified as waste of exceptional importance and an «initiative of mobile phones partnership» was made with the aim to make mobile phones gentle for the environment. In 2004, Stockholm Convention on persistent organic polluters came into force – it defines 12 extremely poisonous persistent polluters and demands their reduction or elimination and it leaves an option for extending the list of polluters.

However, international regulations in the field of environmental protection have not achieved the level which would enable protection of all population and other beings on our planet yet. It is good that various protocols, conventions, declarations and agreements are being adopted but, unfortunately, that occurs more often when the environment is already endangered and rarely when it is necessary to prevent its threatening.

THE NOTION AND CHARACTERISTICS OF ENVIRONMENTAL PROTECTION SYSTEM

In the first decade of this century Republic of Serbia began the process of adopting new ecological legislative. Namely, at the end of 2004, several laws from the field of environmental protection were adopted and they «marked a new era in the field of ecological legislative» (Jovašević, 2005). These laws are: 1. Law on protection of the environment[1], 2. Law on strategic estimation of influences on the environment, 3. Law on integrated prevention and control of environmental pollution and 4.Law on estimation of influences on the environment. By adoption of these laws the system of arranging, improving and protecting the environment as a whole and in segments was put on the higher and radically different level than before (Bezarević, 2008). In this way, our country joined a great number of countries which harmonized their regulations with a range of relevant international acts, primarily of universal character, which enabled making conditions for sustainable development of all biological resources in the function of economic development.

The current Environmental protection law provides an integrated system of environmental protection which secures realization of human rights on life and development in healthy environment and a balanced relation of economic development and the environment in Republic of Serbia. It is determined that environmental protection system consists of measures, conditions and instruments which are necessary for : 1) sustainable management and protection of natural balance, wholeness, diversity and quality of natural values and conditions for survival of all beings and 2)prevention, control, reduction and recovery of all forms of environmental pollution.2

Environmental protection law from 2004, as an elementary ecological law in our country, determined the notion and content of the most significant institutes and notions which represent legal field on the environment. In other words, the environment is defined (Vančina , 1982) as an assembly of natural and man-made values whose complex mutual relations make the environment, or the space and living conditions3 (Prošić, 2008). The main attribute which describes it is quality. The quality of the environment represents its state which is expressed by physical, chemical, biological, aesthetic and other indicators.

Elementary constitutive elements of the environment are: 1. natural resources, 2. protected natural resources, 3. public natural resources, 4. geo-diversity and 5.biological diversity.

The notion of natural value implies natural resources which involve: the air, water, soil, forests, geological resources, plants and animals.4 According to some opinions, a noun – the environment is also used to describe these values. (Jovašević, 2009)

The protected natural resources are preserved parts of nature which have special values and characteristics (geo-diversity, bio-diversity, landscape, scenery and etc.), of permanent ecological, scientific, cultural, educational, health and recreational, tourist and other importance and as goods of general interest they have special protection.5 (Klarer, 1999). Public natural resources are regulated or

1The law on protection of the environment, Oficial Journal of Repablic Serbia, n. 135 /2004, 36/2009 - 72 /2009.
2 Art. 2. (1) The law on protection of the environment.
3 Art. 3. (1) The law on protection of the environment.
4 Art.3 (1) 3 The law on protection of the environment.
5 Art.3 (1) 4 The law on protection of the environment.

unregulated parts of natural resources, the air, water, coastal areas, underground resources, forests, landscapes or spaces which are available to all. 6

The difference between the notions of natural value and natural resources and geo-diversity is unavoidable. Geological diversity represents the presence or prevalence of various elements and forms of geological built, structure and processes, geo-chronological units, rocks and minerals of different composition and origin and different paleo-ecological systems changed in space under the influence of internal and external geo-dynamic factors during geological time (Gluščević, *et.al*, 2000). Bio-diversity includes diversity of organisms within species, among species and among eco-systems and it includes total diversity of genes, species and eco-systems on local, national, regional and global level.

According to the Law on Environmental Protection from the year 2004, the management of natural resources in Serbia is carried out by planning the sustainable use and preservation of the quality and diversity, in accordance with the conditions and measures of environmental protection as required by this law and, also by a series of special laws that cover the area of environmental law in our country. 7 By this law, the values that are the subject of a special legal protection are: 1) natural resources such as renewable and non-renewable geological, hydrological and biological values that are, directly or indirectly, in use or may be in use, and have a real or potential economic value, 2) protected natural goods 3) public natural resources.8

The following organizations were determined and obliged to protect and improve the environment in Republic of Serbia by law: 1. Republic; 2. Autonomous Province; 3. Municipality or Town (local self-government); 4.enterprises, other domestic and foreign legal entities and entrepreneurs who use natural resources, endanger or pollute the environment during their work; 5.scientific and professional organizations and other public services and 6.citizens, groups of citizens, their associations, professional and other organizations.9 All these entities are responsible for every activity they perform and these issues will be discussed later. However, these entities are obliged to cooperate mutually, provide coordination and harmonization in decision making and realization of these decisions. 10 On the other hand, Republic of Serbia and its bodies cooperate in the field of environmental protection with other countries and international organizations. 11

Beside significant and inevitable role of all mentioned entities we cannot avoid the role of different associations of citizens in the field of environmental protection. Namely, citizens' associations within this field prepare, propagate and realize their programs of protection, protect their rights and interests, propose activities and measures, participate in decision making in accordance with the law, contribute or directly work on informing about the environment (Kirn, 1998). 12

THE PRINCIPLES OF ECOLOGICAL LAW

The system of ecological law in Republic of Serbia inaugurate several principles, among them the following principles are emphasized: 1. the principle of prevention and precaution, 2. the principle of integrity, 3. the principle of protecting natural resources, 4. the principle of sustainable development, 5. the principle of polluter's responsibility and his legal follower, 6. the principle "the polluter pays", 7. the principle "customer pays", 8. the principle of subsidiary responsibility, 9. the principle of information and public participation and 10. the principle of protecting the law on healthy environment and access to justice.(Wolf et al, 2002) The principles of international ecological law,

6 Art. 3(1) 5 The law on protection of the environment.
7 Art.11 (1) The law on protection of the environment.
8 Art. 11(2) The law on protection of the environment.
9 Art. 4. (1) The law on protection of the environment.
10 Art. 8. (1) The law on protection of the environment.
11 Art. 8 (1) The law on protection of the environment.
12 Art 7 The law on protection of the environment.

primarily of European ecological law are incorporated in the new system of ecological law of Republic of Serbia. (Čavoški, 2007)

a) The principle of integrity[13].Within this ecological principle it is prescribed that competent Republic authorities, Autonomous Province authorities and authorities in local self-governments provide integration of environmental protection and improvement in all sector's policies in the following way: a) by realization of mutually coordinated plans and programs and b) by applying regulations through the system of licenses, technical and other standards and norms, v) by financing and g) by implementing encouraging measures related to environmental protection.

b) The principle of prevention and precaution 14 This principle implies that every activity must be planned and realized in order to: a) cause the smallest change in the environment; b) represent the smallest risk for the environment and human health; v) reduce load of space and spending resources and energy during building, manufacturing, distribution and usage; g) incorporate the possibility for recycling and d) prevent or limit the impact on the environment at the very source of pollution. The principle of precaution is realized by estimation of environmental influences and by using the best and most available technologies, techniques and equipment. It is interesting that the law envisages that the absence of full scientific reliability cannot be the reason for not taking the preventive measures against degradation of the environment in cases of possible or the existing influences on the environment.

*c) The principle of protecting natural resources*15 By this principle it is prescribed that natural resources (renewable or non-renewable) are used under conditions and in the way which secure preservation of geo-diversity, bio-diversity, protected natural goods and landscape. Therefore, renewable natural resources are used under conditions which secure their permanent and efficient renewal and permanent quality improvement. While non-renewable natural resources are used under conditions which secure their long-lasting economic and reasonable usage including limitation of using strategic or rare natural resources and substitution by other available resources, composite or artificial materials.

*d) The principle of sustainable development.*16 Ecological principle of sustainable development envisages that sustainable development is harmonized system of technical, technological, economic and social activities in total development in which natural and man-made resources of Republic of Serbia are used on the principles of economy and reasonableness with the aim to protect and improve quality of the environment for the present and future generations. Sustainable development is realized by adopting and realization of decisions that secure coordination of interests of environmental protection and interests of economic development.

*e) The principle of responsibility of polluters and their legal successors.*17 The principle of responsibility of polluters and their legal successors implies that legal or physical entity who by his illegal or incorrect activities pollutes the environment in every individual case must take responsibility according to law, which is emphasized in foreign literature as well (Baxter, 2005). However, polluters are responsible for pollution of the environment also in cases of liquidation or bankruptcy of the company or any other legal entity according to law. (Paternai, 2000) It is necessary to stress that polluters or their legal successors are obliged to eliminate the cause of pollution and consequences of direct or indirect environmental pollution. The change of company's ownership or other legal entities or other forms of changing ownership include estimation of the state of the environment and determination of responsibility for environmental pollution as well as paying debts of previous owners for pollution or damage done to the environment.

13 Art.9 (1) 1 The law on protection of the environment.
14 Art.9 (1) 2 The law on protection of the environment.
15 Art.9 (1) 3 The law on protection of the environment.
16 Art.9 (1) 4 The law on protection of the environment.
17 Art.9 (1) 5 The law on protection of the environment.

f) The principle “polluter pays”18 This principle envisages that a polluter pays compensation for pollution of the environment when by his activities causes or can cause environmental loading, in other words, if he produces, uses or puts on the market raw materials, semi products or products which contain harmful materials. In this case, a polluter, in accordance with regulations, pays total expenses of the measures for prevention and reduction of pollution including the expenses of environmental risks and the expenses for the damage caused to the environment.

*g) The principle “customer pays”*19. This principle prescribes that every physical or legal entity that uses natural resources is obliged to pay a real price for their usage and for re-cultivation of the area.

h) The principle of subsidiary responsibility 20 implies that Republic authorities, within their financial capabilities, eliminate the consequences of environmental pollution and reduce damages in the cases when polluters are unknown as well as when this damage originates from pollution of the environment from the sources outside Republic of Serbia territory,

*i) The principle of implementing encouraging measures.*21 It means that state authorities, provincial authorities as well as local self-government authorities take all necessary measures for preservation and sustainable management of environmental capacity, especially in the following way: a) by reducing usage of raw materials and energy, b) by preventing or reducing environmental pollution, v) by implementation of economic instruments and other measures, g) by selection of the best available techniques, equipment and facilities that does not require exceeding costs and d) by selecting products and services.

*j) The principle of informing and participation of publicity.*22 This principle means that, in realization of the right guaranteed by Constitution according to which each person has the right on healthy environment, all people have the right to be informed about the condition and state of the environment and to participate in decision making whose realization could influence the environment. All data related to the environment are public. Breaking the rules related to the environmental protection represents punishable offence for acters. (Nikoliš, 1981)

k) The principle of protection of the right on healthy environment and access to justice. 23 The last principle envisages that citizens and groups of citizens, their associations, professional or other organizations realize the right on healthy environment before competent authority, the court, in accordance with the law.

CONCLUSION

In our opinion, protection of the environment is defined as a range of different procedures and measures that have to be taken in order to prevent endangering of the environment aiming at protection of biological balance. The most important aims of environmental protection are protection of health and life of humans, quality of eco - system, protection of plant and animal species, cultural heritage made by people, protection of balance and ecological stability of nature and rational and appropriate usage of natural resources, etc.

Taking into account the necessity of environmental protection it is of crucial significance to arrange, improve and protect the environment as a whole and in its segments: water, air, soil, flora and fauna. International community realized this aim by adopting universal (under OUN) or regional (European Council and European Union) acts in which it postulated legal standards in this field. Individual countries and Serbia among them are obliged to implement these standards in their national

18 Art.9 (1) 6 The law on protection of the environment.
19 Art.9 (1) 7 The law on protection of the environment.
20A rt.9 (1) 8 The law on protection of the environment.
21 Art.9 (1) 9 The law on protection of the environment.
22 Art.9 (1) 9 The law on protection of the environment.
23 Art.9 (1) 9 The law on protection of the environment.

legislation. These legal standards were implemented in our country by passing a new ecological legislation which represents a base for determining Serbia as a country that firmly protects the principle of sustainable development In this way, Serbia joined a great number of countries which harmonized their ecological regulations to a series of relevant international acts, first of all, those with universal character and therefore it created foundation for sustainable development of all biological resources in the function of economic development of the country.

However, international regulations in the field of environmental protection have not achieved the level which would enable protection of all population and other beings on our planet yet. It is good that various protocols, conventions, declarations and agreements are being adopted but, unfortunately, that occurs more often when the environment is already endangered and rarely when it is necessary to prevent its threatening.

In the first decade of this century Republic of Serbia began the process of adopting new ecological legislative. Namely, at the end of 2004, several laws from the field of environmental protection were adopted and they marked a new era in the field of ecological legislative. By adoption of these laws the system of arranging, improving and protecting the environment as a whole and in its segments was put on the higher and radically different level than before.

The current Environmental protection law provides an integrated system of environmental protection which secures realization of human rights on life and development in healthy environment and a balanced relation of economic development and the environment in Republic of Serbia. It is determined that environmental protection system consists of measures, conditions and instruments which are necessary for: 1) sustainable management and protection of natural balance, wholeness, diversity and quality of natural values and conditions for survival of all beings and 2) prevention, control, reduction and recovery of all forms of environmental pollution. Environmental protection law from 2004, as an elementary ecological law in our country, determined the notion and content of the most significant institutes and notions which represent legal field on the environment.

The system of ecological law in Republic of Serbia inaugurate several principles, among them the following principles are emphasized: 1. the principle of prevention and precaution, 2. the principle of integrity, 3. the principle of protecting natural resources, 4. the principle of sustainable development, 5. the principle of polluter's responsibility and his legal follower, 6. the principle "the polluter pays", 7. the principle "customer pays", 8. the principle of subsidiary responsibility, 9. the principle of information and public participation and 10.the principle of protecting the law on healthy environment and access to justice. The principles of international ecological law, primarily of European ecological law are incorporated in the new system of ecological law of Republic of Serbia.

REFERENCES

Ball, S., Bell, S., (1991). Environmental Law. London , 321-354.
Baxter, B., A (2005) . Theory of Ecological Justice. London ,148-217.
Bezarević, V., (2008). Restrukturiranje upravljača zaštićenih prirodnih dobara i nacionalne strategije, *Pravni život,* 9, 485-497.
Boughtley, A. S.,(1971). Man and Environment. New York, London, 78-92.
Čavoški, A., (2007). Osnovi ekološkog prava Evropske unije, Beograd, 13-21.
Jovašević, D., (2009). Sistem uređenja I zaštite životne sredine u Republici Srbiji. *Politička revija,* 21 (3),87-10.
Jovašević , D., (2005). Zaštita životne sredine, Beograd, 78-92.
Kirn, A ., (1998). Nekoliko temeljnih dilema ekološke etike, *Socijalna ekologija,* 3, 157-170.
Nikoliš,G., (1981) Čovek, društvo, živtna sredina. Beograd,189-219.
Ninković, M., (2005). Zaštita životne sredine,*Lex forum*.21-22.
Paternai, M., (2000). Pravni aspekti zaštite biološke raznovrsnosti. *Pravni vjesnik,* 1-2, 185-204.
Prošić, S., (2008). Bezbednost i životna sredina, *Pravni život,* 9 , 499-505.
Vančina, F., (1982). Čovjekova okolina, Zagreb, 76-82.
Wolf, S., White, N., Stanley, N. ,(2002). Principles of Environmental Law. London, 421-442.

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STRATEGY LINKING BSC AND PUBLIC ORGANIZATIONS

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ABSTRACT

To improve environmental management system to the upper level we try to find possibility for involving those problems in every day life of employees and whole management. Following this way we can obtain core orientation of management of organization on environmental protection. Balanced scorecard in this direction can gives important support. The concept of BSC is most seen through strategic map that characterized with explicative research with strategic assumptions in architecture measures what makes from BSC very important strategic tool. Environmental and social aspects should be included in the frame of 4 already existing perspectives through strategic elements, objectives and measures. Using this method, environmental and social aspects become an integral part of standard BSC and they will be automatically integrated inside the cause-effect chain that has the financial perspective at the top of its hierarchy.

The BSC is becoming a popular tool with its concepts widely supported and dispersed in waste management, public organizations, water supplement and etc. as a result of interest in the real-life applications. In this paper, the development and implementation of a departmental BSC within public organization with water supply will be described and discussed.

Key words: Balanced scorecard, performance measurement, objectives.

INTRODUCTION

When it was first launched at the beginning of the 1990s, the Balanced Scorecard was promoted as a concept that addresses the performance measurement and later on strategic management needs of the private organizations. However, few years later, the Balanced Scorecard concept started to be adopted on a largely bases also by different organizational and governmental bodies in the public sector (Kaplan and Norton, 2001).

It is fact that financial performance measurement which was based financial statements have been serviced, more and less, scientific and objective results for a long time. Today, the invisible resource like as ‘Knowledge’ more create value than visible resource. The traditional financial performance measures worked well for the industrial era, but they are out of step with the skills and competencies companies are trying to master today.[4] These financial measures are inadequate, however, for guiding and evaluating the journey that information age companies must make to create future value through investment in customers, suppliers, employees, processes, technology, and innovation.[13]

The support of the balanced scorecard as a strategy developing instrument has been widely acknowledged in the private sector (Kaplan and Norton, 2001; Neely et al, 2001; Silk, 1998; Wisniewski and Stewart, 2004). Not only does the BSC target financial factors, it provides a basis for determining other important factors that influence how an organization can work towards its vision. The elements included in the BSC varies between implementations, but the process of filling the scorecard with content is important in order to raise the consciousness of important issues to the particular organization. Applying such a process to a setting that is distinguished by often vague and multiple objectives can provide the necessary structure to transform the currently vague objectives into

an actionable strategy. And equally important, the BSC allows public organizations to maintain attention on several areas such as for instance service quality, budget, internal processes and learning.
To remedy this deficiency, Kaplan & Norton devised "Balanced Scorecard"-a set of measures that gives top managers a fast but comprehensive view of the business.

The BSC approach has proved useful to all types of companies, both public and private; it provides a framework for any type of organization to monitor and influence the effectiveness of its strategies. However, as organizations become more service and knowledge-oriented, with less tangible desired outcomes, application of the BSC becomes more challenging.[3] Also, BSC have a basic limitation that fail to capture dynamic interactions among the key indicators involved over time and have no way of taking into account the impact of delayed feedback often caused by introducing new policies and legislative changes on the whole system under investigation like as almost performance measurement methods.[15]

NEED FOR BALANCED SCORECARD ADOPTION IN THE PUBLIC SECTOR

According with Kloot and Martin (2000), the drive for reform in the public sector has traditionally focused attention solely on the measurement of performance. The research performed on several local governmental bodies in the state of Victoria, Australia shows several inconsistencies between the traditional approaches to performance, adopted by the public bodies, versus a desired strategic oriented performance approach that resembles that of a Balanced Scorecard methodology.

Kloot and Martin (2000) argue that this traditional approach to performance in the public sector does not offer a strong linkage between strategic objectives and performance measurement. Additionally the researchers found that the local governments pay much less attention on the means for achieving long term improvement in relation with internal operations and innovations and learning activities.

A similar view is outlined also by Kaplan and Norton (2001) who argue that traditionally, public organizations encountered difficulties when defining clearly their strategy. Accordingly, most of the times, public organizations strategic plans consists of a list of programs and initiatives articulated on the organizational mission and vision, but no outcome that the organizations are trying to achieve, are defined.

Rohm (2001) in one of the presentations for the U.S Foundation for Performance Measurement outlines several reasons for which the Balanced Scorecard should be adopted in the public sector. Some of the ideas resemble and strengthen the arguments previously exposed.

Accordingly in the view of Rohm (2001), Balanced Scorecard should be introduced in the public sector in order to :

- Provide alignment between mission, strategy, processes and personal performance
- Align local government priorities to the state and federal priorities
- Demonstrate the value of programs to citizens
- Develop meaningful performance measure in order to determine the outcomes of the programs
- Link mission and vision to budget request
- Determine resources allocated and contract cost for each initiative
- Increase interagency coordination in order to eliminate waste and duplication

Public sector organizations have increased their use of performance indicators [PI] as a tool for monitoring, managing and measuring performance. PIs have been devised from several different tools and frameworks, such as the Business Excellence Model, Investors in People, charter mark, ISO 9000, the balanced scorecard and benchmarking (McAdam, Hazlett, & Casey, 2005). An alternative list of performance management frameworks was suggested by Lee (2006): the Performance Pyramid, the Results and Determinants Matrix, the Balanced Scorecard, the Consistent Performance Measurement System, and the Integrated Performance Measurement System.

The common point between the two lists is Kaplan and Norton's (1996) Balanced Scorecard. According to Kaplan and Norton (1996, p. 25), "The Balanced Scorecard translates mission and strategy into objectives and measures, organized into four different perspectives: financial, customer, internal business process, and learning and growth". They (Kaplan & Norton, 1996, p. 25) also add that, "The four perspectives of the scorecard permit a balance between short-and long-term objectives, between outcomes desired and the performance drivers of those outcomes, and between hard objective measures and softer, more subjective measures". In Kaplan and Norton's view (1996), strategies are developed following a cause and effect approach. In this vein, "The measurement system should make the relationships (hypotheses) among objectives (and measures) in the various perspectives explicit so that they can be managed and validated" (Kaplan & Norton, 1996, p. 30). For example, investments in learning will lead to a better internal business process, which, in turn, is likely to improve a customer's satisfaction and loyalty, and therefore result in a higher return on investments, which would satisfy shareholders (Kaplan & Norton, 2001).

There is evidence within literature that the BSC has been employed in the USA and Canada (Chan, 2004), Great Britain (Wisniewski & Olafsson, 2004), New Zealand (Greatbanks & Tapp, 2007), and Norway (Askim, 2004), among other countries.

According to Kaplan and Norton (2001), the BSC needs some adjustments in order to fit to the modus operandi of not-for-profit organizations, because their main objectives are not finance-related. They suggest putting the customer at the top of the strategic map. However, even this small alteration could be a complicated one. Kaplan and Norton (2001, p. 98), argue that "in a nonprofit organization, donors provide the financial resources – they pay for the service – while another group, the constituents, receives the service. Who is the customer – the one paying or the one receiving?"

Lee (2006) proposed a systemic performance management framework based on the four dimensions of the BSC, having public schools as a research locus. Another example of using the BSC in public organizations is Petrobras (Petroleum Prospecting and Trading Agency, a public joint stock company whose main shareholder is the Federal Government) (Villas, Fonseca, & Macedo-Soares, 2006). The BSC has also been employed in voluntary organizations involved in health services (Moullin, 2004a, 2004b; Moullin et al., 2007) and higher education (Chen, Yang, & Shiau, 2006). Though widely used in the private and public sectors, there is still a need to investigate the BSC as a strategy for performance management for non-profit organizations, mainly in developing countries.

Public sector worldwide is investing large sums of money in information systems. Accurate figures are hard to come up with, but it is estimated that about US$ 500 billion is spent annually on public sector information systems worldwide (Heeks and Davis, 2002). Tight budgets and a demand for new digital services, both for increased internal efficiency and increased "customer" value, are important drivers for reforming public sector with information technology. Due to the tight budget situation and an increasing demand from central governments on accountability for tax money, public sector managers are turning their attention towards strategic management and performance measurement (Yee-Chin, 2004). Often lacking context specific techniques, these managers are adopting modern management tools from the for-profit sector (Yee-Chin, 2004). This raises the debate as to whether or not techniques, tools, and theories can be exchanged across the sectors without adaptation, or if the sectors are so fundamentally different that no such exchange can be made.

The balanced scorecard (BSC) was developed to help translate an organizations vision and strategy into a set of supporting factors. By developing indicators for the different factors, the balanced scorecard can provide an organization with the necessary tools for performance measurement and monitoring, directly addressing multiple aspects that support the overall vision and strategy (Kaplan and Norton, 1992). Since the appearance in 1992, the BSC has gained widespread acceptance as an instrument for performance measurement. The BSC has later developed into an integrated part of the mission identification and strategy development process (Yee-Chin, 2004). However, recent studies reveal limitations to the BSC. It has particularly proved to be inadequate in addressing contributions from employees and suppliers, in identifying the role of the community, in developing performance

measures to address stakeholders' contributions, in accounting for the importance of motivated employees and not being able to provide adequate distinction between means and ends (Maltz, 2003).
In addition, Yee-Chin (2004) reports that the likelihood of successful BSC implementations in the public sector increases if the target organization already has a clear vision and strategy. This indicates that the strategy developing aspects of the BSC can be improved.

There is a general consensus that public sector is characterized by having a variety of stakeholders with potentially diverging and often vague objectives (Boyne, 2002; Bretschneider, 1990; Traunmüller and Wimmer, 2003). In order to successfully carry out public sector IS strategy processes, the objectives of these stakeholders need to be attended to. That does not necessarily mean that all stakeholders needs can or should be met, but the decision on which to attend to should be made on a rational foundation. Stakeholder theory has been developed as a response to this need in the context of for-profit organizations. Still, we argue that the nature of stakeholder theory allows for application in other settings as it is as much about mapping complex settings as it is about describing context specific patterns of behaviour.

BALANCED SCORECARD FRAMEWORK FOR PUBLIC SECTOR

Many public organizations had difficulties with the original architecture of the Balanced Scorecard which places the financial perspectives at the forefront, followed by the Customer, Internal Process and Innovation & Learning dimensions (Kaplan and Norton, 2001). This is due to the fact that achieving financial success is not the primary objective for these organizations. Instead the citizens or contributors perspective is much more important and represent the primary focus (Kaplan and Norton, 2001). This being the case, the scorecard perspectives can be adapted, in a structure that best fits the strategic interests of public organizations. The new Balanced Scorecard framework for the public sector switches between the Financial and Customer Dimensions positions. Additionally, Kaplan and Norton (2001), proposes the identification of several primary strategic themes that drives the organizations actions which can be placed at the very fore front of the scorecard.

The BSC is widely diffused in business and probably also to some degree in public management. The BSC's acclaimed merits and prescribed design seem to be identical for both the business and the public management contexts. The BSC could have many important applications in public management as well as in business. Use of the BSC in the public sector has been researched by several governments, specifically regarding introducing performance measures to management and procurement. In the US, research identified that a fifth perspective, 'employee satisfaction', could be added to gauge personnel issues, and that the tool had been deployed widely in all sectors.[12]

The key metric for government (or nonprofit) performance, therefore, is not financial in nature, but rather mission effectiveness. But mission effectiveness is not a definite and static thing. Usually, an agency has a rather broad general mission, which incorporates many specific sub-missions or departmental missions within it.[9] The only clear similarity between the two is in the desire for 'customer satisfaction', but even here there is a difference, because the definition of "customer" is different in the two cases. Most public sector scorecards focused upon excellence and sought to work more efficiently, for example, reduce costs, fewer mistakes and more effective use of resources. However, this operational approach was viewed as not being the best way to deliver customer needs. There is also a danger that the more straightforward customer profiles in the private sector will be applied to complex customer and stakeholder profiles in the public sector leading to overly simplified measures within the customer quadrant of the scorecard. [12]

McAdam and O'Neill [8] also reviewed the use of the tool in the public sector and concluded that, in contrast to traditional measurement, the framework had clear advantages for evaluating all aspects of the organization.

The implementation process of the BSC can be described as a series of foursteps (Kaplan and Norton, 2001; Yee-Chin, 2004).

- Translating the vision and gaining consensus;
- Communicating the objectives, setting goals and linking strategies;
- Setting targets, allocating resources and establishing milestones;
- Providing feedback and learning.

According to Yee-Chin (2004), the BSC can assist municipal managers in accomplishing the same strategic planning and control functions as is the case for for-profit managers:

- Clarify and gain consensus about strategy;
- Communicate strategy throughout the organization;
- Align departmental and personal goals to the strategy;
- Link strategic objectives to long-term targets and annual budgets;
- Identify and align strategic initiatives;
- Perform periodic and systematic strategic reviews;
- Obtain feedback to learn and improve strategy.

The revised model is said to be useful in the management of non-profit organizations in:

- Bridging the gap between vague mission and strategy statements with day-to-day operational measures;
- Facilitating a process by which an organization can achieve strategic focus;
- Shifting the organizations focus from programs and initiatives to the outcomes the programs and initiatives are supposed to accomplish:
- Helping organizations to avoid the illusion that they have a strategy because they are managing a diverse and non-cumulative set of programs and initiatives;
- Enabling organizations to align initiatives, departments and individuals to work in ways that reinforce each other so that dramatic performance improvements can be achieved.

The most frequently cited factors, necessary for implementation success, include:

- Top management commitment and leadership buy-in;
- Departmental, middle manager and employee participation and buy-in;
- Culture of performance excellence;
- Training and education;
- Keeping it relatively simple, easy to use and understand;
- Clarity of vision, strategy and outcome;
- Link of the BSC to incentives;
- Resources to implement the system.

As a whole the leadership determinants of high performance in the approaches of intangible assets and human capital can be summarized in the following factors:

- knowledge, intelligence, skills, competence
- schooling and training
- innovativeness and creativity
- stability and experience
- values, organizational culture, commitment and motivation
- entrepreneurship
- ability to co-operate and trust
- employer image and reputation

Kaplan and Norton (1996, p.127) define firstly two types of strategic areas that are critical: conditional indicators and capability indicators. They count to core areas: personnel stability, work productivity and satisfaction, personnel competence, infrastructure requirements and work climate. They combine also intellectual ‘capital’ elements, such as information systems and networks to their personnel aspect. Kaplan and Norton are even more interested in the functioning of infrastructure and intangible aspects in promoting personnel learning and grow.

BSC-based thinking highlights the view that existing situation, the needs, strengths and weaknesses of personnel, general vision and targets will decide in separate organization which of potential determinants are strategic. Strategic leadership determinants represent a kind of synthesis of existing needs and targets. When the vision is prepared on the ground of many-sided analyses of environment also the competitive policy aspects can be taken into consideration. So in defining leadership determinants to high performance BSC approach emphasizes empirical aspects. Theoretical setting points out only the frames. It brings into light mechanisms and generative causalities. You have to specify them in real contexts in order to know what really functions in certain circumstances. Kaplan and Norton (2001, p.309) see furthermore that when specifying personnel management practices these operations must get support of personnel. The functioning of strategies depends largely if the personnel feel them challenging and supporting. BSC-model highlights that the success is a function of different aspects. It is not enough that the owners and principals are satisfied with the competitiveness of the organization, and the customers must see the buying of its services profitable, the work attitudes of the personnel, control mechanisms and organizing should support the commitment of the personnel to organization. So the organization should offer the feelings of success not only to the principals but also customers and the personnel.

BSC-model is built upon service orientation and quality thinking but it takes only a probabilistic attitude to the universalistic definition of strategic leadership determinants of high performance. The determinants should be in line with quality thinking but the more specified definition of quality determinants can be made only in real conditions. Organizations can come into different strategic policies for example when defining their specific strategies in service principals and production processes and this reflect further their personnel policy. If the focus is in new production and new products this choice should highlight those personnel practices that promote creativity and innovativeness. But if the competitiveness lays on low prices, personnel management focus should be on cost spending inner processes. So in BSC-approach the leadership determinants of high performance vary in accordance with the choices made beforehand in general visions and strategies.

If the BSC-approach is adapted in the public sector the core leadership determinants to high performance are to be found from a wide range of potentially strategic success factors, such as:

- the sufficiency and the availability of human resources
- appropriate personnel structure
- stability
- healthy and safety working conditions
- work motivation, commitment and work satisfaction
- cooperativeness, trust, social skills and climate
- competence and expertise
- innovativeness and initiative
- up-to-date technical infrastructure.

The advantages of BSC in defining core leadership determinants are obvious. It does not give readymade lists for leadership determinants but demands to produce organization specific personnel policies that have close links to vision and other strategies. It provides simplifications and outlines that fit well for strategy purposes. In BSC –model high performance means balanced success; success from the point of view of owners or principals, customers, personnel and society. Important requirements to adapt the BSC-model are good communication and information systems, trust and possibilities for participation. The definition of leadership determinants demands common use and understanding of core concepts, active dialog, rationality that bases on good communication. If he whole personnel share the vision, strategies and personnel management policies, it is highly probable that also the operations in practice really lead to high performance.

THE BSC MODEL IN A REAL SITUATION IN PUBLIC ORGANIZATION

The Balanced Scorecard helps form a strategy for this implementation, but it is not designed to be used as a blueprint because every company is different. Companies have different goals, different customers, and different industries. This is precisely the reason why the Balanced Scorecard is needed to help form one strategy for the business and bring all areas of that business to work in harmony for the achievement of that one goal. The structure and strategy of an organization must be reflected in the Balanced Scorecard. It is possible that an organization consists of strategic business units that have their own scorecard, and these individual scorecards cannot be combined into one larger scorecard. In that instance, overall performance of the organization usually provides the measurement of how well the individual scorecards are doing. It is best to try and find a common theme or strategy that can traverse all units of business. When this occurs, the role of the larger scorecard would be to police the individual scorecards and measure how effective they are in achieving the common strategy. The Balanced Scorecard is designed to bring together a company to focus on the structure of the company and to achieve the overall goal.

Translating the vision is a means of expressing the mission/vision statements with an integrated set of objectives and measures. This forces the top management to develop operational measures, which requires them to discuss, and eventually agree on, a means of achieving the goals of the company. Communicating and linking is a process that facilitates the communication of strategies throughout the entire organization. Departmental and individual objectives must be aligned with the strategy through evaluation procedures and incentives. To have goal congruence between the individual employees and the company, scorecard users engage in three activities: communicating and educating, setting goals, and linking rewards to performance measures which are in turn linked to the overall strategy. Communicating and educating is achieved by maintaining policies that ensure all employees are aware of the strategies of the organization. Also, it is important for the lower level employees to be able to communicate upwards about whether or not the strategies are realistic from the competitive or operational perspective. Setting goals alone is not sufficient to change employee’s mind-set. Linking rewards to performance is an important incentive to help an organization achieve its purpose. What the balanced scorecard adds to the traditional means of linking rewards to financial performance is that it takes a more holistic look at the organization. It ensures that the correct criteria are used as a measure of performance before rewards are given. Business planning is the third process used by managers with the balanced scorecard. By using the scorecard, businesses will integrate their strategic planning and budgeting processes. This makes sure that the budgets support the strategies of the company. The users of the scorecard pick measures that represent each of the four perspectives, and then set targets for each. Then they will decide which specific actions will help them in reaching those targets. Using short-term milestones to evaluate the progress toward the strategic goal is what results from using the balanced scorecard. The fourth, and final, process is feedback and learning.

The BSC model is based on research within the public organization area – on BSC impact and its application to water supply organization. A study research approach is used to study the phenomenon of the BSC model and its development and implementation in a public organization. The aim of this paper is to analysis indicators of business processes in water supply organization and implementation of BSC softwares so that they can serve as a possible direction for improving the effectiveness of the process.

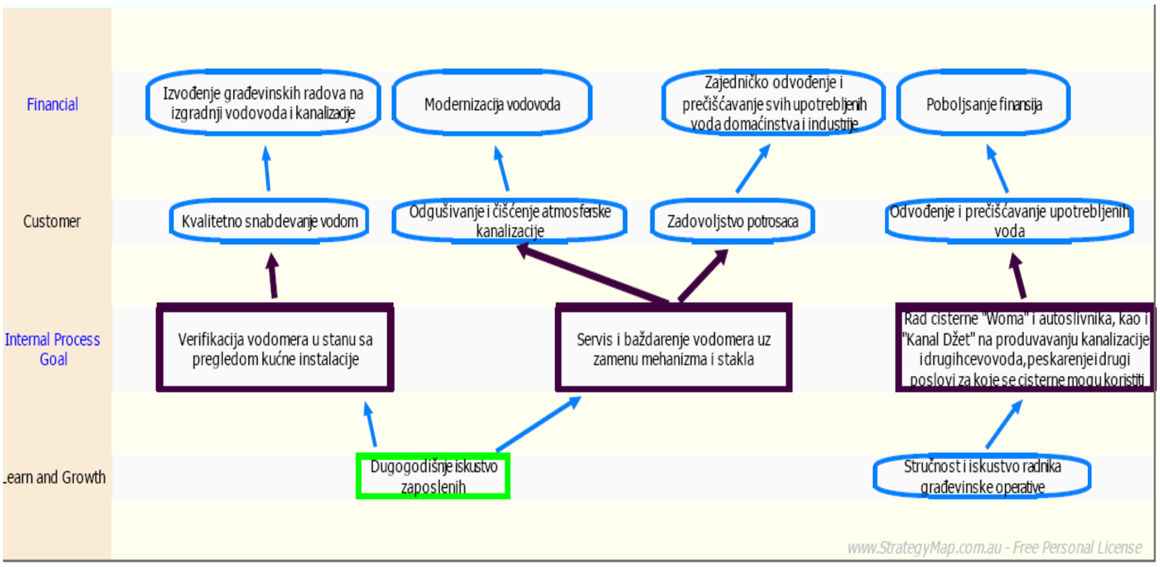
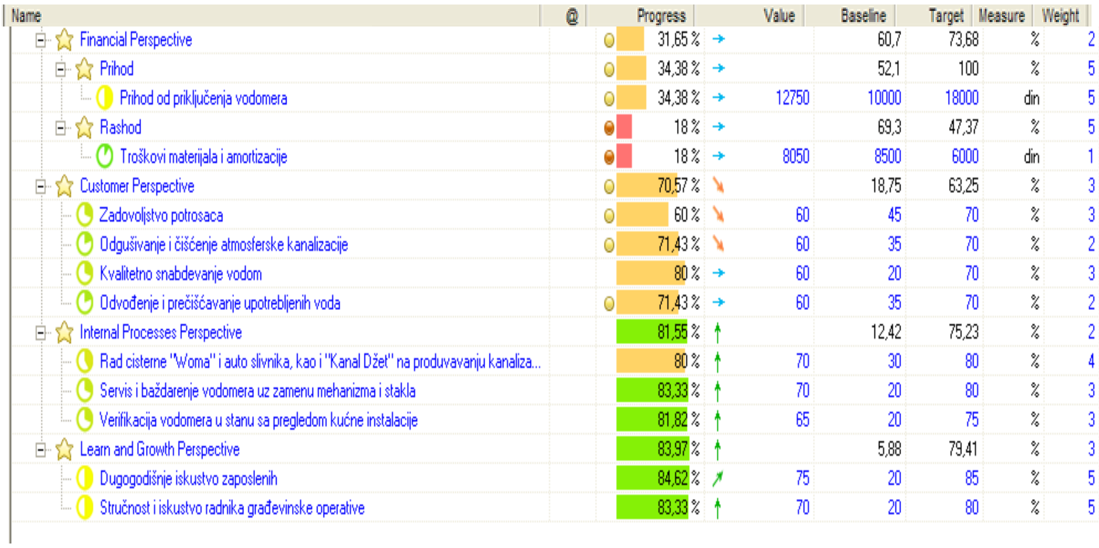


Figure 1. BSC Strategy Map of water supply in public organization



Name	@	Progress	Value	Baseline	Target	Measure	Weight
Financial Perspective		31,65 %		60,7	73,68	%	2
Prihod		34,38 %		52,1	100	%	5
Prihod od priključenja vodomera		34,38 %	12750	10000	18000	din	5
Rashod		18 %		69,3	47,37	%	5
Troškovi materijala i amortizacije		18 %	8050	8500	6000	din	1
Customer Perspective		70,57 %		18,75	63,25	%	3
Zadovoljstvo potrosaca		60 %	60	45	70	%	3
Odgušivanje i čišćenje atmosferske kanalizacije		71,43 %	60	35	70	%	2
Kvalitetno snabdevanje vodom		80 %	60	20	70	%	3
Odvođenje i prečišćavanje upotrebljenih voda		71,43 %	60	35	70	%	2
Internal Processes Perspective		81,55 %		12,42	75,23	%	2
Rad cisterne "Woma" i auto slivnika, kao i "Kanal Džet" na produvavanju kanaliza...		80 %	70	30	80	%	4
Servis i baždarenje vodomera uz zamenu mehanizma i stakla		83,33 %	70	20	80	%	3
Verifikacija vodomera u stanu sa pregledom kućne instalacije		81,82 %	65	20	75	%	3
Learn and Growth Perspective		83,97 %		5,88	79,41	%	3
Dugogodišnje iskustvo zaposlenih		84,62 %	75	20	85	%	5
Stručnost i iskustvo radnika građevinske operative		83,33 %	70	20	80	%	5

Figure 2. BSC scorecard of water supply in public organization

These pictures of BSC model show that if the result of strategic thinking is an effective strategic plan, from which we obtain an effective operational plans, then our business plans, which are the result of the latter, and the results arising from the business plans are outputs of the highest possible performance. Also, measuring the impact of performance shows that whether cause/the resulting model meets or does not meet the rejection of the results we anticipated and performance measurement of results are demonstrated to us after a specified time.

The overall view of the strategic balanced scorecard is then fed into and evaluated against the defined business objectives. These connections help to understand how the contribution of BSC towards the business will be realized: building the foundation for delivery and continuous learning & growth (future orientation perspective) is an enabler for carrying out the roles of the IT division’s mission (operational excellence perspective) that is in turn an enabler for measuring up to business expectations (customer perspective). Establishing the link with the business objectives through a cascade of scorecards and defining the cause-and-effect relationships within the scorecards are important steps in determining the maturity of the balanced scorecard. It is understood that major milestones in this further development will be:

- the detailed cause-and-effect relationships between the output measures and performance
- drivers have to be further elaborated,
- short and long term targets have to be further defined,
- individual and group objectives of employees have to be further linked to the BSC,
- the scorecards have to be further integrated in the strategic and operational management processes.

BSC activities costs are in a more detailed level. These three organizations approval processes of both the overall enterprise architecture and the systems level architectures delivered through major projects. The enterprise architecture dictates certain architectural and technical standards for application and technical systems and is reviewed and re-approved on a regular basis. The goal is to develop an overall risk management strategy and measure attainment of the defined target state risk level. Next, a regular survey process using generic questions needs to be developed to measure customer satisfaction and a process for assessing the „state of the infrastructure“. Each of this organizations have a characteristic process and its costs of that process so operational services baselines and targets and unit scorecards of these organizations are developed and a measurement process for personal development are implemented – this is shown on pictures 1. and 2.

There should be scheduled activities that provide for sufficient levels of operational awareness, a sampling of which follows:

- Hold periodic meetings between management staff with agenda items designed to fully communicate subjects such as current initiatives, status of problem areas and actions taken to date, scheduled and planned training, and policy and procedure revision status of organizational or contract change implementation, as appropriate.
- Review status reports and trend analyses of performance measures. Perform limited on-site review (if applicable) of selected areas of significant risk as appropriate.
- Maintain awareness and involvement at a level such that a „for cause“ issue is not a surprise. When a „for cause“ condition exists, certain surveillance activities may be assigned to other disciplines or functional areas. In these instances, supporting documentation resulting from the findings should be provided to the organization. Reports generated as a result of internal audits should be considered valuable diagnostic tools.

Selected significant risk areas typically refer to those actions or activities that require compliance with laws, regulations, and contract terms and conditions. There should be various control systems employed as necessary to ensure compliance and to test the currency and adequacy of the business system. The following suggestions can assist in the validation and verification of the self-assessment process and results :

- Mutually understand what and how the organization will measure performance.
- Become familiar with the data sources and methods that will be used in the calculations.
- Confirm that the collection methodology is accurate, complete, and timely.
- Confirm that the data is properly controlled.
- Become familiar with the trend analysis techniques to be used and gain assurances that the organization’s personnel are qualified in this area.

CONCLUSION

This paper has discussed characteristics of public sector organizations and found that a balanced scorecard approach seems well suited as a strategy development instrument for this particular context as it holds the potential for incorporating several different objectives. This will incorporate the stakeholder complexity directly into the strategy development process, giving valuable and diverse information when setting up the sub-goals and necessary activities to reach these goals. Also, the stakeholder analysis process in itself draws attention the diversity of objectives from a variety of stakeholders and allows managers to develop strategies and accompanying measures that account for key stakeholders' interest. Still, while a stakeholder based approach to IS strategy development in the public sector seems theoretically promising, it needs empirical validation.

The balanced scorecard combines an effective measurement system that helps solidify a company's strategic objectives with a management system that can help drive change in key areas such as product, process, customer, and market development. The measures of the balanced scorecard helps focus a company's strategic vision, encourages thinking about current and future success and helps provide a balance between external and internal measures. This broad view helps managers see what trade offs they are making among their key success factors. The organization's measurement system affects the behavior of managers and employees. But many senior managers recognize that no single measurement can provide enough information about the critical areas of the business. Therefore, a balanced set of measurements is needed.

Organizations today use decentralized business units that focus on intangible knowledge, capabilities, and relationships created by employees. Some organizations understand that strategy must become a continual and participative process. The change from centralized command, and financial measures that come from past actions can no longer measure the objectives that need to be addressed. We must measure the strategy and the best tool to do this is balanced scorecard.

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REFERENCES

Kaplan, R. & Norton, D. (2001), The strategy focused organization. How Balanced Scorecard companies thrive in the new business environment, Harvard Business School Press, Boston, MA.

Kloot, L. & Martin, J. (2000), Strategic performance management: a balanced approach to performance management issues in local government, Management Accounting Research, Vol. 11, pp. 231-251.

Chris Wilson, David Hagarty and Julie Gauthier, "Results using the balanced scorecard in the public sector", Journal of Corporate Real Estate, 2003.8, Vol.6 No.1, 2.

Kaplan, R.S. and Norton, D.P., ``The Balanced Scorecard-Measure that Drive Performance", Harvard Business Review, 1992, Vol. 70 No. 1, pp. 71-79.

Rohm, H. (2001), Managing public sector organizations with the balanced scorecard, Presentation, U.S. Foundation for Performance Measurement.

Askim, J. (2004). Performance management and organizational intelligence: adapting the balanced scorecard in larvik municipality. International Public Management Journal, 7(3), 415-438.

Chan, Y. C. L. (2004). Performance measurement and adoption of balanced scorecards: a survey of municipal governments in the USA and Canada. International Journal of Public Sector Management, 17(3),204-221

McAdam, R. and E. O'Neill. 1999. 'Taking a critical perspective to the European business excellence model using a balanced scorecard approach: a case study in the service sector', Managing Service Quality, Vol. 9, No. 3, p.191–7.

Paul R. Niven, "Balanced Scorecard Step-by-Step for Government and Nonprofit Agencies", John Wiely & Sons, 2003

Chen, S. H., Yang, C. C., & Shiau, J. Y. (2006). The application of balanced scorecard in the performance evaluation of higher education. The TQM Magazine, 18(2), 190-205.

Greatbanks, R., & Tapp, D. (2007). The impact of balanced scorecards in a public sector environment Empirical evidence from Dunedin City Council, New Zealand. International Journal of Operations & Production Management, 27(8), 846-873.

Rodeney Mcadam and Timothy Walker, "An inquiry into BSC within best value implementation in UK local Government", Public Administration Vol. 81 No. 4, 2003, p.873–892.

Robert S. Kaplan, David P. Norton, "The Balanced Scorecard - Measures That Drive Performance," Harvard Business Review on Measuring Corporate Performance, Boston, Harvard Business School Press, 1998.

Traunmüller, R. and Wimmer , M. (2003). E-Government at a Decisive Moment: Sketching a Roadmap to Excellence. R. Traunmüller (Ed.). Proceedings of the 2nd International Conference, EGOV 2003. Springer Verlag, pp 1 – 14.

Sang-hyun Park, Jun-cheol Lee, Jeong-hwa Lee, Dong-ho Kim, Sang-wook Kim, On Building a Dynamic BSC Model for Strategic Performance Measurement, Korean System Dynamics Society, Vol.2 (1), 2001. 5, pp.70-92.

Kaplan, R. S., & Norton, D. P. (1996). The balanced scorecard: translating strategy into action. Boston: Harvard Business School Press.

Lee, N. (2006). Measuring the performance of public sector organisations: a case study on public schools in Malaysia. Measuring Business Excellence, 10(4), 50-64.

McAdam, R., Hazlett, S. A., & Casey, C. (2005). Performance management in the UK public sector: addressing multiple stakeholder complexity. International Journal of Public Sector Management, 18(3), 256-273.

Moullin, M. (2004a). Eight essentials of performance measurement. International Journal of Health Care Quality Assurance, 17(3), 110-112.

Moullin, M. (2004b). Evaluating a health service taskforce. International Journal of Health Care Quality Assurance, 17(5), 248-257.

Moullin, M., Soady, J., Skinner, J., Price, C., Cullen, J., & Gilligan, C. (2007). Using the public sector scorecard in public health. International Journal of Health Care Quality Assurance, 20(4), 281-289.

Villas, M., Fonseca, M., & Macedo-Soares, T. D. L. v. A. de (2006). Assegurando o alinhamento estratégico da tecnologia de informação e comunicação: o caso das unidades de refino da Petrobras. Revista de Administração Pública, 40(1), 127-153

Wisniewski, M., & Olafsson, S. (2004). Developing balanced scorecards in local authorities: a comparison of experience. International Journal of Productivity and Performance Management, 53(7), 602-610.

Boyne, George A. (2002). Public and private management: What is the difference? Journal of Management Studies. Vol 39, Issue 1.

Bretschneider, S. (1990). Management Information Systems in Public and Private Organizations: An Empirical Test. Public Administrations Review, Vol , pp 536 – 545.

Maltz, (2003). Beyond the Balanced Scorecard: Refining the Search for Organizational Success Measures. Long Range Planning. Vol 36, pp 187 – 204.

Neely, A., Adams, C. and Crowe, P. (2001). The Performance Prism in Practice. Measuring Business Excellence, Vol 5, No 2, pp 6 – 12.

Silk, S. (1998). Automating the Balanced Scorecard. Management Accounting, Vol 80, pp 38–44.

Wisniewski, M. and Stewart, D. (2004). Performance Measurement for Stakeholders. The Case of Scottish Local Authorities. The International Journal of Public Sector Management., Vol 17, No 2, pp 222 – 233.

Yee-Chin, L. C. (2004). Performance Measurement and Adoption of Balanced Scorecards. A Survey of Municipal Governments in the USA and Canada. The International Journal of Public Sector Management, Vol 17, No 3, pp 204 – 221.

Australian National Audit Office (2003), Centrelink’s Balanced Scorecard, Audit report. Gueorguiev, I., Dimitrova, S., Komitska, M., Traykov, H. & Spassov, K. (2005), Balanced Scorecard based management information system – A potential for public monitoring and good governance advancement, The Electronic Journal of e – Government, Vol. 3, No. 1, pp. 29-38.

Age Johnsen, “Balanced scorecard: theoretical perspectives and public management implications”, Managerial Auditing Journal, 2001, Vol.16 No.6, p.319-330.

Akkermans, H., von Oorschot, K., “Developing a Balanced Scorecard with System Dynamics”, Journal of the Operational Research Society, May, 2002.

Rydzak F., Magnuszewski P., Pietruszewski P., Sendzimir J.3, Chlebus E., “Teaching the Dynamic Balanced Scorecard”, Proceedings of 22nd International Conference, System Dynamics Society, 2004,

Mumford, E. (2001). Advice for an action researcher. Information Technology & People, 14(1), 12-27.

Radnor, Z., & Lovell, B. (2003). Success factors for implementation of the balanced scorecard in a NHS multi-agency setting. International Journal of Health Care Quality Assurance, 16(2), 99-108.

Heeks, R. and Davies, A. (2002). Different Approaches to Information Age Reform. In Reinventing Government in the Information Age, R.B. Heeks (ed.), Routledge, London, pp 22–43.

Hoff, K. G. and Holving, P. A. (2002). Balansert målstyring. Universitetsforlaget, Oslo, Norge.

Hood, C. (1991). A Public Management for All Seasons? Public Administration, Vol 69, pp 3–19.

Daake, D. and Anthony, W. P. (2000). Understanding Stakeholder Power and Influence Gaps in a Health Care Organization: An Empirical Study. Health Care Manage Review, Vol 25, No 3, pp 94 – 107.

Avison, D., Baskerville, R. and Myers, M. (2001) Controlling Action Research Projects,” Information Technology & People Vol 14, No 1, pp. 28-45.

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EXAMPLE OF COST EFFECTIVENESS OF INDIVIDUAL SOLAR COLLECTOR INSTALLATION AND ITS CONTRIBUTION TO THE ENVIRONMENT PROTECTION

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ABSTRACT

The use of renewable energy sources has increased lately in all European countries. The reason for this lies partly in the national regulations and European directives, but in individual households the economic aspect plays significant role. The existence of financial assistance for improving energy efficiency in buildings and reducing costs during the exploatation of implanted devices for processing renewable energy sources, encourages households to act more responsible towards the environment. As the countries of our region don't give sufficient support to renewable energy processing at the moment, the majority of such interventions are reduced to the efforts of individual investors.

This paper will show an example of installing solar panels as a support for domestic hot water and space heating, with the calculation of the investment's cost effectiveness and its contribution to the environment. The goal is to use solar energy for household needs and so reduce pollution resulting from the use of traditional fossil fuels for heating water and space. This research has resulted from a high intensity of solar radiation and the large number of sunny days per year in the observed area. The object of the analysis is an apartment in the territory of Podgorica, which serves as an example for the analysis of buildings with similar characteristics.

The aim of this paper is to examine the possibility of a solar system implementation from the economic aspect and the aspect of environment protection and thereby determine cost effectiveness of investment.

All of the foregoing will be discussed below. In the first part an overview of the current situation and the reason for the realization of such endeavors will be shown; analysis of the architectural and climatic conditions for the use of solar energy will define the necessary activities and the main expectations from this investment will be presented. The second part will describe the components of the solar system with all installations, indicative budget and required amount of electricity for water heating and space will be calculated and eventually the whole project will be observed from an economic point of view to determine the return on investment.

Key words: renewable energy sources, solar collectors, cost effectiveness.

ARCHITECTURAL ASPECTS OF SOLLAR SYSTEM INSTALLATION

Improving energy efficiency in buildings can be done in three ways: traditional (by replacing of low-quality windows and insulation of the building envelope), passive (by forming the greenhouse and loggia) and active (by installation of equipment for processing renewable energy, solar collectors and photovoltaic panels). Which of these methods are to be applied depends on the investor's needs and capabilities and characteristics of the object. This paper will now consider only the third option - installing solar panels to support domestic hot water and space heating, although in this example the significant savings in energy consumption could be achieved by replacing windows and glazing loggia.

Systems for processing renewable energy sources can be installed both on to the new and the existing buildings. Fitting systems into the building and construction works are certainly easier with new buildings. However, the number of existing buildings is much larger than the percentage of the new ones, so that every thought about improving their energy efficiency is highly welcomed. Still, it carries with it certain complications in terms of subsequent installation and connection to existing installations, all of which should be taken into account when considering such a procedure.

When we talk about the reconstruction of existing facilities and improving their energy efficiency, we usually mean the intervention in family houses. They are, however, possible in other forms of housing such as apartment buildings for collective housing. In this country where the building maintenance is still not centralized, joint interventions of all residents are generally impossible when it comes to ventures complicated than painting the building’s common areas. It returns us to the interests of individual investors. It is possible to intervene and in particular flat in a building, if there are spatial and climatic conditions. Flats largely depend on its location in the building and its relation toward the sides of the world, so many do not have good orientation for such a venture. In this study the question of whether to intervene in an apartment or house is not important, so it can serve as an example for other apartments or houses with similar characteristics (size, power consumption, orientation).

Land that was taken for analysis is located in a residential building in Podgorica (latitude 42.43 °, longitude 19.27 °), on the fourth out of five floors. The whole apartment is south oriented and has two large balconies on which the installation of solar collectors is possible. The shadow of the surrounding buildings doesn’t fall on them, so all day they are exposed to sunlight. This disposition and height at which the apartment is situated makes it ideal for using solar energy, especially taking into account the number of sunny days on this location.

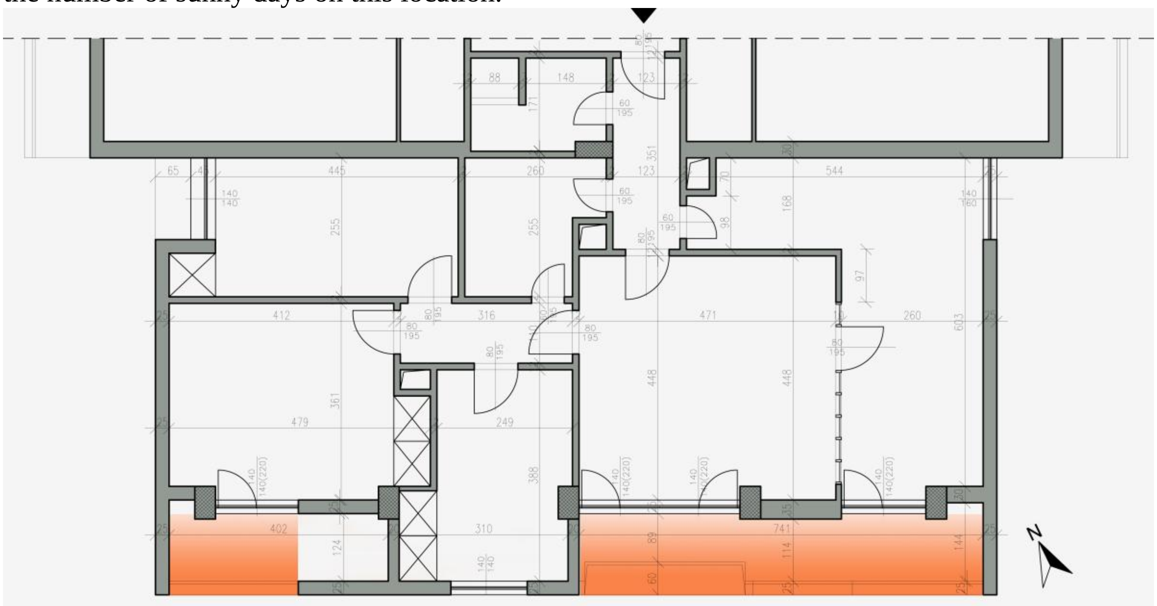

Figure 1. The flat floor area and highest intensity of solar radiation

According to the Hydrometeorological Institute of Montenegro, the total number of sunshine hours in Podgorica in year 2010 is about 2000 and is presented in the following table [1]. It can be seen that the intensity of solar radiation is worst during the winter months, while in the rest of the year is rather high, and annually it is total of about 1523.42 kWh.

Table 1: Total number of sunshine hours in year 2010 in Podgorica

Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
75	40	147	169	191	216	324	349	221	129	76	66

The installation of solar collectors for heating domestic hot water and to support surface (floor) heating is anticipated. Collectors are mounted on to the loggia, facing south. Additional heating should be supplied with electricity. The need for hot water is planed for 4 persons, low-intensity - 30 liters at 45°C, a total of 120 liters. Cold water temperature in February is 10°C, and in August of 12°C. As far as space heating is concerned, residential heating surface is 80 m^2, of which the floor heating can take 30-65 m^2. Heating season lasts from October to March. The average peak load is 4.5 kW and the average outdoor temperature in the heating period is -3°C. The projected temperature in the system is 40°C/25°C.

TECHNICAL ASPECTS OF SOLLAR SYSTEM INSTALLATION – RESULT ANALYSIS

In this study are observed solar collector system installation and accessories of brand Viessmann[24], one of the world's leading manufacturers in the field of heating systems. These calculations were carried out by T*SOL Pro 4.5 - the Simulation Program for Solar Thermal Heating Systems. The results are determined by a mathematical model calculation with variable time steps of up to 6 minutes. Actual yields can deviate from these values due to fluctuations in climate, consumption and other factors.[25]

The solar system consists of four collectors, the collector circuit, hot water tank and regulation. Collectors have a total area of 10.07 m² and active solar area 9.32 m². Collector tilt angle to the horizontal surface is 60°. Combined reservoir has a capacity of 750l, with additional heating by electricity power of 12 kW (Figure 2).

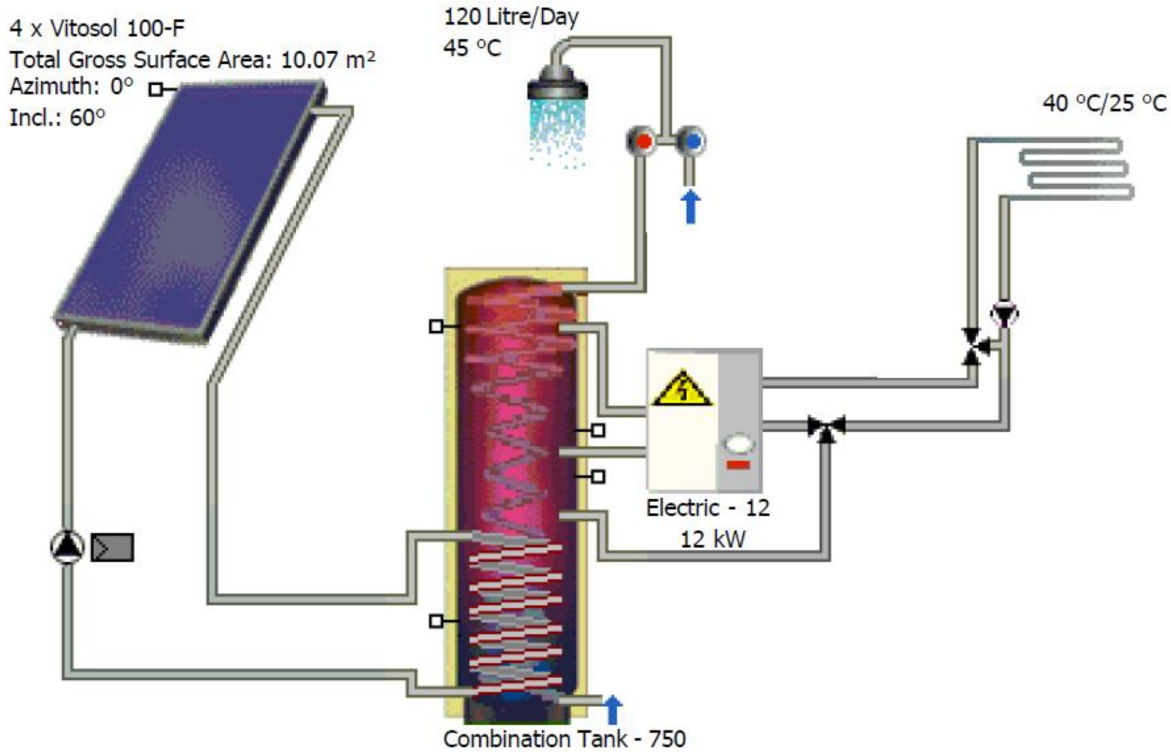

Figure 2. Solar system schematic diagram

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[25] Vladimir Vulićević, dipl. ing., Author of the calculation, tel.: +381113097887, e-mail: vlva@viessmann.com

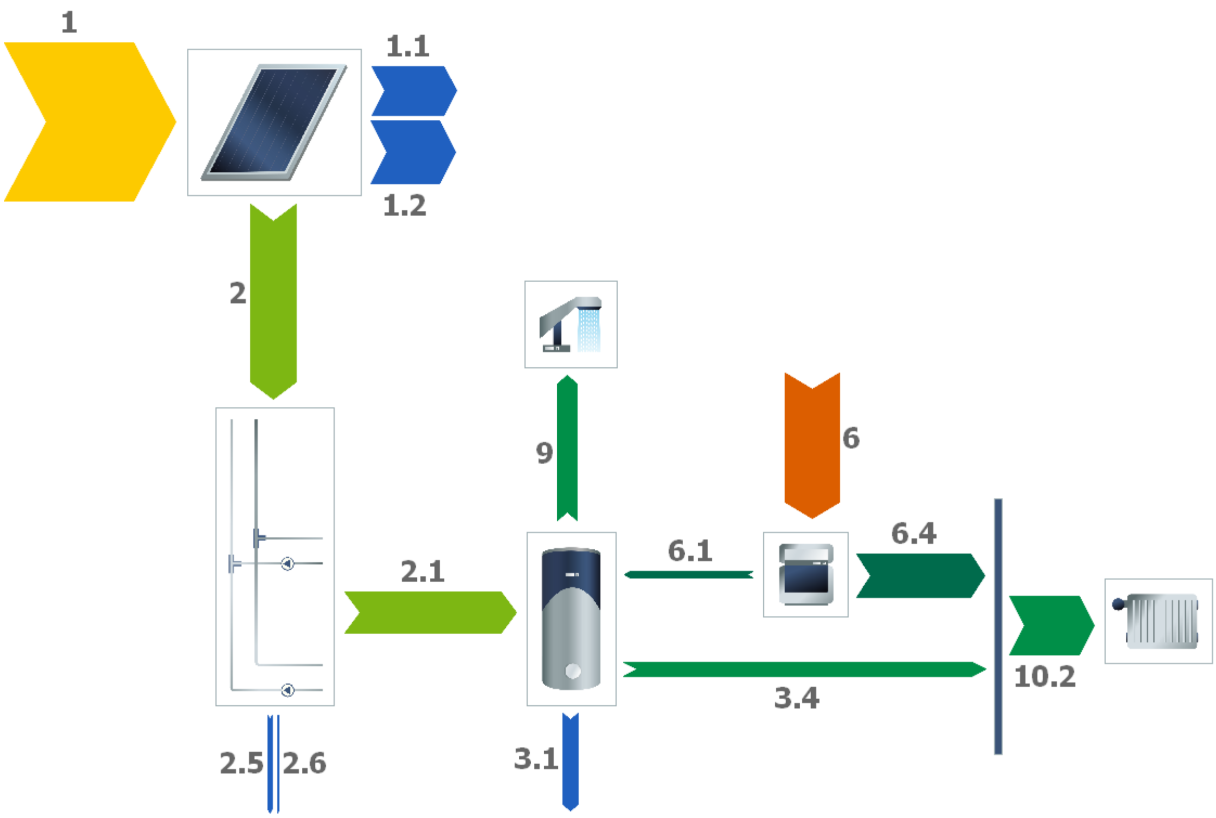

Figure 3. Energy balance schematic diagram (The system schematic diagram above does not represent and cannot replace a full technical drawing of the solar system)

Table 2: Explanation of the energy balance schemes

No.	Explanation	Energy (kWh)
1	Collector surface area irradiation (active solar surface)	14,626
1.1	Optical collector losses (reflection and other losses)	4,532
1.2	Thermal collector losses (heat conduction and other losses)	5,781
2	Energy from collector array (before the piping)	4,313
2.1	Energy from collector loop to storage tank (minus piping losses)	3,785
2.5	Internal piping losses	446
2.6	External piping losses	82
3.1	Tank heat losses via surface area	1,480
3.4	Heat from tank to low temperature space heating	1,274
6	Final energy current into system	5,057
6.1	Supplementary energy to tank	694
6.4	Supplementary energy to low temperature space heating	4,107
9	Heat from tank to domestic hot water appliances	1,724
10.2	Requirements for low temperature space heating	5,381

Simulation of the solar system gave the following results on an annual basis:

Table 3: Results of Annual Simulation

Installed collector power	7.05 kW
Installed gross solar surface area	10.07 m²
Solar energy that radiates to the active surface of the collector (total) and per unit	14.63 MWh 1,570.03 kWh/m²
Energy produced by collectors (total) and per unit	4.31 MWh 462.98 kWh/m²
Energy produced by collector loop (total) and per unit	3.79 MWh 406.30 kWh/m²
Domestic hot water heating energy supply	1724.35 kWh
Space heating energy supply	5.38 MWh
Solar contribution to domestic hot water heating	2510.97 kWh
Solar contribution to space heating	1274.13 kWh
Energy from auxiliary sources	4.8 MWh
Electricity savings	**4,208.3 kWh**
CO_2 emissions avoided	**2,802.73 kg**
Share of solar energy in total energy for hot water heating (Solar Fraction)	**78.3 %**
Share of solar energy in total energy for space heating (Solar Fraction)	**24.0 %**
Total share of solar energy for heating water and space (total solar fraction)	**44.1 %**
Fractional energy saving (EN 12 976)	**36.0 %**
System efficiency	**25.9 %**

The total annual amount of energy required for heating domestic hot water is 1724.35 kWh and for space heating 5381 kWh. Four panels with total area of 10.07 m² and active solar area 9.32 m² produce a total power of 7.05 kW. Although the sun radiates 14630 kWh per year of energy to the surface of the collector, when the optical and thermal losses of the collector and the collector circuit are taken away, only 3786 kWh of energy reaches the hot water tank. [2] Since the reservoir loses 1480 kWh through the surface, remains only 2305 kWh of energy. In this model an additional electrical heating of the total capacity of 4800 kWh is used; small part of it is used to maintain the hot water in the tank (694 kWh), and most of it is used for space heating (4107 kWh). Thus, when energy from the tank (2305 kWh) and additional energy (694 kWh) are gathered, the total energy is distributed as follows:

- energy for domestic hot water heating - 1724 kWh
- energy for space heating - 1274 kWh.

This settles the needs for domestic hot water with solar energy share of nearly 80%. As far as space heating is concerned, of the required 5381 kWh, solar energy gives 1274 kWh and 4107 kWh comes from additional resources. Therefore, the share of solar energy is nearly a quarter of the necessary (Figure 4).

The total solar fraction (Figure 5), or the solar energy consumption as percentage of total consumption, makes 44% of the total amount of energy needed, which means that the proposed solar panels cover 44% of the annual needs for heating hot water and facilities in the building. This allows savings in power consumption of 4208 kWh, and reduces CO_2 emissions up to 2802.73 kg.

Fractional energy savings is defined in the standard in brackets, as well as its way of calculation, and for the given conditions and the specific system it is 36%. The efficiency of the solar system depends on several factors - the location, the collectors themselves, but mostly of the application. The lower the temperature level is (for example in swimming pools) the efficiency is higher, and if a higher temperature is required (for hot water and heating) it decreases. The degree of efficiency in this case of 25.9% is quite fair value due to the demands.

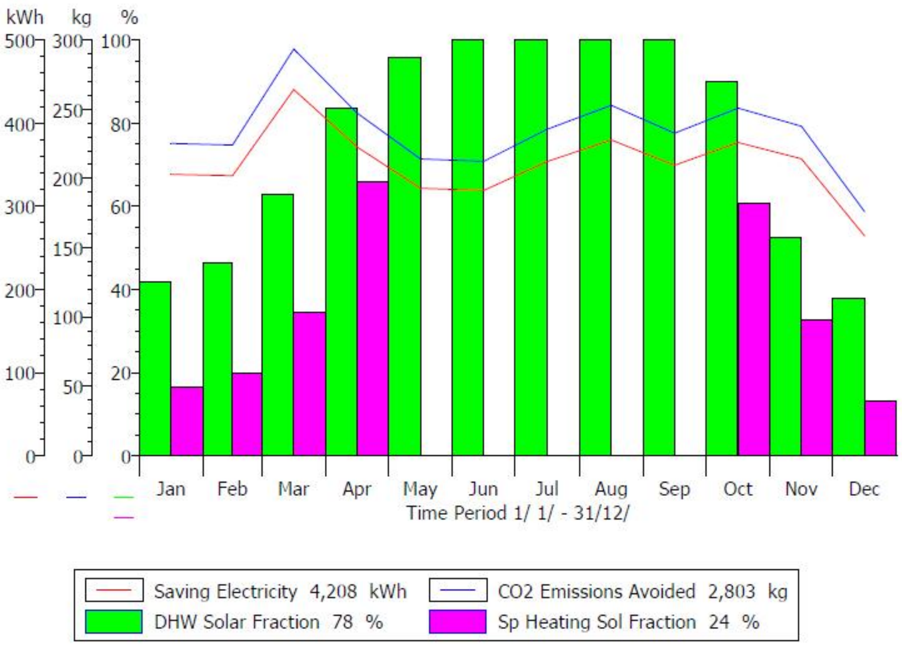

Figure 4. Solar fraction for domestic hot water and space heating

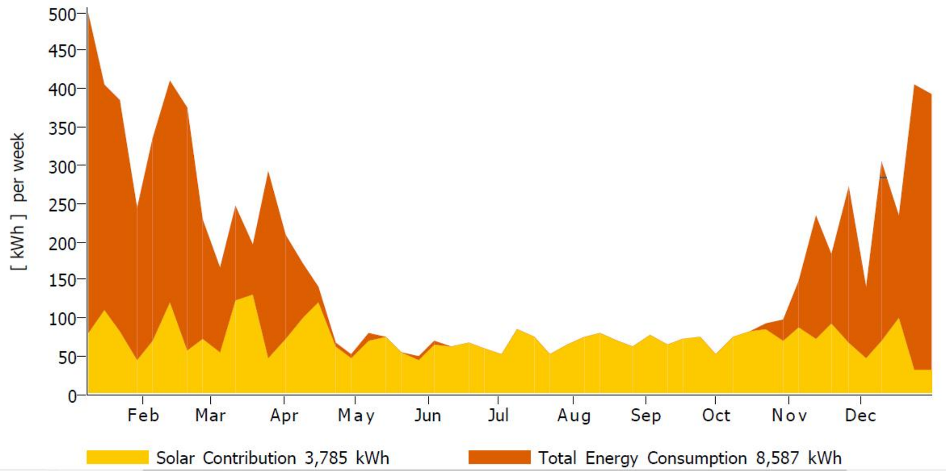

Figure 5. Solar energy consumption as percentage of total energy consumption per annum

ECONOMIC EFFICIENCY CALCULATION

Installation of solar panels in the existing facilities requires specific intervention to the installation and integration into the existing situation. It is assumed that there is already distributed cold water and electricity in the kitchen or bathroom. This whole project would include the preparatory work (the cold water and electricity supply to the solar system), installation of the solar system, installation of the floor heating and hot water to all consumers. However, to check the return period of the solar system it is necessary to define what is taken into account for analysis. Collectors and collector loop with necessary equipment and regulation belong to solar installation, so as the buffer (heat accumulator) and installation of the mentioned. This is an installation that is itself sufficient for heating hot water and only that will be taken into account. It will be assumed that the preparatory work on water and electricity supply to collectors is already done, so they will not be considered. The works on bringing hot water to all consumers will be left out, because these can vary depending on the arrangement of rooms. Space heating requires additional devices, such as surface heating system (floor or wall), but because they are not part of the solar heating system – they won’t be analyzed here, although require substantial financial resources.

The price of electricity is an element that influences the return period of the solar system. In our country it is unrealistic and lower than in other European countries, so the growth rates of 10% per year will be taken into account. The current price of electricity in Montenegro amounted to more than 8 euro cents, and it is estimated that the consumer will pay the amount of about 12 euro-cents.

In Montenegro, currently there are no subsidies for installing solar systems in existing facilities. This significantly affects the viability of extending the period of such investments and encourages investors to over-think on the subject. In other European countries the use of renewable energy and the replacement of traditional with modern heating systems are strongly supported. Will this policy be transferred to Montenegro and other underdeveloped countries in the region, remains to be seen. Until now, such individual advancements in environmental responsible behavior are mainly financed from investors own resources.

So when you take into account the amount of investment and the electricity prices annual percentage increase, we get the result shown in the following table:

Table 4: Economic efficiency calculation

Annual solar system capacity	3,784.46 kWh
Annual electricity consumption - pump	144.98 kWh
Annual electricity savings	4,208.3 kWh
Economic efficiency parameters	
Life span	25 years
Electricity price increase rate	10 %
Running costs price increase rate	0.5 %
Costs	
Investment	-8,561 €
Subsidy	0 €
Saving	49,657 €
Running costs	-2,736 €
Net present value	**38,360 €**
Amortization period	**11.29 years**
Cost of solar energy	**0.12 €/kWh**

The selected system of solar collectors annually saves approximately 4208.3 kWh of energy for water heating. When this amount is multiplied by the electricity price of 0.12 Euros per kilowatt, with growth rates of 10% per year - for 25 years, which is the lifetime of this system, we get the savings in electricity consumption of around 50 000 Euros. [3] The costs of the system, other than the initial investment, include operating and service maintenance costs. The latter are up to 50 Euros per year, and the first relates to the operation of circulation pump in the collector circuit. The program has calculated that the pump of about 60 W power runs 2439 hours per year, totaling about 150 kWh. When from the total saving the initial cost for purchasing and installing (about 8561 Euros) and maintenance (a total of 2736 Euros) are taken away, the value of the system of about 38 000 Euros is get. The period for which this investment will pay off the by energy saving is 11 years. Given that the system has guaranteed lifetime of 25 years, this means that at least for 14 years the energy for water heating is received from the sun absolutely free.

CONCLUSION

Although the issue of using solar energy is present since the beginning of humanity, its implementation is today much easier by using modern technical systems for collecting and regulating the heat, all in order to provide greater comfort in architectural structures. For this purpose, many computer programs for quick and easy calculation of the necessary parameters have been developed.

This paper presents one such case, where with the help of simulation program for solar heating systems a return period of investment cost for installation of solar collectors for an apartment has been presented.

For an apartment in Podgorica, with the heating surface of 80 m^2, for a family of four, the solar collector area of about 10 m^2 satisfy about 80% of the domestic hot water and about 25% of demands for space heating per year. It is an investment that pays off for 11 years, after which all the energy obtained from sunlight is completely free for all this installation’s lifetime. Doing so, annual savings in electricity consumption of 4208 kWh is realized, and a CO_2 emission of 2802.73 kg is reduced. It may be a small amount on a global scale, but the contribution of each individual to the environment is extremely important, and should be promoted.

However, the country where this project takes place hasn’t so far recognized the importance of individual enterprise of this kind, and provides no incentives for their implementation. It is large disadvantage, but it is assumed that in the future, however, it will be corrected, to help those who wish to behave responsibly towards the environment. But we should not worry about when will that happen, because the sun by then, due to the greenhouse and global warming effect, will heat only more and more.

REFERENCES

Micev, S., Izvještaj Hidrometeorološkog zavoda Crne Gore, from 25.02.2011.
Vulićević, V., Project Report: Porodicni stan u Podgorici, from 02.06.2011.
Vulićević, V., Economic Efficiency Calculation, from 03.08.2011.

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ECONOMIC AND SOCIAL PARAMETERS IN CHOOSING THE LOCATION FOR RECYCLING FACILITIES AND BUYBACK CENTERS

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ABSTRACT

Municipal structure, such as recycling facility, must be designed according to the long-term needs, and not only the existing ones. This is because the projects of this kind usually have investment return period of 5 to 10 years. It is recommended that the location infrastructure is previously prepared, which lowers the initial costs. Optimal location is the location which completely or partially conforms to the local needs. This means that it is necessary to analyze all of the inherent characteristics of possible locations to ensure that the most appropriate location is designated for this purpose. This paper will present the method of choosing the location for recycling facility using SWOT and SCBA (Social Cost Benefit Analysis) on the example of New Belgrade. Also, paper will present results of the survey conducted on 2300 of New Belgrade inhabitants about location and possibilities of municipal solid waste elimination.

Key words: materials recovery facility, economic parameters, SWOT and Social Cost Benefit Analysis (SCBA), New Belgrade

INTRODUCTION

Recycling facilities are characterized by certain location requirements depending on the character of technology. These are primarily: traffic connectivity, treatment of wastewater produced during the process, needs for certain amount of water required for waste treatment, needs for appropriate infrastructure and superstructure, possible vicinity of central heating plant which could distribute heat energy produced during waste treatment to end users, etc. (Al-Khatib, 2007) (Vidanaarachchi, 2006). Based on the abovementioned facts, it may be concluded that locations which completely or partially conform to the local needs are considered to be optimal locations implying that in choosing the location it is necessary to first conduct an analysis of all existing characteristics of the location and then choose a design variant that will best meet these characteristics. (Badovinac, 1984). It is particularly important to consider not only economic factors in choosing the location for recycling facility and transfer of stations, but also the so-called social criterion relating to the level of acceptance of location by the population of the given area. Namely, notwithstanding evident cost effectiveness of the location for accommodation of recycling facility, social disapproval may be a direct reason for stopping the realization of such projects.

Taking into account the fact that, in initial stages of introducing recycling system and onsite waste treatment into a certain territory, the recycling facilities and buyback stations for materials recovery are considered to be *a priori* ecological hazard, as well as economically unprofitable, the analysis of some examples of locations on the New Belgrade territory (the largest residential municipality in the Balkans) will suggest answers to common questions and dilemmas in this field (Nenković, 2004.). On this polygon, a detailed social and economic analysis of possibility for locating a waste treatment plant has been conducted including the social cost-benefit analysis (SCBA), SWOT analysis, as well as a survey of local population about the possibility of building a waste treatment plant.

ECONOMIC AND SOCIAL ANALYSIS IN THE NEW BELGRADE AREA

General data

New Belgrade, with 200 high-rise buildings and 600 big housing blocks (amongst which there are many shopping centers and commercial buildings) is the largest city-type municipality in the Balkans. The New Belgrade citizens generate about 169.66 tons of waste per day. Approximate waste amount transported from the New Belgrade territory to waste dumps in one year is O [t] = 61,927 tons, where O is the waste amount generated in one year. It should be taken into consideration that the obtained data on waste amount are only approximately accurate since, in principle, they may not be found in none of the local institutes of public utilities. The problem on the territory of the New Belgrade municipality lies in the fact that its population lives in multi-storey buildings where the waste disposal system has been architecturally envisaged through chutes existing in almost all buildings, so that it is difficult to carry out primary waste selection. (Nenković, 2007). The research is focused on locations (and their immediate surroundings) in New Belgrade used for various purposes and with different beneficiary structure, but which have uniform characteristics, i.e. high building and population density in the immediate vicinity. These are the following locations: a part of the plot of the former Chinese Embassy and a plot of land along the street of Partizanske avijacije in Bežanijska kosa[1].

Methodology

Two types of analysis, the economic and the social one, have been carried out for the subject area. In economic analysis, a set of created factors has been used considering that locating the communal waste treatment plant in a housing block brings about only a change of purpose within the existing physical structure where the given location has infrastructure and local road accessibility at greater or smaller distance, which considerably facilitates the choice of criteria for determining suitability of the location. Created factors taken into consideration in the research include: 1) social level of integrity of recycling facility; 2) vicinity/distance of housing block from the nearest waste dump; 3) road accessibility (vicinity of the roads having high traffic flow); 4) possibility for meeting requirements with relation to capital; 5) conformity to the existing infrastructure and wastewater drainage system on the plot; 6) pollution - air, land, water; 7) presence of noise and vibrations coming from recycling facility; 8) new jobs opening; 9) lower rents in the surrounding area; 10) pollution reduction in the surrounding area through primary waste selection; 11) reduction of utility service charges; 12) threats to investing; 13) the issue of ownership over location (solved/unsolved); 14) opportunity to earn from primary waste selection. Besides these factors, defining the ownership and investment structure in the project has played a key role in determining justifiability of such solution, because it is often the case that contracts that are made between public and private sector do not yield results of mutual benefit. In this connection, important role of foreign investments through concession arrangements should also be mentioned since in countries undergoing transition such investments have in recents years proved to be the major mode of initiating the recycling facility construction projects (Tchobanoglous, 1993.). Through the SCBA (Social Cost Benefit Analysis) and SWOT analysis, the justifiability of building a recycling facility has been analyzed from the standpoint of ecology and economy, as well as from the standpoint of the possibility of its fitting not only into physical structure of housing settlements, but also into social structure of population living on the given territory. In the SWOT analysis, systematization of location parameters and criteria which can affect the location has been made by ranking their impacts on the given activity. Given the fact that in the initial implementation phase of the project of recycling facility location the initial social approval has the most impact on a certain territory and, consequently, on the level of integration of beneficiary’s space, this parameter has been considered to be the most important one in the analysis. Furthermore, the analysis of the location has also taken into account the road accessibility, as well as vicinity of the waste dump, which may have

1 on the subject locations, and for the needs of mater's thesis of Nenković-Riznić entitled „Public (interest groups) participation in locating materials resource recovery facilities (MRRF) in housing settlemets“, detailed analyses have been performed, also inlcuding surveys of people living on the subject locations.

positive or negative impact on activities in choosing the location for the facility. With relation to the location criteria, the most important ones are pollution reduction in the surrounding area and opportunity to earn from primary waste selection. Through the social cost-benefit analysis, a time frame for the return of basic resources invested in the process has also been specified. In this context, costs and benefits have been determined considering impacts of the facility on the community's quality of life, as well as benefits of the project for the local population. Given that these values are usually immeasurable and subjective, it has been necessary to introduce variables which could be quantified, e.g. reduction of charges for utility services, tax subsidy, etc. (Christensen, 1999.). The starting assumption employed in the SWOT analysis and preliminary SCBA has been a general type of facility of equal outline regardless of location which would be determined based on an approximate annual communal waste amount generated on the territory of the New Belgrade municipality. Within the social analysis, a survey of local population has been conducted on both locations aimed at finding out the attitude of citizens towards potential location for waste treatment plant in New Belgrade. The survey has included questions relating to the level of knowledge on this problem area, generated waste amount and composition, waste disposal methods, problems in waste disposal, and suggestions relating to improvement of waste disposal, as well as a question relating to choosing the location for recycling facility according to one’s own affinity (Nenković, 2000 a and b).

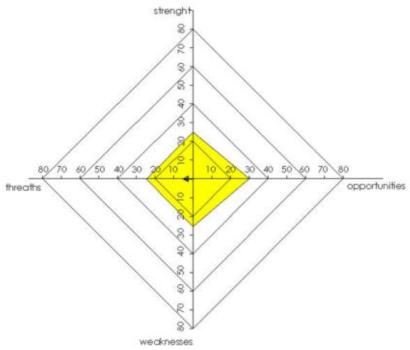
ANALYSIS RESULTS

Location No 1 – The Chinese Embassy

Based on the research results and through adequate economic analysis, the major weakness of the location, namely, undefined ownership status over the land plot presenting a very insecure "terrain" for private investments, has been determined. After defining the ownership status, this location could have significant comparative advantages over other locations precisely because of high social acceptance. Opportunities, weaknesses, strengths and threats to investing in this location are given through the following SWOT analysis (Table 1).

Table 1: SWOT analysis for the Chinese Embassy location

Location parameters	coefficient	strength			weaknesses		
		3	2	1	-1	-2	-3
level of social integrity of the facility and respond of space beneficiaries	7		14				
vicinity/distance of housing block from the waste dump	5						-15
road accessibility (vicinity of the roads having high traffic flow)	6				-6		
meeting the requirements relating to capital	2					-4	
conformity to the existing infrastructure and waste water drainage system on the plot	3		6				
pollution – air, land, water	4			4			
presence of noise and vibrations from the facility	1			1			
TOTAL:		**25**			**-25**		
Criteria	coefficient	opportunities			threats		
		3	2	1	-1	-2	-3
new jobs opening	2	6					
lower rents in the surrounding area	5						
pollution reduction in the surrounding area through primary waste selection	7		14				
reduction of utility service charges («infostan»)	4			4			
threats to investing	1						-3
issue of ownership over location (solved/unsolved)	3						-9
opportunity to earn from primary waste	6			6			

selection							
TOTAL:		**30**			**-27**		
SWOT ANALYSIS 	• the analysis indicates the fact that the strength, weaknesses, opportunities and threats are almost equal. Thus, regardless of the fact that social acceptance represents one of the most important factors for starting the program of locating the facility in this block, somewhat worse road accessibility considerably diminishes suitability of the subject location.						

While creating a cost framework (through the SCBA) for building a recycling facility, the costs of connection to the existing infrastructure and costs of pollution reduction by using filters have not been taken into consideration, as well as the cost of construction of secondary roads within the facility since they have to be the subject of a separate tender and, thus, created only after making decision on building the recycling facility (Table 2).

Table 2: SCBA – phases I and II for the Chinese Embassy location

Costs			**Σ**
Building land prices	plant 35 000m^2	unit price 15 € /per m^2	525.500 €
Construction of waste treatment plant			750.000 €
Charges for external economic effects	224424 inhabitants x 20 % lower charges for utility services (224424 x 13 €x20/100)		583502 €
TOTAL COSTS			**1.859.002 €**
SCBA			
Investment return period **1,859,002/633,465≈ 3 years**			

A comprehensive survey of about 100 inhabitants has also been conducted (survey results are given in Table 3). The survey results have shown that there is a huge interest of local population in the mentioned problem area. It has been shown that even in 99% of the cases there is no primary waste selection and that people have no previous knowledge (except for the knowledge gained through education carried out during the survey period) about this field (results show that even 82% of the people evaluate their knowledge as being poor). Average waste amount generated per inhabitant is at the level of average waste amount generated in New Belgrade, which is between 1 and 2 kg per day. Dominant type of used packaging is plastic packaging, the data which may serve for determining the technological line within the waste treatment plant. Considering age structure of inhabitants living in this block (the majority belongs to the age group over 50), expectations that they will, without stimulation, have any other motive for waste disposal in containers intended for this purpose placed in front of residential buildings, are greatly unrealistic. Precisely because of these facts, the citizens have quoted the unpleasant odors as a major problem (in 74% of the cases) and occurrence of insects (black cockroaches, yellowish brown cockroaches – in 14% of the cases). It is particularly interesting that 34% of the respondents have agreed upon the location for the waste treatment plant in their immediate surrounding. Results for the subject location have shown readiness of citizens for implementation of this type of program, of course, subject to maximal observance of all principles of environmental protection, as well as subject to prior environmental impact assessment (EIA).

Table 3: Potential location for a waste treatment plant – the Chinese Embassy location and survey results

- the waste treatment plant on the location of the former Embassy of Peoples Republic of China
- 99% of the citizens do not carry out primary waste selection
- 82% of the citizens have a poor knowledge about waste treatment methods
- approximately 1-2 kg of waste generated per day - dominant recyclables are plastics
- only 34% of the inhabitants agree upon building the waste treatment plant on the subject location

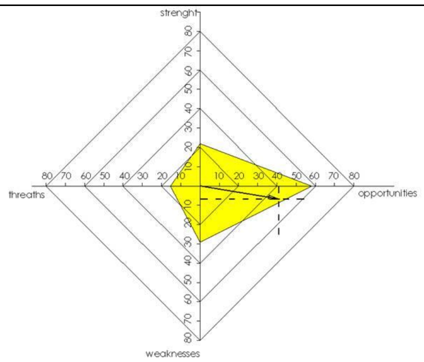
Location No. 2 – Bežanijska kosa

Suitability of the subject location is reflected in direct access to a high-speed road, as well as high level of utility infrastructure and large plots earmarked by the Master Plan of Belgrade for developing public utilities. The weaknesses lie in the initial social disapproval and great distance from the waste dump. On the other hand, because of the territory polluted by waste falling out of containers and problem with rodents, locating the waste treatment plant on this plot would reduce pollution and, consequently, improve its ecological image.

Similarly, this has proved that, regardless of ecological and economic advantages and positive effects which the waste treatment plant may have, it is not possible to build such plans without initial social approval. The SWOT analysis for this location is given in Table 4.

Table 4: SWOT analysis for location of Bežanijska kosa

Parameters location	coefficient	strength			weaknesses		
		3	2	1	-1	-2	-3
level of social integrity of the facility and respond of space beneficiaries	7				-7		
vicinity/distance of housing block from waste dump	5						-15
road accessibility (vicinity of the roads having high traffic flow)	6		12				
meeting the requirements related to capital	2			2			
conformity to the existing infrastructure and waste water drainage on the plot	3	9					
pollution- air, water, land	4				-4		
presence of noise and vibrations from the facility	1						-3
TOTAL:		**23**			**-29**		
Criteria	coefficient	opportunities			threats		
		3	2	1	-1	-2	-3
new jobs opening	2	6					
lower rents in the surrounding area	5						-15
pollution reduction in the surrounding area through primary waste selection	7	21					
reduction of utility service charges («infostan»)	4		8				
threats to investing	1			1			
ownership over location (solved/unsolved)	3	9					
opportunity to earn from primary waste selection	6		12				
TOTAL:		**57**			**-15**		

<table>
<tr><th>SWOT ANALYSIS</th><th></th></tr>
<tr><td>
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STRENGTH: high level of utility infrastructure, excellent road accessibility
WEAKNESSES: initial social disapproval, great distance from the waste dump
OPORTUNITIES: pollution reduction in the surrounding area, the use of bio-gas
THREATS: lower rents in the surrounding area
</td></tr>
</table>

Price framework has been calculated using the SCBA as given in Table 5.

Table 5: SCBA – Phase I and II for the location of Bežanijska kosa

Costs			Σ
Building land price	the plant 35 000m^2	unit price 11 € /po m^2	385000 €
Construction of the waste treatment plant			750.000 €
Charges for external economic effects	224424 inhabitants x 20 % lower charges for utility services (224424 x 12 €x20/100)		583.617 €
TOTAL COSTS			**1.718.617 €**

SCBA
Investment return period **1,718,617€/644686≈ 2 years and 9 months**

Based on survey results, and as expected, the subject area has the youngest age structure (over 45% of the population is under 50 years of age) and, thus, its citizens are very much interested in initiating the entire action, as well as in responding to the survey. Survey results (Table 6) have shown that in the subject area the level of knowledge (prior to the survey) about the issue is very high (namely, about 80% of the citizens are acquainted with this ecologically justifiable waste reduction system).

The waste amount per inhabitant is at the level of the New Belgrade average, which is between 1 and 2 kilograms per day. The citizens most often use cardboard (32%) and plastic packaging (47%), but they do not separate household waste. However, considering the number of stories in buildings, as well as primary waste disposal in containers placed next to roads, there is a great potential on this territory regarding possibilities for primary waste selection to be done in containers intended for this purpose. The major problem of waste disposal on this location faced by inhabitants of Bežanijska kosa is a great number of rodents due to inadequate waste disposal, as well as unpleasant odors. Even 89% of the citizens who live on this location agree that the public should be informed through public media and local representatives about advantages of waste recycling over other ways of waste elimination. Respondents have also shown a great interest in potential benefits which they could get for collecting secondary row material, as well as in form of reduced charges for “infostan” (aggregated collection system of bill charges). The most interesting survey results relate to threats to quality of life, as well as to location for the waste treatment plant. 74% of the population has the opinion that the quality of life would not be under threat, still 65% of them have opted for locating waste treatment plant outside their housing block. The reasons for this should be sought in lack of readiness of local population to accept evidently ecologically justifiable solution for waste elimination despite its comparative advantages, as well as in the principle "not in my backyard" which is typical for citizens of big cities all over the world.

Table 6: Potential location for waste treatment plant in Bežanijska kosa and survey results

survey area
potential location for waste treatment plant

- vicinity of the transformer station and heavy traffic road of Partizanske avijacije
- the youngest age structure - high survey response rate
- 79% of the inhabitants have a poor knowledge about waste treatment methods
- they don’t see a reason for primary waste selection since there is no waste treatment
- dominant recyclables are plastics (47%) and cardboard-paper (32%)
- even 65% of the inhabitants disagree on building the waste treatment plant on the subject location

Comparative analysis

Through the next comparative analysis, we have tried to determine comparative advantages of one location over the other based on the following six basic criteria: environmental pollution reduction, degree of meeting the urban planning and technical criteria, legal property relations, cost effectiveness and, in particular, social acceptance.

Table 7 shows the assessment of degree of meeting the mentioned criteria according to the system of suitability: suitable, tentatively suitable and unsuitable.

Table 7: Comparative analysis – local experiences

	ecological context (worsening of living conditions)	economic context	urban planning and technical criteria (level of spatial integration)	social and institutional criteria (social level of integration)	legal property relations	criteria for physical structure (design and technology)
Chinese Embassy	+	+	+-	+-	-	+-
Bežanijska kosa	-	+	+	-	+	+-

The abovementioned table suggests the fact that in choosing the location for waste treatment plant on the New Belgrade territory, the socio-institutional, i.e. urban planning and technical criteria, have played a key role. The said comparative analysis has included somewhat less relevant criteria and actual terrain data for the site considering that, in current social circumstances and so far unraised issues of engaging population in the decision-making process, it has been impossible to determine actual situation in this field.

General recommendation for process of planning that will follow is to create an information base for all mentioned locations and thus determine key conditions of the location, which could contribute to more realistic comprehension of problems and threats to investing.

CONCLUSIONS

Although the initial research limitations (lack of relevant information on the building land prices, impossibility of creating prices for construction of secondary roads within the waste treatment plant, as well as filter installation and maintenance costs) have influenced the fact that, in economic sense, the results of social cost-benefit analysis should be taken with a grain of salt, previous SWOT analysis shows that comparative advantages of location are greater considering the level of social integrity in the process. Namely, in cases of full or partial participation of local government, stakeholders and population in particular, the degree of possibility to introduce recycling process to certain plots on the New Belgrade territory proportionally increases.

Besides the quoted interest groups, it is also necessary to include other stakeholders in the decision-making process in choosing the location for recycling facility. Except for decision makers, at the state, city or local government levels, it is also necessary to include state and private industrial and business sector into informing and decision-making processes.

Only if relation at the level of administration-citizens-investors-interest groups is realized, it would be possible to expect shorter period of population adaptation to newly created conditions and, thus, faster investment return period.

Based on the abovementioned results of the social cost-benefit analysis and SWOT analysis, it may be concluded that creation of a uniform recycling system (which would imply not only initial decision making on choosing the location for recycling facility, but also the definition of waste collection system on the New Belgrade territory) must be followed by active participation of inhabitants.

Based on the abovementioned analyses, the following researches results may be derived:

- education of citizens must be carried out according to their own affinity regarding the location, but also according to the existing site location conditions (in the context of waste amount and composition of certain recyclables on the given territory, as well as economic advantages);
- basis of population education must be created based on realistic economic benefits from the location in the immediate vicinity of housing settlement because, notwithstanding the key role of social factors, economic indicators may be extremely important in choosing the location. At the same time, the focus should be placed on economic advantages for population (reduction of charges for city building land, tax reduction, benefits from selling primarily selected waste), because they may also be basic initiators of raising population awareness about the given problem area;
- it is also necessary to create in advance a tariff system for primarily selected waste, which will be presented to the citizens during education process;
- within education, it is necessary to insist upon positive environmental impact, particularly to members of local environmental non-government groups, in order to avoid possible conflicts in the space;
- education of investors and stakeholders should be based on an economic approach to accommodation of a waste treatment plant on a plot, at the same time indicating the advantages of locating the recycling facility in the vicinity of bigger community plants (central heating plants), or on plots with the exiting infrastructure, which would lessen initial investment. It is also necessary to suggest to the business sector the necessity to avoid investing in locating the waste treatment plant on plots where it is necessary to first invest in demolition of existing structures (such as Chinese Embassy) because in later phases such initial investments are exceptionally unprofitable. It is also necessary to avoid plots with unsolved ownership relations, because the procedure may become more time consuming and additionally more legally complicated;
- it is not sufficient to meet all requirements regarding economic and ecological criteria for the location if there is no initial social approval, given that it is easier to change nature and negative economic circumstances than people’s attitude.

All above conclusions, in addition to the implementation of the project of choosing the location for recycling facility, may also be implemented on all other complex urban phenomena and forms which in their realization, besides participation of economic parameters in decision making, also include social parameters (participation of inhabitants).

Only in case the relation at the level of administration-citizens-investors-interest groups is realized, economically more consistent realization of the project may be expected, without obstacles like charges for the realized recycling facilities which would be high for citizens.

REFERENCES

Al-Khatib I., Arafat H., Basheer T., et al. (2007): *Trends and problems of solid waste management in developing countries: A case study in seven Palestinian districts*, Waste Management, Volume 27, Issue 12.

Badovinac P. (1984): *Mikrolokacija u urbanom planiranju – doktorska disertacija*, JUGINUS, Beograd.

Vidanaarachchi C., Yuen S. and Pilapitiya S. (2006): *Municipal solid waste management in the Southern Province of Sri Lanka: Problems, issues and challenges*, Waste Management, Volume 26, Issue 8.

Mega, V.: (1999): *The participatory city- Inovations in the European union*, Social Sciences Selection, Vol.2 num.11, www.unesco.org/most/vmega.htm

Nenković, M (2004): *Mogućnost uvođenja sistema reciklaže na teritoriji opštine Novi Beograd*, naučni časopis ECOLOGICA, Društvo za širenje i primenu nauke i prakse u zaštiti šivotne sredine Srbije i Crne gore, Beograd.

Nenković, M.(2007): *Učešće javnosti (interesnih grupa) u lociranju OMR postrojenja (postrojenja za obnovu materijalnih resursa) u stambenim naseljima*- magistarska teza, Arhitektonski fakultet, Beograd.

Nenković-Riznić M. (2010), *Possibilities for recycling facilities placement in Serbian cities*, Međunarodni naučno stručni sipozijum INSTALACIJE I ARHITEKTURA, Zbornik radova, Arhitektornski fakultet Beograd, 2010, str. 133-147.

Nenković-Riznić M. (2010) *Ekonomski faktori u izboru lokacije reciklažnih postrojenja i otkupnih stanica*, Časopis "Reciklaža i održivi razvoj“ broj 1. vol 2., Tehnički fakultet u Boru, str..9-19.

Tchobanoglous , G., Theisen, H., Vigil, S.(1993): *Integrated solid waste managment - Engineering Principles and Managment issues*, McGraw-Hill International Editions, New York.

Christensen, T.H.; Cosso, R.; Stegmann, R.(1999): *Waste managment and treatment of Municipal solid waste (vol. V)*, CISA (Environmental sanitary engineering centre, Cagliari), Sardinia.

Štiglic, Dž. (2004): *Ekonomija javnog sektora*, Ekonomski fakultet, Beograd.

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ECONOMIC ACTIVITY AND THE ENVIRONMENT IN SERBIA

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ABSTRACT

This paper shows the economic activity and environmental conditions in Serbia. Then the work will be displayed in the assessment of damage to the environment, as well as research results. It will be shown the need for investing in environmental protection, and then are represented by the results obtained.

Key words: economic value, environment, investment.

INTRODUCTION

The relationship of economic activity and environmental protection in Serbia, half by the end of the twentieth century, does not deviate from the general, global, rule of law in this area. Moreover, it exhibits almost all features these principles, in terms of the SEE countries and countries in the transition. As for the second half of the twentieth century, the consequences of economic development on the environment, in Serbia, can be seen as the segments, such as effects on air, water, land, etc.. As well as chronologically, the effects during the different stages. There are three stages, during which they created three "layers" damaged environment in Serbia.

RATING THE ECONOMIC VALUE OF ENVIRONMENTAL DAMAGE BY MEDIUM IN SERBIA

Application of the method

From February to September 2004, in preparation for drafting the National Environmental Action Plan, NEAP, the European Agency for Reconstruction has initiated as part of the Environmental Capacity Building program 2003, a study by title Assessment of the Economic Value of Environmental Degradation in Serbia. The study represented the first attempt to quantify the amount of economic damage to the environmental medium in Serbia. [6]

Benefit transfer method is reflected in the fact that the results of previous studies evaluating environmental. The most commonly performed in other countries and regions transfer, with the necessary corrections, the conditions of the country is carried out researches. As the correction factors are usually taken the average income calculated according to purchasing power parity, the size and characteristics of the population, geographical conditions, the level of Inter-environment, the level of urbanization, the previous state of the environment and so on. Relying on the results of previous studies conducted in different geo-physical and socio-economic conditions are not always right. The described procedure gives better results if a local impact is weaker. However, comes to global influences, the results can be considered correctly.

Given the lack of previous analysis of this kind in Serbia, and the lack of at least one analysis done using the method of conditional evaluation, the authors applied the rather befit transfer easy way. He consisted in: a) assess the emissions of pollutants b) the application for Serbia adjusted unit value per ton of pollution, c) the designation of minimum and maximum values.

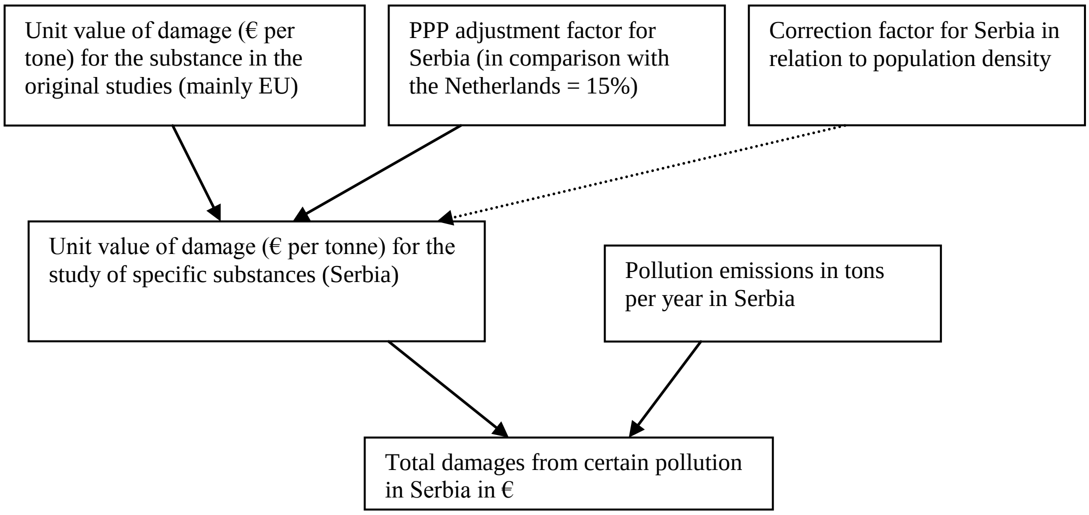

Figure 1. Graphic representation of the economic damage to the environment [3]

As for the valuation of damages time NATO campaign, it should be noted that the described method and applied in the study (Jantzen, Pesic 2004) gives a picture of the economic value of flows of pollution, but no funds. The fact that the environmental damage caused middle in the third stage, today, the character will have the most funds, and should be further analyzed.

Results

In a study (Jantzen, Pesic 2004) damage to the environment is addressed by segment, etc the media in which the emission of pollutants occur. In the chapter dedicated to the economic damage to air, analyzed are: a) emissions, "greenhouse gas" causing global climate change, b) acidification, created emissions of sulfur dioxide, nitrogen oxides and ammonia, c) formation of troposphere ozone, emissions of VOC (volatile organic components), d) and particulate matter emission of PM-10, as well as e) emissions of lead from gasoline.

By applying unit values are adjusted damage, certain low and high values of damage annually in Table 1.

Table 1: Total damage (low and high level) of air pollution in Serbia in 2003. [5]

Emissions CO_2 year	45592200 t		
Unit damage €/t		1.31	10.0
Total damage		**59,6 million €**	**455,9 million €**
Emissions SO_2 year	525000 t		
Unit damage €/t		541	1.341
Total damage		**284 million €**	**703,8 million €**
Emissions NO_3 year	161000 t		
Unit damage €/t		87	145
Total damage		**14 million €**	**23,3 million €**
Emissions NH_3 year	90000 t		
Unit damage €/t		39	332
Total damage		**3.5 million €**	**29,8 million €**
Emissions VOC year	97000 t		
Unit damage €/t		7.6	15.5
Total damage		**0,74 million €**	**1,5 million €**

Emissions PM-10 year	60000 t		
Unit damage €/t		1.174	2.126
Total damage		**70,5 million €**	**127,5 million €**
Emissions Pb year	351 t		
Unit damage €/t		40.147	80.294
Total damage		**14,1 million €**	**28,2 million €**
TOTAL	**DAMAGE: AIR**	**447,2 million €**	**1370,1 million €**

When it comes to water, assessment of damage was limited to the discharge of waste water from industry and households, the release of nutrients from livestock farms, over-exploitation of groundwater, especially in Vojvodina. The obtained results to range from approximately € 180 million to 575 million € per year. If you include the heavy metals in rivers, especially in the sediments, the amount of damage is significantly increased, ranging from 640 to 2,800 million € per year. This drastically increases the total damage occurs not only as a result of higher unit values for certain heavy metals (lead of 832 to € 43,449/t, cadmium from 43,449 to € 103,491/t, arsenic 43,450 to € 51,250/t, zinc from 166 to € 43,500/t) but also as a result of high concentrations of heavy metals in river flows, especially in the Ibar River. However, we believe that the analysis of water damage to be repeated and some other method to get a realistic picture. As for the disposal and treatment of him in Serbia, the situation is far from satisfactory. Improper disposal of municipal and hazardous waste, including medical, creates great pressure on the environment. This pressure is manifested through the emission of methane from dump, leakage of water from the landfill not acceptable, fly ash as a result of spontaneous fire, waste, pollution of land and taking illegal waste dumps and so on. All this creates a total damage of around 100 to 275 million € per year. [9]

That the analysis of economic activity damages the environment in a complete and comparable with similar analysis in the European Union, the authors have included noise, especially in cities, traffic and industrial plants. Environmental noise is considered unacceptable by over 50 dB (A). It is estimated that the damage range from 57 million to 181 million € per year. We believe that the obtained values should be reconsidered, especially in terms of calibration factors, applied to benefit transfer (effect of noise on property prices in cities).

As a special chapter is included in the analysis of the phenomenon of wind erosion in Vojvodina, inadequate procedures originated in agriculture. The consequence is the erosion that leads to loss of humus, layer, resulting in reduced soil fertility and yield and revenue losses from agriculture. This segment damage was estimated at 80 million € per year. However, to make the picture complete, it is necessary to include the damage from other types of erosion in central Serbia, and damage from inadequate application of mineral fertilizers and pesticides in agriculture of Serbia. Unfortunately, the authors study data on the intensity of these damages were not available.

Summing up the estimated amounts, the available data mostly for 2003. year, the authors came to a total value of claims, which range from 2500 € to 861 million.

If you are involved and damage from heavy metals in rivers, this range varies from € 1300 million to 4700 million €. However, this should be taken with caution, as damage caused by heavy metals in river sediments have the character of the stock of pollution damage (pollution stocks) rather than the flow of pollution (pollution flows), as well as other values obtained in the analysis. Also, when to include the damage deposit of industrial waste, pollution of land inadequate use of pesticides and fertilizer and so on, would receive the value of the fund pollution damage, and no 5 would be appropriate to compare them with the level of GDP for a given year. Estimated value of funds of pollution should be considered in the context of the estimated national wealth, which has the character of the fund. We are not aware that there valuation of national wealth Serbia in 2003 year, and this higher range will not damage or put in relation to GDP as it would be theoretically inconsistent, nor with national wealth whose value we do not have.

In assessing the amount of future environmental damage in Serbia, the authors Jantzen and Pesic (2004) developed nine possible scenarios for a period of ten years. From the standpoint of economic growth were considered three options: A) slow growth, with an average annual rate of 1.8%, slightly above the population growth, b) intermediate growth rate, a rate of 4.73%, based on the current growth of Poland, Hungary and the Czech Republic (Economist 2004), and C) with stop rapid growth of 8%, such as Russia (Economist 2004). [7]

From the stand point of the dynamics of shame, are also considered three options: A) variant ceteris paribus, which implies that the dynamics of damage followed the growth of the economy, etc. that there is no technological and structural changes; B) variant with autonomous technological progress and structural changes, leading to reduced pollution per unit of GDP of 2% C) using a variant of the environmental protection measures, and in the context of EU accession, reducing the damage to the Unit of GDP of 5%.

Starting from a lower amount of damage overestimated in 2003. year of about € 860 million, received nine possible scenarios, of which only three (green) include environmental remediation protection in Serbia. Other scenarios show a smaller or larger increase in damage.

Table 2: Projections of damage (small amounts) to the environment in Serbia 2013th [8]

	Environmental policy		
Economic growth	0 %	Technological progress - 2 %	EU policy - 5 %
Low 1.80 %	€ 1027960000	€ 842800000	€ 621230000
Medium 4.73 %	€ 1365250000	€ 1125830000	€ 837060000
High 8 %	€ 1856670000	€ 1540130000	€ 1155770000

If we started from a higher amount of estimated damages of about € 2500 million, would receive the following value of the damage in 2013. year (Table 3), only three of these point to a better state of the environment.

Table 3: Projections of the damage (higher costs) to the environment in Serbia 2013th [8]

	Environmental policy		
Economic growth	0 %	Technological progress - 2 %	EU policy - 5 %
Low 1.80 %	€ 2988250000	€ 2450000000	€ 1805900000
Medium 4.73 %	€ 3968750000	€ 3272750000	€ 2433310000
High 8 %	€ 5397310000	€ 4477000000	€ 3359800000

ASSESSMENT NEEDED INVESTMENTS IN ENVIRONMENTAL MEDIUM IN SERBIA

To obtain a complete picture of the scenario variants of the measures of environmental protection, in context of EU accession, the authors of previous studies have had the task of having to realize investment in the preparation of National Action Plan for Environmental Protection of the NEAP and the National Environmental Strategy, NES. If there were methodological concerns in the process of evaluating damage to the environment medium, in that there was less wandering in the application of methods of assessment required investment the environment in Serbia? Bearing in mind that the contents of the EU, etc. all provisions of the directives, regulations and recommendations relating either directly or indirectly on the environment in the EU and on the basis of attitudes NEAP forums, the authors Jantzen and on foot made a review of financial needs necessary to implement the National Environmental Strategy, NES.

Method

Starting point for estimating the necessary investment in the environment was a deviation of the current situation, the segments of the middle (water, air, soil, etc.). Certain deviations require investment, which are determined by the cost of introducing and implementing the most economical currently available technologies. When we say current technology, we refer to today, the existing methods and procedures and the most economical one. If in the future, for example, appeared a new method for the elimination of sulfur dioxide from the air, which would be more efficient or cheaper than existing (in terms of lower costs for the elimination of tons of SO 2 emissions of pollutants) pictures cost would certainly changed. Therefore, a certain level of investment by type and extent of needs, as well as the most cost-effective technologies today. On this basis, have been designed and an operational maintenance and use of newly introduced system.

The analyzed time horizon of ten years, divided into two periods, the first of the beginning of 2005. end of 2009. and the other from early 2010.- 2014. year. Total expenditure as an investment, and operating, for environmental middle are around € 4 billion, for a period of ten years. It should be borne in mind that costs for existing infrastructure (etc. In the field of waste management, water collection waste, purification air etc.) As well as existing institutions (the control and supervision of environmental management at all levels, etc.) were not assessed. So the word is just about the additional financial resources are necessary to improve the existing system and closer to EU standards. Also, some of the analyzed investment is not only the ecological character, but will have other multiple uses. However, expenditures that are not primarily ecological character, but they have indirect positive effects were not included in this analysis.

RESULTS

According to projections made out (Table 4) total costs range from € 26 million per year, first, to 720 million € per year at the end of the period.

Table 4: Total annual expenditures and direct actions to improve environmental protection in Serbia (excluding expenditure on indirect actions) in million € (by calculation) [4]

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	**Total**
Waste	€ 6	€ 36	€ 52	€ 70	€ 138	€ 138	€ 133	€ 139	€ 144	€ 150	€ 1006
Energy	€ 4	€ 2	€ 54	€ 47	€ 51	€ 141	€ 192	€ 243	€ 227	€ 224	€ 1205
Mining		€ 2	€ 0.3	€ 10	€ 12	€ 2					€ 26
Industry	€ 0.8	€ 22	€ 36	€ 26	€ 23	€ 23	€ 26	€ 30	€ 33	€ 38	€ 258
Transport	€ 0.1	€ 1	€ 15	€ 12	€ 12	€ 68	€ 79	€ 94	€ 107	€ 127	€ 515
Agriculture	€ 1	€ 12	€ 14	€ 15	€ 15	€ 11	€ 12	€ 13	€ 15	€ 16	€ 124
Land	€ 0.1	€ 2	€ 2	€ 2	€ 3	€ 3	€ 3	€ 13	€ 3	€ 3	€ 24
Air	€ 0.4	€ 5	€ 17	€ 18	€ 14	€ 80					€ 135
Water	€ 11	€ 14	€ 14	€ 16	€ 22	€ 108	€ 115	€121	€ 127	€ 134	682
Nature	€ 2	€ 2	€ 3	€ 1	€ 4	€ 3	€ 3	€ 3	€ 3	€ 3	€ 27
Noise	€ 0.3	€ 0.5	€ 1	€ 0.9	€ 1	€ 1	€ 2	€ 3	€ 4	€ 5	€ 19
Radiation	€ 1	€ 1	€ 1	€ 1	€ 3	€ 18	€ 18	€ 18	€ 1	€ 1	€ 63
Total	€ 26	€ 99	€ 213	€ 219	€ 298	€ 595	€ 583	€ 667	€ 664	€ 720	€ 4085

In addition to be seen and expenses that are not primarily focused on the environment, but indirect have effects, such as the construction of transport infrastructure (road and rail bypass, facilities for receiving and processing of drinking water, improvement of district heating systems, air fleet modernization regeneration of road transport). By our rough estimates they are about 4 billion €. These expenses are not considered investments in the environment, but will have positive external effects.

As regards direct expenditure, they gradually increase as a result of economic development opportunities and increase their own funding. At first these are mostly modest costs of creating adequate infrastructure, creating an adequate legal and regulatory system, improve supervision and administration, all of which does not put capital-intensive activities. At a later stage, will be more and more capital-intensive investments, but the will and the relationship of investment and operational expenses changed. At the beginning of the structure will certainly dominate the investment (systems for waste water treatment, sanitary landfills, air filters, etc. projects recycling.) Until later all will be significant costs of managing and maintaining existing systems, etc. operating costs.

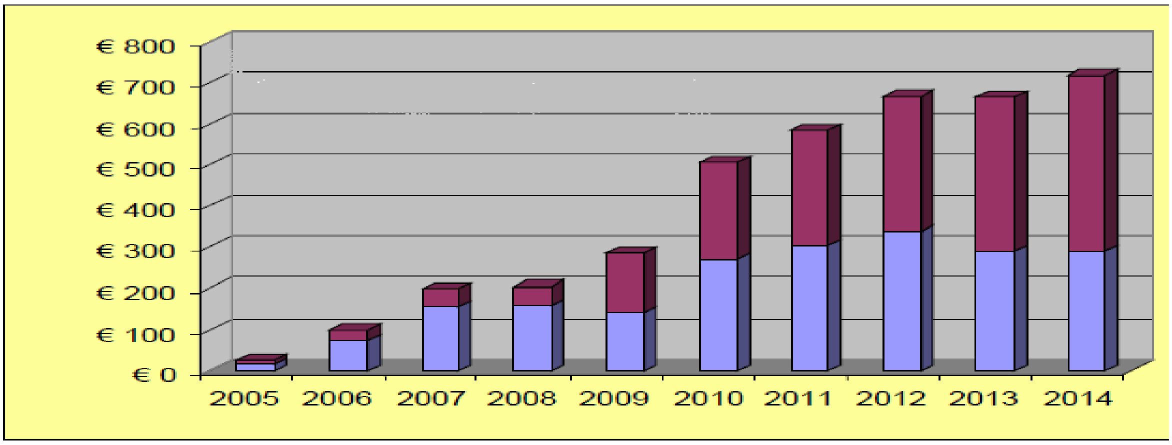

Figure 2. The dynamics and structure of total expenditure on secondary schools in Serbia [2]

It can be concluded that the highest costs in the energy sector will be about 30%, and waste management, about 25%, water 17%, transport 13%, 6% of industry and agriculture 3%. As for the costs associated with air, it is only about costs not included in the cost of the energy, transport and industry [7]. If you would turn on them, the costs related to air quality in Serbia amounted to approximately € 1.7 billion, or about 41.5%. Significant investments are expected in the solid waste, averaging about 15 million € per year. An operational costs for managing sanitary landfills will grow, and at the end of the period reached full level of about 20 million €. Cost of reclamation of existing dump will begin to occur in 2009. of at least € 2.5 million per year. Operating costs for solid waste collection system will grow to a level of about 70 million € per year, at the end of the period. Investment costs of recycling and composting, provided for in the long stage, will amount to an average of about 14 million a year, while operating expenses increased by at least 15 million € and there are stabilized. [1]

To achieve the goal of the necessity of treatment 50% of industrial wastewater by 2014. year, will require about 10 million € per year, in terms of new investments, while operating costs have risen to the level of 17.5 million € in 2014. year.

CONCLUSION

The benefit of implementation of EU standards for environmental protection is difficult to quantify without precise projections of economic growth, etc. pace and structure of the economy, for at least twenty years. We are not aware that there are such macroeconomic projections for Serbia, because we can not see any relationship between costs and benefits of applying EU standards, as a percentage of future GDP.

If we, in turn, tried to analyze the relationship of economic activity and environmental secondary schools per capita dimension, assuming that the population of Serbia will not change drastically the next decade, and assuming that the application of measures and standards of the EU this area, could lead to a reduction damage at least 50%, we can conclude that the benefit-cost ratio ranged from 1.1 to 3.1 after the first decade of implementation. Such cost-benefit ratio could be even better after the second decade of the 2014th by 2024. Because it would reduce investment costs, both in absolute and relative level, making room for operational costs, technical systems and social institutions, dedicated to environmental middle. How will mention cost-benefit ratio precisely amount, depends not only on environmental policy, but the pace and especially the character of the sustainability of economic development of Serbia.

REFERENCES

The Economist, 2004, Emerging-market indicators, page 102, London, issue June 12-18, 2004.

Ecotec 2001, The Benefits of Compliance with the Environmental Acquis for the Candidate Countries, in co-operation with EFTEC, IEEP, Macroeconomic and TME, London.

UN EEC (2003) Showing the environmental situation in Serbia in 2002. The (film) United Nations European Economic Commission, Committee on Environmental Policy.

Gregory, R. (1991) Interpreting Measures of Economic Loss: Evidence from Contingent Valuation and Experimental Studies. Journal of Environmental Economics and Management.

Group G 17 (1999) Final account. Economic Consequences of NATO bombing: An evaluation of damage and resources needed for economic reconstruction of Yugoslavia order. M. Dinkic, Poles Culture, Belgrade.

Jantzen, J. and Pesic, R. (2004) Assessment of the Economic Value of Environmental Degradation in Serbia & EAR DHV.

Kaderjak, P. and Powell, J. (1997) Economics for Environmental Policy in Transition Economies - An Analysis of the Hungarian Experience. Edward Elgar, Cheltenham UK.

D. Pearce W. Turner and K. (1990) Economics of Natural Resources and the Environment. Harvester Wheatsheaf, New York and London.

Pesic, R. V. (2002) Economics of natural resources and environment. Faculty of Agriculture, Belgrade.

King and Mazzotta, 2004, Ecosystem Valuation, Univ. of Maryland, and Univ. of Rhode Island.

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TRADE AS A FACTOR OF SUSTAINABLE DEVELOPMENT OF URBAN ENVIRONMENT

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ABSTRACT

The primary task of economic development planners is to ensure "growth with a human face". While these ideas may seem utopian, we believe that trade (as one of the most propulsive activities) could play an important role in empowering the less developed regions. Trade as a business even now has a key role in supplying the population and economy. The state must take care that residents of the entire territory of the republic can buy basic groceries. Local economic development planners also need to take into consideration the effort included in the revitalization of trade because the goods retailers needed a commercial basis for a strong local economy. It is necessary to provide conditions for trading activity (re) moved in less developed areas. Consequently, there would be hiring of local workforce, which would result in increasing levels of consumption, and then saving. Because of the many limiting factors leading to the disappearance of the center, when it comes to retail, concern about the wider community in this area is not surprising, nor are the intentions of policy makers to carry out immediate rehabilitation of the trade center area. For preparation of a strategic revitalization (narrow urban areas) is required sincere cooperation between the private and public sectors.

Keywords: trade, retail, private and public partnership, rehabilitation center.

PLANNING AND ECONOMICS OF THE FREE MARKET MATCHES

Growth and development of national and / or the global economy achieves its purpose only if it results in increasing the quality of life of residents in a particular area. The primary task of economic development planners is to ensure "growth with a human face". It is essential that increased social wealth is distributed in proportion with the invested work allowing the newly created material to reinforce the wealth of the richest individuals as well as the ones in the lowest social ladder. While these ideas may seem utopian, we believe that trading (as one of the most propulsive activities) could play an important role in empowering the less developed regions.

In the twentieth century both extreme concepts of economic system proved unsustainable. In the first half of the twentieth century the idea of "pure competition", in which factors of production and businesses were driven only by the "invisible hand of the market", resulted in the greatest economic crisis of all time. States that have decided to have a monopoly over the management of economic system, and to negate the market towards the end of the millennium have experienced failure1. Based on the mistakes that were made in the past it can be concluded that the most appropriate policy is that the creators move between two extreme poles (the planned economy and free market competition).

History has shown that the state is not a good entrepreneur, but that market does not always lead to optimal system state. Hence it is necessary to let the market play a key role under the constant supervision of the state which should contribute to the stability of economic systems and encouraging

1 Although the Socialist Federal Republic of Yugoslavia (SFRY) in the early fifties even managed to break away from the Soviet model of growth and to decide on indigenous economic system (read: self governing), the crisis that struck countries of the former USSR (inflation, shortages of basic foods ...) was almost the same outline of the former common state in which she herself belonged to Serbia.

the development of underdeveloped areas conducting its measures. It is in the field of economic policy implemented by the government, trade policy in the twenty-first century plays the key role not only in preventing abuse of market direction but also in commercial activities in less developed areas in order to enhance the quality of life and work in given areas.

DIRECTING TRADING ACTIVITIES TO UNDEVELOPED AREAS

The macro aspect

The statement given in the title may seem, but only seemingly, as an oxymoron, since for a long time the view that the capital should itself that determines the activity and location at which to fertilize. According to the given logic, most of the major trading companies should be due to high concentration of population and purchasing power even more important, its retail outlets to locate only in Belgrade, and perhaps even in Novi Sad and / or not. If we apply the same logic from the perspective of Serbian citizens, everyone should move to Belgrade, because there are the best conditions in terms of utility infrastructure, the amount of average salary range of cultural institutions that are at our disposal ... It is obvious that one or other aspect have the same problem. For Serbia, or any other country, it would not be suitable for the entire population to migrate to the capital, nor the situations in which the total economic activity (eg, trade) takes place only at one point.

Trade as a business today has the key role in supplying the population and economy. For commercial companies is to decide where, for example, to open a retail store2. The state must take care that residents of the entire territory of the republic can buy basic groceries.3 Harmony between these two views can be achieved by economically active (primarily trade) policies that would have resulted in the construction quality of infrastructure (roadways, providing connections to power / water / gas / telephone network). In such a way the necessary preconditions for economic decentralization are fulfilled, because it is beyond real to expect that a modern hypermarket opens at a distance of 100 kilometers from the capital, if the inhabitants of the capital cannot get to that very point of sale in the shortest period of time by a quality road. Through tax incentives, by providing almost free city-building land outside the capital, the traders would be stimulated to proliferate their activities in the wider area of the capital. In this way multiple effect is achieved: from the improvement of supply for most of the country to hiring labor in parts of the country which, as a rule, struggle with high rates of unemployment.

"Local economic development planners also need to take into consideration the effort referring to the revitalization of trade because the goods retailer needed a commercial basis for a strong local economy" (Fitzgerald and Leigh, 2002). The philosophy of this concept is formed as "a brave retail point" ("*virtuous cycle of retail*") which is explained in the publication by U.S. Department of Housing and Urban Development (1999., P.3). The essence of the concept is the trade to be seen as the driving activities in less developed regions (see illustration 1).

2 "The entire system of trade marketing plays an important macro and micro sites. Macro location, including selection of local or regional area for the construction of a retail outlet, and determines the specific micro-location site for the construction of certain facilities to the achievement of the higher results of operations and meet customer needs. "/ underlined by: D.B. / (Končar, 1998).

3 A similar analogy can be applied at the city level (municipalities). Local authorities across the General Urban Plan (GUP), as well as on the importance of urban plans below, determine the precise location where they can build retail stores. Consequently, it allows the companies to decide on the locations of its facilities, but also takes into account the wider social interest, including the supply for a particular city neighborhood basic foodstuffs.

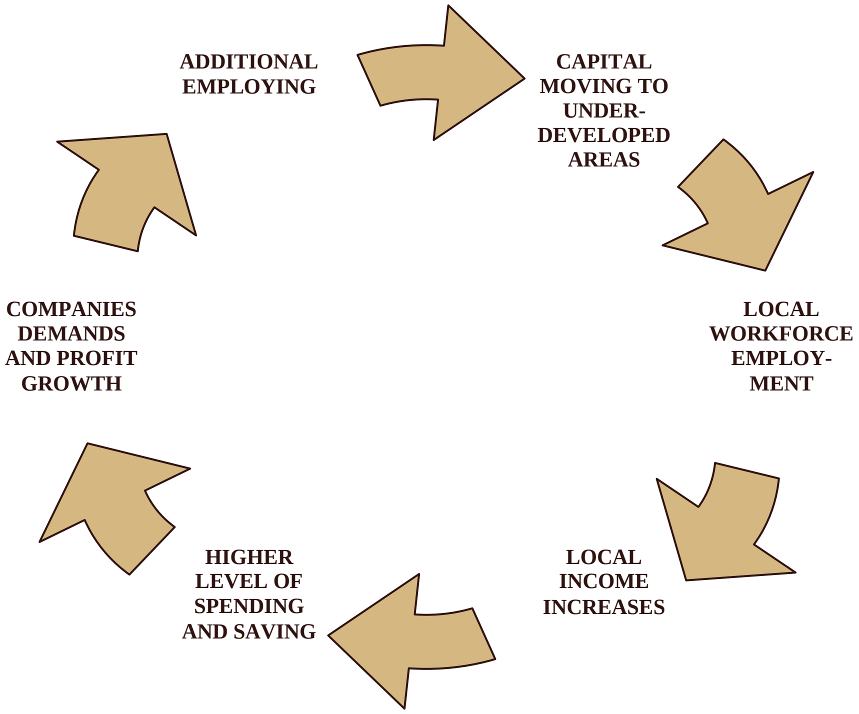

Figure 1. Brave wheel of retailing

The concept of "virtuous retail point" can be applied both at the *state level* (encouraging investment in less developed regions) and the *level of local government* (targeting investment in underdeveloped parts of the city / municipality). The point is that the trading activity moves to less developed areas. Consequently, employing a local workforce that will result in increasing levels of consumption, and then saving4. The growth will be realized levels of consumption and trade effects, since higher consumption corresponds with the increase in demand. All these processes will lead to increasing trade company profits and additional employment. Besides these benefits, the implementation of "virtuous retail point" provides a better supply of goods and services in less developed areas. In this way, all consumers have the right to exercise choice. Parts of the town which had a problem with increasing crime, also recognize some benefit by implementing the concept described, since inverse proportionality is established between the level of performance of legal duties and vandalism (Crime).

"Brave wheel of retailing is self-sustaining. Creating sustainable economic development and providing communities with low-income countries to achieve higher levels of earnings, even better buy, a stronger tax base and more work" (*U.S. Department of Housing and Urban Development, 1999*).

Micro aspects

With the emergence of urban agglomerations (ie. metropoliten areas) there have been "permanent changes caused by scientific and technological innovation, urbanization, depopulation of narrow urban centers, population explosion, and the decentralization of retail activity" (Končar, 1998). The data from the United States best display the new circumstances of business running: the largest volume of retail activities in 1999 was seen at shopping centers5. Note that 65% of total sales in the U.S. is

4 The trade effects that will be achieved should not be surprising, since it is a labor intensive activity in which the presence of manual human labor can hardly be avoided. In today's trading there are also expressed computerization and automation processes. However, human labor is still irreplaceable.

5 "In the United States in 1999 there were over 44,000 shopping centers. They contributed 47.5 billion dollars of tax revenue from the sale and they had a staff of 8% of the total number of workers who are not employed in

realize at the discount stores, and that 72% of total sales is realized after 17 hours or on Sundays. The average time a customer spends in moles decreases as a result of the fact that people have less time to do shopping6.

It should not be surprising that the retail activity is moved to the suburbs. *First*, the central city areas are reserved for "business life" as opposed to the suburbs, which takes place in "private life" of citizens. Retail stores are increasingly located on the outskirts, in order to be closer to the customers' homes. *Second*, the center is impractical place for opening large retail stores because the infrastructure, as a rule, does not match the requirements of modern trade. Persistent problem in central urban areas is the lack of parking spaces so possible Sunday shopping in that area would have been unthinkable. *Third*, office space rents in the central city area are several times higher than in the suburbs. The problem is additionally complicated by the fact that it would be impossible to open an object of a few tens of thousands of square meters in the city centre, because there simply is not enough space available.

All these factors contributed to the disappearance of the center, when it comes to retail, and hence the concern of the wider community in this area is not surprising, nor are the intentions of policy makers to carry out immediate rehabilitation of the trade center area. However, the very central urban areas have certain advantages (heritage, primarily) that should be used to develop a strategy for revitalization by private and public sector. Lead by the idea of exploiting these advantages, the U.S. non-profit state organization was created to preserve the main streets (The National Trust for Historic Preservation's Main Street program)7.

To create a quality strategy for revitalizing urban areas of immediate need is a sincere cooperation between the private and public sectors.

COOPERATION BETWEEN THE PRIVATE AND PUBLIC SECTOR

Public-private partnership has been present in developed market economies for many years. It is an innovative form of community development. In brief, public-private partnership is a joint, cooperative action of the public sector with the private sector in the production of public goods or *public service*.

The main goal of public-private partnership is the realization of common interests, ie. economical, efficient and successful production of public goods or implementation of public services in relation to the traditional way of providing public services. Generally speaking, this type of cooperation involves the planning, production, delivery, financing, operation and collection of public affairs. Private public partnership can be applied in different fields (ecology, education, investment, local economic development, social welfare, public utilities, poverty reducing actions ...).

The main characteristics of the relational partnership are:
1) *long-term contractual co-operation* (20 to 25 years),
2) *division of investment risk* and *responsibilities*,
3) *division of credit* between partners.

It is necessary to distinguish public-private partnerships and traditional models of cooperation between the two sectors. Public procurement is not a model of public-private partnership, since it is not present long-term cooperation and usually there is no business risk divided between subjects of cooperation.

agriculture the importance of this sector for the local economy cannot be ignored". (International Council of Shopping Centers, 2000).
6 The data was presented by Robert Gibbs, in 2000, the "In town Retail Trends Seminar", Atlanta Development Authority, Atlanta, GA (Fitzgerald and Leigh, 2002).
7 "The form inherent to the city center represents its advantage - rich architecture, small business, the link with the past," a sense of space "- not only for developing the business area as a successful market, but also to make this part of town again the center of social identity". (National Trust for Historic Preservation, 2000).

The establishment of a public company does not consider the PPP, while outsourcing is the border of public-private partnership.

Public-private partnership is positioned between the traditional forms of conduct of public affairs (public procurement, the establishment of public enterprises) and privatization (financial privatization, full privatization, functional privatization). Basic forms of cooperation are: informal cooperation, concessions (public-legal cooperative agreements), long-term contracts (civil and legal cooperative agreements), and partial privatization and common project society (socio-legal cooperation).

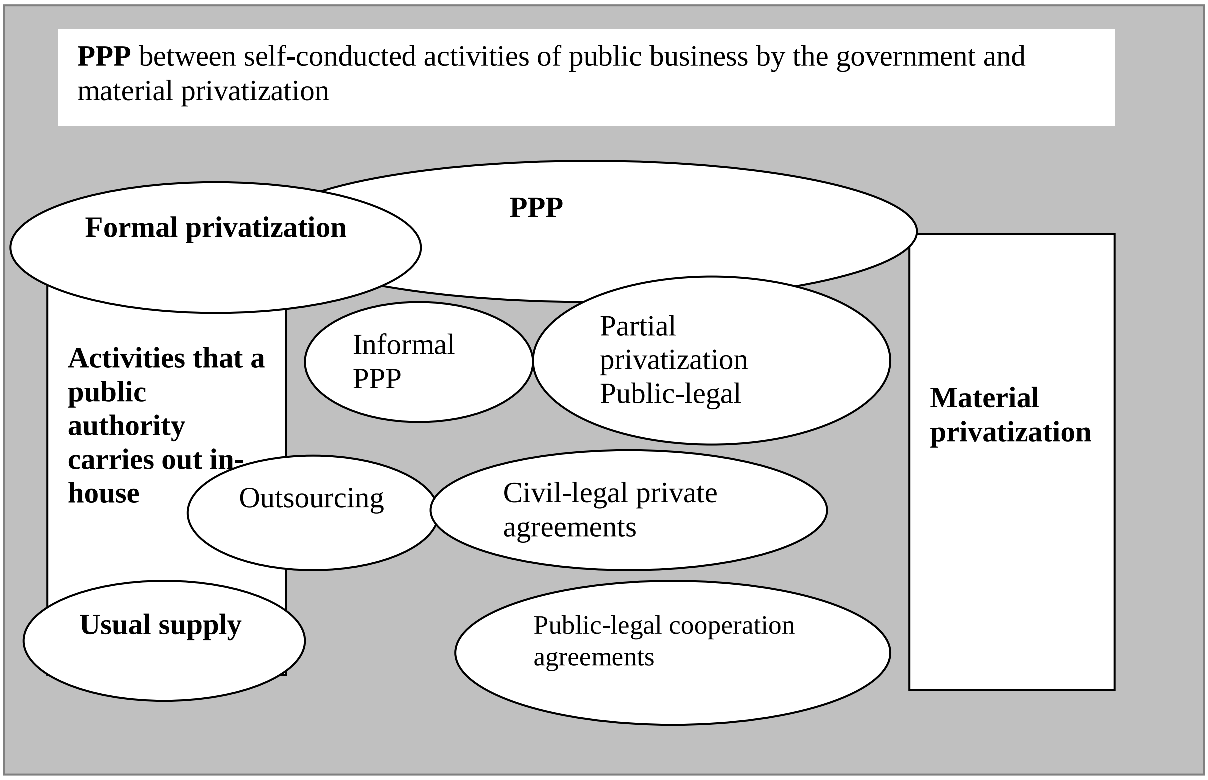

Figure 2. Place and forms of public-private partnership

It is important to know that public-private partnership is not a solution for the implementation of all public services. The public sector should be the driver of the idea of partnership. The most common *reasons for the PPP* from the perspective of the state are: lack of staff expertise within the public sector, high costs in the execution of its public affairs done. The public sector is expected to define the basic directions of development in order to achieve continuous improvement of the local community. Private sector must also have an interest. Partnership is necessary to remove the distrust which, generally, exists between the two sectors.

The most common errors in understanding the public-private partnership:
1) by entering this kind of cooperation the local government loses control over the provision of services;
2) public-private partnership is possible only in infrastructure projects;
3) the main reason for entering local government in the PPP is to avoid liability;
4) the quality of services realized through public-private partnership will decline over time;
5) public-private partnership leads to reduced number of employees in local government;
6) the price of services realized through this kind of cooperation of the two sectors will grow, and profits will "spill over" into the private sector;
7) public-private partnership is the same as privatization.

Cooperation between public and private sector as a model to improve the local community is an under-utilized opportunity for Serbia, although there are examples of success8. In order to achieve significant results the government needs to be agile in launching a public-private partnership. Only this way this form of cooperation will be promoted in the private sector, which is unthinkable without a *public-private partnership*.

THE CITY REVITALIZATION STRATEGIES

A partnership of public and private sectors is crucial in the development and implementation of revitalization strategy of the very center area. The basis of cooperation of until recently opposed sectors is interest. *Private initiative* is interested to regain the old, and win new customers, while the public sector arrangement tends to encourage central city area residents by arrangements for the better quality of life.

The three fundamental components of the strategy for revitalization of the main street or central business areas are (Fitzgerald and Leigh, 2002): market analysis and marketing plan to create a business area, improving the image and design, community building.

Market analysis, marketing plan and improving the image

Marketing activity9, as with conventional products, begins with market research. The point is to *determine the attitudes of existing* and *potential customers* in the relevant part of the city, but also to know the opinion of economy subjects on Main Street. The primary data which are often obtained by market research and / or focus groups will be a signpost for the holders of business activities, as well as for local government that will try to correct the deficiencies (eg. damage to pavement, graffiti, etc.) that create a negative image of the city centre. By analysis of a large number of secondary data available useful information can be obtained. For example, the census can be a free way to get to the demographic profile of potential consumers (number and type of household, age / gender / educational structure ...).

The results can be used to determine *what the most current* and potential customers in the city center are bothered by. By carrying out market research entrepreneurs will be given significant information about the supply of products and / or services that are lacking in the city center. The primary task for the holders of business will be to attract other entrepreneurs who have this "missing bid" in their offer to this area. Consequently, in preparing a marketing plan, in the focus of interest are not only customers but also commercial entities whose products and / or services are to increase the attractiveness of the entire neighborhood.

On the other hand, a *survey of traders* in the particular part of the city can provide information about the offer without sufficient demand in their facilities. If the above scenario is there, businesses will focus on potential customers who might come to the city center in the purchase of products offered. Of course, the condition for the realization of this idea is that the products are attractive and affordable, and that the main reason for non-arrival of customers is their lack of information about a given offer.

"*Disagreement between consumer desires* and *local goods and services* must be analyzed in order to create effective marketing strategies. This discrepancy may be due to the assortment of goods and services that exceeds or is below the usual demographic and income profile of consumers who would definitely buy in the retail area. The usual steps in marketing analysis are the following:
1) Definition of retail trade areas;
2) Preparation of the population profile (ie. customers) in the retail trade area;

8 http://www.mku.co.yu/downloads/aktivnosti/VIP_prez_Katarina%20Milanovic_final.pdf

9 "Marketing is focused on increasing consumer awareness and attractiveness of its business areas and retail locations. To achieve this, the negative image that has led to declining business district must be changed." / underlined: D.B. / (Fitzgerald and Leigh, 2002).

3) Preparation of profile business activities in the commercial district;
4) Preparation of profiles of existing and potential space for retail activity in town;
5) Prepare a SWOT analysis (strengths, weaknesses, opportunities and threats) Trade District (Fitzgerald and Leigh, 2002).

One of the goals of the marketing plan that defines the central city area is creating a costumer's perception of the particular part of the city that retailers want to project about themselves. It is believed that concrete action in the form of decision to buy in the main street will arise from the power of image. In creating a positive image the local government will have a critical role, because it is impossible to talk about the positive perception of the customer if there are crumbling facades, litter, and sidewalks that are not reconstructed.

Community building

Revitalization of the center area is caused by the cooperation of private and public sectors. "Building a community within a successful retail revitalization strategy may require the **involvement** of *business owners* and *chambers of commerce* activities, *social groups* such as churches and nonprofit organizations, and local governments" / underlined: DB / (Fitzgerald and Leigh, 2002).

Generic force (as the specific "commercial anchors") of the city center is not in big stores, such as malls. Alternative points of support, such as churches, police stations and libraries have the crucial role in attracting customers to the city centre, according to Robert Gibbs. Gibbs believes that the point is to build a retail moving force near buildings that attract people who otherwise would not be in that area."

In order to increase the attractiveness of the city center it is recommended that retailers develop partnerships among themselves to coordinate their actions. One way of achieving a given objective is to organize the retail association. Retailers in the neighborhood of *Pico-Union*10 (Los Angeles, USA) have formed such association and achieved remarkable results11. Generally speaking, there is a range of benefits arising from the organization of the retail association in the city center. First, there is the exchange of information, experiences and business practices of local traders. In this way, they improve the business and increase sales. Second, joined traders with the "common voice" can make a significant impact on decision-making for the community rather than every single one of them can.. Third, cooperation is achieved, "local money recycling" is obtained through the implementation of procurement from local suppliers instead of buying outside the business area. In this way money circulates among the association members themselves.

Local government plays a significant role in the revitalization of some urban areas. The two main ways to engage the local government (Fitzgerald and Leigh, 2002):
1) to encourage economic development - the reduction of local taxes, providing loans at lower interest rates, providing subsidies ...
2) to improve living and working in the district - the elimination of defects on the road and sidewalk, greater agility in maintaining the hygiene of the village, the reduction of crime ...

Apart from separate business activities of *joined retailers and local government*, it is essential that the private and public sector have strong coordination in action. Based on inspection of the seven

10 http://en.wikipedia.org/wiki/Pico-Union,_Los_Angeles,_California .
11 Pico-Union was a noisy part of LA with high intensity of traffic. Over time, this part of the city became poorer, and residential and office space rents has decreased. Until the moment of formation of the Association, traders were suspicious of each other, there was no mutual communication. The association, at the very beginning, defined its mission, key issues and actions for the formation of the community. Joint association money was used to improve downtown facades, and for organizing holiday promotion, planting new trees, setting of garbage bins and sponsoring local youth art programs. The results of the joint work of retailers were exquisite. Almost all economic entities had the attractiveness of this business area, and benefit from the new situation increased.

Southern California cities, Loukaitou-Sideris has developed a series of four recommendations for the commercial revitalization (Loukaitou-Sideris, 2001). First, it is necessary to encourage the joint funding between the private and public sectors. Second, it is unthinkable to have the city centre area revitalized without the cooperation between the local government and retailers. The third and fourth recommendations refer to the encouragement of revitalization of "visual power" (eg. reconstruction of the façade provides a strong visual impact).

CONCULUSION

The primary task of economic development planners is to ensure "growth with a human face". Growth and development of national and / or the global economy achieves its purpose only if it results in increasing the quality of life of residents in a particular area. The state must take care that residents of the entire territory of the republic can buy basic groceries. Local economic development planners also need to take into consideration the effort included in the revitalization of trade because the goods retailers needed a commercial basis for a strong local economy. It is necessary to provide conditions for trading activity (re) moved in less developed areas.

The concept of "virtuous retail point" can be applied both at the *state level* (encouraging investment in less developed regions) and the *level of local government* (targeting investment in underdeveloped parts of the city / municipality). A partnership of public and private sectors is crucial in the development and implementation of revitalization strategy of the very center area. The three fundamental components of the strategy for revitalization of the main street or central business areas are: market analysis and marketing plan to create a business area, improving the image and design, community building.

REFERENCES

Bubnjević, D. (2009). *Trgovina XXI veka*. Zrenjanin: Art-Projekt.

Group of authors. (2004). *Strategy and Policy Trade of the Republic of Serbia*. Belgrade: Faculty of Economics in Belgrade.

Končar, J. (1998). *Economics of Internal Trade and trade policy*. New York: Prometheus.

Fitzgerald, J., & Leigh, N. Mr. (2002). *Economic Revitalization*. New York: Sage Publications.

U.S. *Department of Housing and Urban Development*. (1999).

International Council of Shopping Centers. (2000).

National Trust for Historic Preservation. (2000).

http://www.initiatived21.de/.

http://www.mku.co.yu/downloads/aktivnosti/VIP_prez_Katarina% 20Milanovic_final.pdf.

http://en.wikipedia.org/wiki/Pico-Union, _Los_Angeles, _California.

Loukaitou-Sideris, A. (2001). Revisiting inner-city strips: A framework for community and economic developoment. *Economic Development Quartely*, 14 (2), Retrieved January 29th.

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ECOLOGICAL AND ECONOMICAL ASPECTS OF THE USED OILS REFINING

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ABSTRACT

High level of the environmental pollution worldwide demands emergency activities in all scopes of human activities. The specific feature of the used oil is that it is factually at the same time both very great and dangerous pollutant of human working and living environment, as well as significant secondary crude material with its utility value. That is the reason why it has so great ecological and economic importance and the attentiveness in treatment is in the intensity function of the phenomenon problems of the former or latter component. In the paper are treated general ecological and economic aspects of storing and processing of the used oils.

Key words: ecology, environment, economy, used oils.

INTRODUCTION

The wasted oils are one of several key matters in the field of the wastage management because of a few causes. The most important reason relates to the significance which the used oils have as the potentional contaminant of the living environment, especially if one takes in consideration total quantities of the wasted oils that are generated under modern conditions and their actual or potential danger. According to the data of the European Commission in the year 2003, in fifteen countries of EU have been collected nearly 2 million tons of the wasted oils.1 In the EU countries with severe legal prescriptions and stiff fines for illegal storing of the used oils, of 10 to 30% private car drivers themselves change oil2 and only a little quantity is given to the controlled storing and recycling. In the data for the used oils in the USA3 one can see that these oils originate mostly from the car engines and other transport means and that their percentage is 70%. According to the same data in the USA about 25% of the wasted oils are being stored irregularly and uncontrollably.

The assesments of the quantities of the wasted oils being generated in the Repubic of Serbia can be considered incomplete4, and it was estimated that in this state during one year is being generated about 106.000 tons of used engine oil and 257.000 tons of the mixed organic – water emulsion. Under these circumstances one should keep in mind as well as that in Serbia there are only several plants treating the wasted oils (oil refineries in Novi Sad and Belgrade). Meanwhile the greatest quantity of the used oils from vehicles engines one finds on the wastage dumping sites or in town sewage systems. Great part of the wasted oils is uncontrollably incinerated in house ovens or is used as protection in wood impregnation, for lubrication of different moulds (building blocks), in weedkilling and dust.

1 Report from the Commision to the Council and the European Parliament on implementation of the Community Waste Legislation … For the period 2001-2003 (COM 2006) 406, final, p. 5
2 European Commission communication of 23 February 1997 To the Council and European Parliament concerning the application of Directives 75/439/EEC, 75/442/EEC, 78/319/EEC and 86/278/EEC on waste management
3 http://www.synlube.com (January, 2006)
4 *Dangerous wastage in the Republic of Serbia* in the plants liable to the Law of the integrated prevention and the control of the contamination of the living environment (the project financed by EU through the European agency for reconstruction, May 2007.) page 12

ECOLOGICAL PROBLEMS

Being at risk from pollution of the living environment and struggle against that danger give the specific hallmarks of the turn of the 21^{st} century. The accumulations of the wasted materials especially in large housing estates, get hair-raising proportions. As well as human health is endangered both directly and indierctly through flora and fauna destroying by human being themselves, although they depend of them.

So, there are many reasons nowdays why the struggle against environment contamination has become necessity. According to its significance and material means that are invested in this struggle, it is shoulder to shoulder with the struggle for food as well as the struggle against natural catastrophes and the other forms of the fight for survival.
With soiling (smearing) or polution of the human environment is considered the presence in large quantities, of the remainders of material or energy produced reluctantly, that have survived their purpose, or they were formed by chance or have the unpredictable, harmful activity. Here can be classified as well as all oil derivatives.

Human environment contamination by wasted oils is a very actual problem in all industrially developed countries as well as in Serbia. These problems are also being aggravated by a large number of motor vehicles and inadequate oil manipulation in all its phases. The matter becomes especially important and expressed in the conditions when individual proprietors of motor vehicles (travellers' cars and lorries) and agricultural machines (tractors operate oil replacement themselves).

The pollution by the used oils results in soil contamination and especially of watercourses. The essential mechanism of water pollution (because oil penetriates also from soil into watercourses) is in prevention of oxygen penetration into water because it also deteriorates living conditions of great number of flora and fauna sorts, intoxicates microorganisms and creates poisonous substances. Especially dangerous is the oil presence in watercourses of the so-called protected sanitary zone which serves for the supplly of the high quality water for settlements and industry.

According to some statistical data one fifth of the pollution of all waters originates from the wasted oils. According to the other data, by way of illustration one ton of the wasted oil in water according to its consequences is parallel to the quantity of classical wasted waters generated by a housing estate of 40.000 inhabitians. Likewise one has to know the datum that the concentration of the wasted oil in the water of 1-2 mg/l makes water undrinkable and dangerous for health.

Concerning the impact of the used oils to the soil itself, large-scale experimental investigations have indicated that oils act very toxically onto the microflora of the surface layers and in this way they make it dead for the flora during a long period of time. As well is observed very high fall of bacteria on the contaminated surfaces. During the experiments in which the testing soil parcels have been treated by the wasted oils, it has been perceived their drastical activity as well as onto many plants of the zone. Almost all vegetation has been totally burnt down. After the control of the treated surfaces lasting several months, the vegetation has not been recovered. It was remained totally dry and burnt down, and the soil was further fat and polluted. The wasted oils are very dangerous and harmful atmosphere pollutants if they are burnt down in order to get thermal energy. This is very frequent phenomenon especially expressed during recent years because of the shortage of other power materials. Taking in consideration that the used oil is not classical fuel, it is not burnt down in a technically correct way. Irregular burning-places are usually used, and the very process of burning is being performed very uncontrollably. Taking into consideration the composition of the used oilconsidering its content of sulphur, nitrogen, chlorine, phosphorus, metalliferous compounds from additives, coke and the others, the burning products are very noxius to human health.

Large cities where are concentrated many inhabitants, are particularly endangered environments. In different parts of a city are located big industrial plants, auto repair shops, large and numerous motor transportation organisations. All of them are potentionally big sources of the contamination of the living and working environment by the used oils. This ecological situation can be solved or partially can be lessened its injurious effects by organized and modern collecting and manipulation of the used oil, its processing into the high-quality product as well as through legal means (statutory systems).

It has to be at once stated that in our country besides vast potentials of the used oils, neither in the organisational nor technical field is done nothing sufficiently in the organized and modern collecting of the wasted oils. There are relatively few working organizations which have a good and contemporary solution, so – called oil station, where they collect and manipulate the used oils, and similarly manipulate with fresh lubricants. Only such form of work prevents oil drain into environment in the least quantities, too.

Regarding processing capacities, they are exceptionally low for our needs not only as installed capacities, but as well in relation to the quantity they produce. These capacities are on the level of cca 30.000 tons per year. They are located on three sites, and their actual production is on the level of 10 to 12000 tons of basic oils production per year. In addition only one of these three installed capacities uses the previously described modern processing technology.

Regarding legal provisions in this field, the activities began twenty years ago. The common characteristic for the exposed legal provisions in relation to the wasted oils is the explicit ban that these oils can be uncontrollably destroyed. But besides it, all these legal provisions have not given the expected results.
One of the reasons is that subordinate legislation is not worked out in details more precisely and in more detailed way. On the other side there are inadequate sanctions as well the inspection has to be more strict and in accordance to the existing regulations. In the meantime one has also to point out the fact that our whole society has not yet approached to the unique solving of these problems.

So, nowadays the level of the collected quantities of the wasted oils that can be processed, is under 10% in relation to the existing potential considering the consumption of fresh oils.

THE ECOLOGICAL REASONS FOR PROTECTION

The wasted oils have to be treated and removed in a way that prevents the contamination of the living environment.

On principle there are two ways:
- repeated using,
- efficient eliminating.

The repeated using comprehends rerefining or regeneration in order to get basic oils that are used for the production of new lubricating oils, refining through separating solid contaminants, the using in the field where is not so important purity and quality, the use as a fuel (in accordance with the existing regulations).

The efficient separating implies controlled incineration and controlled storing.

Of course the best solution would be to collect all wasted oils and their regenerating. Meanwhile, nowhere worldwide it has not been totally realized. There are many reasons for it, and all of them can be grouped in according to the organisational, technical-technological and economical reasons.

Collecting the used oils implies a working organisation which would deal with it profesionally. On the other side, it understates a certain equipment and an organized collecting of the used oils in the working organizations that use lubricants. It is often necessary to separate specially the oils for metal processing from the others, because they are not adequate for regeneration on account of the nature of the basic oils and additivies from which they are produced. Eventually, one can never avoid the matter of the economy of dealing with the works as collecting, selecting, transporting and processing of the wasted oils.

It has to be emphasiyed that it is really impossible to collect and regenerate all wasted oils. On account of that it often happens worldwide that they are used for heating. Of course, it has to be done in accordance with the existing legal prescriptions about environmental protection.

It is known that lubricating oils contain as additives the compunds of zinc, barium, lead, sulphur, phosphorus and others. All of them are poisonous and because of that the wasted oils must not be uncontrollably thrown. The products of the burning of these additives are as well poisonous substances that in the form of gases and ash can pollute wide landscapes and space and endanger health of population.

As it can be concluded, it is not so easy to get rid of the used oils. On account of that it is considered that any kind of the application through which would be at the same time protected the environment, presents the acceptable solutions. Meanwhile, it happens that the used oils would be insomuch contaminated that they are not for any further use neither for heating, so there remains as the only one solution the controlled burning in special furnaces. Of course, for this kind of burning, the oil must be also previously processed in the adequate way

The controlled storing presents the cheapest manner for the solution of this problem if there is an appropriate location for it, but such locations are, unfortunately very few. There is always danger from some kind of oil migration through soil to the spring (source) of the drinking water or a river.

ECONOMICAL SIGNIFICANCE

For economy of every country irrespective her level of development, there is great economical interest to get from the secondary raw material treated as waste, basic oil and return it into the working cycle.
This especially because the basic oil presents the highest level of the raw oil processing, exeluding, of course the petrochemical products. In the developed western countries, first of all in the USA, Canada, Germany, Scandinavian countries, already a number of years, there are the most numerous capacities also for the processing of the used oils. The countries of the Eastern Europe also pay great attention to the collecting and processing of the used oils, just from the economical reasons. In some of these countries (Bulgaria, Poland) they went very far in their legal regulations, so that consumer can not buy fresh lubricant if he /she does not bring back a certain percentage of old oil. For our country, which is anyhow in short supply with its own production of the basic oils in relation to its annual needs, this processing should be more imperative task. Every ton of basic oil obtained by the rerifining of the used oil for our community means cca 350 US$ less outflow of foreign currency. On the level of Serbia the imported quantities of basic oils for the needs of the domestic lubricant manufacturers in 1984. year, were cca 60.000 tons, so only on this basis from this country was drained away more than 20 million of American dollars.

If one takes in consideration that in our country are spent about 240.000 tons of engine and industrial oils which as the wasted ones can be returned into the process of the returned processing, then it is easy to get the data that with modest cca 30% of the returned oils can bi solved the raw material basis for the production of the previously mentioned 60.000 tons of the imported basic oils. Of course, it prefers as well the existence of new processing capacities, and also totally another approach in the respect of collecting this precious raw material. That it is also possible speak as well the data that already now in many European countries is being reached the level of the returned engine oil from 40 to 45% in regard to the consumption of the fresh ones, while it moves with the industrial oils even within (the) limits of 70 to 80%.

The above mentioned data are sufficient and convincing that economical logic requests the undertaking of all capable measures on the state level in order to be created the conditions for more efficient collecting and processing of the wasted oils.

CONCLUSION

More and more severe ecological regulations, more and more higher pressure of *“green public“*, more and more demanding consumers’ expectations in respect to solving the problem of collecting the wasted oils give rise to the fact that the care for environment nowadays means the minimizing of risk and harmful activities during production, distribution, use and collecting of the wasted oils.

The wasted engine oil is the ecological problem. One should not expect that the state in regard to the collecting of the wasted oil will be in the immediate future changed. On account of that ought to be organized the education of the industrial as well as agricultural manufacturers.

The best manner for the preservation and protection of the living environment is the avoiding or limitation of the activities that could pollute and endanger the life survival on the carth. The precondition for it is the better knowledge of material properties (oil), so that one can ensure adequate safe handling, using, staring, disposal and demolition of waste.

REFERENCES

M. J. Neale, Tribology Handbook, *Butterworths,* London (1973).
V. B. Guthrie, Petroleum Products Handbook, *Mc Graw,* New York (1960).
Shell Group of Companies, The Petroleum Handbook, *Elsevier*, London (1983).
Črnjar, M.: Economics and politics of environment protection, The Economical faculty of the *University and the Voice of Rijeka,* Rijeka, 2002.
Isoski, Z.; Todić, D.; Petrović, D.: The Management of the waste oils in the regulations of the European Union and the Republic of Serbia.

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ANALYSIS OF ECONOMIC POTENTIAL OF THE END-OF-LIFE VEHICLE MARKET IN SERBIA

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ABSTRACT

The work ”Analysis of Economic Potential of the End-Of-Life Vehicle Market in Serbia” presents an analysis of key factors of management of used car market in Republic of Serbia. It explores the interdependency of market factors in shaping the demand and supply ELV recycling. The work also examines the feasibility and optimal functioning of recycling and estimates the economic potential of ELV recycling system and necessary investments.

The paper uses life-cycle analysis of ELV and Life Cycle Costing of ELV recycling; it calculates the amount of generated solid waste and shredder residues.

The work shows that the domestic market demand for the ELV recycling of secondary raw materials is large enough for materials that would arise with increased level of recycling in Serbia from 14% to the European level of 75%. ELV Recycling system in Serbia needs necessary investment of 24 million euros at ten plants with the optimal capacity of the shredder treatment of ELV 10,000 / year.

Analysis of the financial operations of the collection, and process of dismantling and shredding in Serbia shows an income of -26.88 €, 30.36 € and 29.59 € respectively for each part with indicator price per individual ELV of 33.07 €.

Key words: End-Of-Life Vehicle Market in Serbia, dismantling ELV, Life Cycle Costing of ELV.

INTRODUCTION

Analysis of economic potential of ELV market in Republic of Serbia is challenging due to underdevelopment of recycling system, lower level of recovery rate of ELVs and still not developed market for some arising materials.

Overview of present situation in recycling system of ELV in Serbia shows lack of proper management of arising ELVs and lack of integral management system of recycling. The demands for materials of ELVs recycling are recognized in few companies, mostly for scrap metal. Reparation parts (mostly clamps, brake pedal, stabilizing bars – all that parts of special significance to the security) are done without quality control and adequate technologies.

Tradition in recycling of metals in Serbia exists in the process of manufacturing of parts – ELVs recovery is still done for adequate compensation from customers who take auto-parts from uncategorised or illegal damp-fields by themselves. After all, on such damp-fields, “dismantlers” make illegal treatment of vehicle shells by burning color and other anti corrosion and anti vibration materials from them (Pavlovic, 2006).

General recycling in Serbia is in the stage where Germany, Austria and Switzerland were in seventies – with unregulated landfills, waste treatment plants, waste incineration and completed transfer stations (Jovanovic et al., 2008).

Still, in Serbia we can recognize some improvement in ELVs recycling, which is significant in the region of Western Balkan Countries. This is mostly due to an existing recycling centre equiped for shredder treatment in „Centar za reciklažu a.d. Beograd“ (part of Sholz group) and to an incentive for scrappage of old cars in 2009. and 2010, when, it is estimated, 15.000 ELVs were recycled.

Historicaly, with the beging of eighties in Republic of Serbia (known for the best non-ferrous metals manufacture country in West Balkan region) the framework for recycling of secondary materials was set. However, this positive trend was not continued in the years folowing economic crisis due to the disintegration of SFR Yugoslavia and emerging problems in recycling industry. There were less raw materials as a result of neglected or even completely broken activities of business actors. The costs of transportation and processing at the time were excesive, there were unresolved problems of financial nature which lead to less sales and difficult debt collection. The survival of many companies for the collection and preparation of scrap metal was brought into question (Ilic, 2002).

At present, in Serbia, according to Stana Bijelović (Chief of Department for Secondary Material Market of the ex national Recycling Agency) waste recycling rate is only 14 percent (Cvetkovic, 2009). This rate is estimation for recycling of ELVs in Serbia, as well.

THEORY

Analysis of the economic potential of the market of ELVs in Serbia is interdisciplinary demanding task which seeks exploring the interdependency of market factors in shaping the demand and supply system of recycling of ELVs. In addition of market analysis and cost effectiveness of recycling operations, the work examines necessary investments for optimal functioning of ELV recycling system in Republic of Serbia.

In order to answer such a comprehensive task the simplification and approximation are required, and the reliance on a large number of domestic researches, and, the large number of similar works in European Union and other developed countries conducted.

For examinination of ELV recycling system, a tool for analysis the life cycle of ELVs was used. Firstly, Life Cycle Analysis of ELVs in order to comprehend all the energy and raw material input and output of the system. Secondary, Life Cycle Costing of ELV recycling system which helped in analyzing the optimal technological treatment in Serbia.

METHODS

In the absence of comprehensive reserches including experimental one, archival research and content analysis were conducted together with use analogies based on prior knowledge in this field.

All calculation of Life Cycle Costing of ELVs in Serbia are done based on the work *Strategic Guidance Model for Product Development in Relation with Recycling Aspects for Automotive Products* (Muhamad Zameri Mat et al., 2010) on a chosen functional unit basis of avarage ELV in Serbia (i.e. avarage mass of ELVs in Serbia is 1000 kg).

Recyclability rate and the avarage composition of the Serbian automobile is based on the work *Access to the recycling of motor vehicles* (Sudarevic et al., 2005), ilustrated in Table 1 below.

Table 1: Recyclability rate and the avarage composition of the Serbian automobile (Sudarevic et al., 2005)

Unit	Weight per vihicle		Recyclability rate	
	%	kg	%	kg
FERROUS METALS	**68**	**680**	**90**	**612**
Shell	25	250	90	**225**
Other steel part	28	280	90	**252**
Cast iron	15	150	90	**135**
NON-FERROUS METALS	**6**	**60**	**90**	**54**
Alloy AlSi	4.4	44	90	**39.6**
Copper	1	10	80	**9**
Lead	0.6	6	90	**5.4**
PLASTICS AND COMPOSITES	**8**	**80**		
ABS	1	10	80	**8**
Polypropylene	1	10	80	**8**
PVC	0.8	8		
Polyester	1.2	12		
Polyurethane	1.5	15		
Other	2.5	25		
FLUIDS	**1.4**	**14**	**44**	**6.2**
Fuel	0.2	2	100	**2**
Engine oil	0.4	4	90	**3.6**
Hypoid oil	0.3	3	0	**0**
Brake fluid	0.04	0.4	0	**0**
Antifreeze with water	0.3	3	0	**0**
Meripol	0.1	1	0	**0**
Freon	0.06	0.6	100	**0.6**
RUBBER	**5**	**50**		
Pneumatics	3	30		
Other rubber parts	2	20		
GLASS	**3.5**	**35**		
TEXTILE	**1**	**10**		
OTHER	**6.1**	**61**		
BATTERIES	**1**	**10**		

FINDINGS

Let's look at the data of registered motor vehicles and trailer in Republic of Serbia since 2003. year. The greatest number of registered passengers' cars was produced by Zastava (domestic trademark). Regarding foreign trademarks, the following manufacturers were the most notable: Volkswagen, Opel, Ford, Fiat, Renault, Mercedes, Peugeot and Skoda.

Table 2: Registered road vehicles and trailers in Republic of Serbia since 2003. year, Statistical Office of the Republic of Serbia

Rep. of Serbia	**Motorcycles**	**Passenger Cars**	**Special passenger cars**	**Buses**	**Lorries (trucks)**	**Special lorries**	**Tractors**	**Trailer**
2010	38229	1567113	79	8034	162779	-	239295	99025
2009	34500	1637002	13475	8853	148255	23552	7356	28596
2008	31794	1486174	13573	8553	139243	24166	7344	27665
2007	24897	1476642	14574	8887	129877	25802	7263	26389
2006	20380	1511837	15109	9312	126045	27498	128017	103859
2005	16042	1481498	15920	9696	116440	28222	126816	101465
2004	14824	1455060	16525	9209	110075	28179	125873	99767
2003	13287	1388109	16107	9144	101433	24713	121377	96509

Let's look a number of first time registered road vehicles and trailers in the Republic of Serbia for 2008. year, it will help us to assess the total annual number of ELVs in Serbia.

Table 3: First time registered road vehicles and trailers in Republic of Serbia, Statistical Office of the Republic of Serbia

Rep. of Serbia	**Motorcycles**	**Passenger Cars**	**Special passenger cars**	**Buses**	**Lorries (trucks)**	**Special lorries**	**Tractors**	**Trailer**
2010	13313	145173	5	471	13215	-	4769	4198
2009	5674	126382	364	357	8447	832	2341	2107
2008	8140	87284	199	480	13903	718	1387	2924

The total annual number of end-of-life of vehicles (ELV) can be theoretically calculated from the data of *Statistical Office of the Republic of Serbia*. Estimated annual number of ELV can be calculated using the following formula:

The total number of ELVs in 2008 = State the vehicle at the end of 2007 + the number of first time registered vehicles in 2008. – Number of registered vehicle at end of 2008. - Number of vehicles exported in 2008. year

I.e. 1 476642 + 87 284 – 1 486174 = 77 752 ELVs in 2008.

This number represent a 5.23 percent of total passenger cars in 2008 year. However, based on national estimates that the annual number of ELVs is 8-10 percent of anual registered passenger cars, we have amount to 118,893 to 148,617 passenger cars in 2008. year

As a aproximation for futher calculation in this work we will estimate 100000 ELVs arising annualy in Republic of Serbia.

Taking this number of ELVs in the Republic of Serbia as well as the percentage of participation of individual material per vehicle, anualy arising: 68,000 tons of ferrous metals, 6,000 tonnes nonferrous metals, 8,000 tonnes of plastics and composites, 1,400 tons of fluids, 5,000 tons of rubber, 3,500 tons of glass, 1,000 tons of textiles, 1,000 tons of batteries, as well as 6100 tonnes of other waste from ELVs.

Table 4: Estimation of annualy lost of secondary materials from ELV recycling in Serbia

Material	**At the level of the current recycling rate of 14% ELVs arising in Serbia, annually in Tonnes**	**At the level of the possible future recycling rate of 75% ELVs arising in Serbia, annually in Tonnes**	**Lost of materials arising from ELV recycling in Serbia, annually in Tonnes**
Ferrous metals	9520	51000	41480
Non-ferrous metals	840	4500	3660

Now, look on a general overvied of value and financial analysis of ELV recycling in Serbia based on functional unit and recyclibility rate shown above and prices of secondary materials in Serbia.

The general characteristic of the ELV which are analyzed is as follow.
Vehicle = Zastava
Total weight = 1000 kg/ ELV

Content Based Material Categories of ELV
Quantity of ferrous materials (kg) = 680
Quantity of nonferrous materials (kg) = 60
Quantity of plastic materials (kg) = 80
Quantity of others materials (kg) = 131.2
Quantity of hazardous materials (kg) = 48.80
Total = 1000

Nominal Mass of Materials
Ferrous materials (kg) = Expected % of ferrous materials x Quantity of ferrous materials (kg) = 90% x 612 = 550.8 kg
Nonferrous materials (kg) = Expected % of nonferrous materials x Quantity of nonferrous materials (kg) = 90% x 54 = 48.6 kg
Plastic materials (kg) = Expected % of plastic materials x Quantity of plastic materials (kg) = 0% x 80 = 0 kg
Hazardous materials (kg) = Expected % of hazardous materials x Quantity of hazardous materials (kg) = 100% x 48.80 = 48.80 kg
Waste materials (kg) = 750 – (550.8+ 48.6 + 48.80) = 101.8 kg

Value Analysis has been developed based on the three main analyses. There are acquisition analysis, dismantling analysis and also shredding analysis. Each part of the analysis has data for the costs and also revenues for every process, every component or every material involved. Based on that, the return for each analysis can be calculated.

Acquisition

Cost of buying EOL vehicle (€/vehicle) = 34.3185
Payment from vehicle manufacturer or local authority (€/vehicle) = 40.0383
Total acquisition cost (€) = 30.8883
Total acquisition revenue (€) = 4.004
Total profit of acquisition (€) = Total acquisition revenue - Total acquisition cost = 4.004 – 30.8883 = -26.88 €

Dismantling

Data of the Dismantling Process
Cost of dismantling processes (€/kg) = 0.0573
Cost of disposing of hazardous materials (€/kg) = 0.114
Market price of spare part components (original) (€/kg) = 0.23
Market price of spare part components (remanufacture or reconditioning) (€/kg) = 0.114

Costs of Dismantling Process
Dismantling processes (€) = Cost of dismantling processes (€/kg) x Reused components or parts (kg) = 0.0573 x 250 = 14.325
Disposing of hazardous materials (€) = Cost of disposing of hazardous materials (€/kg) x Nominal mass of hazardous materials (kg) = 0.114 x 48.8 = 5.5632
Total Dismantling Cost (€) = Cost of Dismantling processes (€) + Cost of disposing of hazardous materials (€) = 14.325 + 5.5632 = 19.89

Revenue of Dismantling
Spare parts components (original) (€) = Market price of spare part components (original) (€/kg) x Quantity of components or parts (original) (kg) = 0.23 x 187.5 = 43.125
Spare parts components (remanufacture or reconditioning) (€) = Cost of disposing of hazardous materials (€/kg) x Quantity of components or parts (remanufacture or reconditioning) (kg) = 0.114 x 62.5 = 7.125
Total Revenue of Dismantling (€) = Revenue of spare parts components (original) (€) + Revenue of spare parts components (remanufacture or reconditioning) (€) = 43.125 + 7.125 = 50.25
Total Profit of Dismantling (€) = Total Revenue of Dismantling - Total Dismantling Cost = 50.25 – 19.89 = 30.36 €

Shredding

Data of Shredding
Cost of shredding processes (€/kg) = 0.0573
Cost of disposing of waste (landfill cost) (€/kg) = 0.0114
Market price of ferrous materials (€/kg) = 0.137
Market price of nonferrous materials (€/kg) = 0.251
Market price of plastic materials (€/kg) = 0.063
Market price of the other materials (€/kg) = 0.0114
Market price of waste materials for useful purpose (€/kg) = 0.0457

Costs of shredding
Shredding processes (€) = Cost of shredding processes (€/kg) x Total of Content Based Material Categories of Recycled Components or Parts = 0.0573 x (680 + 60 + 80 + 131.20 + 48.8) = 57.30
Disposing of waste (landfill cost) (€) = Cost of disposing of waste (landfill cost) (€/kg) x Nominal mass of waste materials (kg) = 0.0114 x 68.5 = 0.7823
Total Cost of shredding (€) = Cost of shredding processes (€) + Cost waste disposal (landfill cost) (€) = 57.30+ 0.7823= 58.08

Revenues of shredding
Ferrous materials (€) = Market price of ferrous materials (€/kg) x Nominal Mass of Ferrous materials (kg) = 0.13701 x 550,8 = 75.46
Nonferrous materials (€) = Market price of nonferrous materials (€/kg) x Nominal mass of nonferrous materials (kg) = 0.25126 x 48.6 kg = 12.21
Plastic materials (€) = Market price of plastic materials (€/kg) x Nominal mass of plastics materials (kg) = 0.10 x 0 = 0
Other materials (€) = Market price of other value materials (€/kg) x Nominal mass of other materials (kg) = 0.01 x 0 = 0

Total Revenue (€) of shredding = Revenue of ferrous materials (€) + Revenue of nonferrous materials (€) + Revenue of plastic materials (€) + Revenue of other materials (€) = 75.46+ 12.21 = 87.67
Total Profit of Shredding (€) = Total revenue of shredding – Total cost of shredding = 87.67 – 58.08 = 29.59

Indicator

After completing an analysis above, the grand total of the return for acquisition, dismantling and also shredding can be calculated. This value is called as the indicator

Grand Total of A + D+ S = Total profit of acquisition (€) + Total profit of dismantling + Total profit of shredding (€) = -26.88 + 30.36 + 29.59 = 33.07 € (Indicator)

Financial Analysis – Case 1

In the financial analysis, it is assumed that the capacity of the recycling company is 10000 ELV/ year in the Case1 (ELV recycling center developed according to *Instruction on conditions which must meet certified operator for the recycling of scrap vehicles* by *Ministry of Environment and Spatial Planning RS*, 2009). So that the profit generated by the company is about 33.07 x 10000 = 330700 / year. The details of the investment invested by the company are as follows:

Table 5: Investment cost for the recycling company Case 1 (Muhamad Zameri Mat et al., 2010)

Investment	**Quantity**	**Cost (€)/unit**	**Investment Cost (€)**
Land and Building			1.200.000,00
Weighbridge	1	60.000,00	60.000,00
Environment lock	1	100.000,00	100.000,00
Forklift	5	20.000,00	100.000,00
Dismantling equipment	1	600.000,00	600.000,00
Truck	3	90.000,00	270.000,00
Crusher	1	30.000,00	30.000,00
Container/skip	10	2.000,00	20.000,00
Engine hoist	5	500	2.500,00
Trolley jack	5	300	1.500,00
Skip loading	1	15.000,00	15.000,00
TOTAL			**2.399.000,00**

Payback period (year) company Case 1 = (2399000/ 330700/ year) = 7.25 years.

Financial Analysis – Case 2

In the financial analysis Case 2, it is assumed that the capacity of the recycling small scale local community company is 514 ELV/ year. In the work *Establishing a business in the recycling of motor vehicles in the municipality of Apatin* (Medic, 2010) it is estimated that each year, on basis of municipality of Apatin (approx. average size municipality in Serbia), approx. 514 ELVs arising.

So that the profit generated by the company Case 2 is about (159,24 x 514) - 46200 = 35649 / year and payback period (year) company Case 2 = (247900/ 35649/ year) = 6.95 years.
The details of the investment invested by the company are as follows:

Table 6: Investment costs of municipal dismantler (Case 2) where an estimated 514 ELV/year

	Investment Cost (€)
Second hand Car Crusher	**68.500**
Vehicle de-pollution unit	**6.400**
4 Tanks (4 x 1000 l)	**2.000**
Forklift	**7.000**
Warehouse of hazardous waste	**10.500**
Scissor lift	**1.300**
Land, concreting and set out (300 m2)	**50.000**
Equipping the reception office with a spare parts warehouse (40 m2)	**14.000**
Depolution workshop (120 m2)	**42.000**
TOTAL:	**201.700**

Table 7: Approximation of dismantling costs of municipal dismantler (Case 2)

	Annual costs of dismantling (€)
4 workers	**28.800**
Electricity	**2.400**
Costs and expenses incurred	**1.560**
Bussiness expenses	**8.400**
Amortization	**4.200**
Other costs	**840**
TOTAL	**46.200**

Table 8: Approximation of revenues of dismantling per vehicle (Case 2)

	Weight per vehicle		**Recyclability**		**Market price €/tons**	**Revenue (€)**
	%	**Tonnes**	**%**	**Tonnes**		
Ferrous metals	68	0,68	90	0,612	150	**91,8**
Non-ferrous metals	6	0,06	90	0,054	1100	**59,4**
Plastics	8	0,08	100	0,08	63	**5,04**
Fuel	0,2	0,002	100	0,002	1000	**2**
Oil	0,4	0,004	90	0,002	500	**1**
TOTAL						**159,24**

DISCUSSION

In the findings we finde that the return for the acquisition process is -26.88 €. That means the acquisition process is currently not profitable to the company. The return for the dismantling process is 30.36 €/vehicle. For the shredding process, the return is 29.59 €/vehicle. Both of these processes give some profit to the company. The grand total is 33.07 €/vehicle. It shows that the current design of the vehicle is valuable when it reaches end-of-life.

In the financial analysis of Case 1, it is assumed that, the capacity of the recycling company is 10000 ELV/year. The company Case 1 generates a net of 330700 €/year. Meanwhile, the total investment for the whole site is 2399000 €. So based on this data, the payback period is calculated around 7.25 years.

In the financial analysis of Case 2, it is assumed that, the capacity of the recycling company is 514 ELV/year. The company Case 1 generates a net of 35649 €/year. Meanwhile, the total investment for the whole site is 247900 €. So based on this data, the payback period is calculated around 6.95 years.

CONCLUSIONS AND IMPLICATIONS

In Case 1 of ELV recycling center developed according to reletivly new *Instruction on conditions which must meet certified operator for the recycling of scrap vehicles* by Ministry of Environment and Spatial Planning RS (2009), there is a need for 10 recycling center in Republic of Serbia in which it should be invested 23.990.000 € according to annualy arising of 100.000 ELVs.

Financial analysis of ELV recycling center Case 2, however, provides us an alternative scenario of development of ELV recycling system Serbia in which already functioning ilegal damp-fields are subject of development by environmental standardization. In this scenario, diversification of dismantlers will provide ELV dismantling at the source which will influence increase in recycling rate of ELVs. In this scenario, approx. 29 million euros investments should be done in 120 such centers for optimal ELV recycling system in Serbia.

TABLES

REFERENCES

A study to examine the benefits of the End of Life Vehicles Directive and the costs and benefits of a revision of the 2015 targets for recycling, re-use and recovery under the ELV Directive (2006) – Final Report to DG Environment, Birmingham, UK: GHK in association with Bio Intelligence Service.

Cvetković, J. (2009). *Recycling is still underdeveloped*. Belgrade, SRB: Politika.

Ilić, I., Gulišija, Z., Radovanović, N., Sokić, M., Matković, V., Marinković, J. (2002) *Resources and recycling of secondary raw of non-ferrous metals.* Bor: RTB - Institute for copper.

Jovanovic, Z.; Haase, H,; Ziems, D. (2008). *Developmental stages of waste management in the German speaking countries and challenges for Serbia on its path to EU.* Bor, SRB: Ekoloska istina - Bor, Kongress: EkoIst '08 (Sokobanja).

Kozić, A., Sudarević, D. (2005). *Access to the recycling of motor vehicles*. Kragujevac, SRB: Association for Quality and Standardization of Serbia. Quality Festival 2005, 32 National Conference on Quality.

Medić, D. (2010). *Establishing a business in the recycling of motor vehicles in the municipality of Apatin.*. Zrenjanin, SRB: Technical Faculty “Mihajlo Pupin”.

Pavlović, prof. dr Milan; Šubara dr Nadežda (2006). *Eco logistics*. Zrenjanin, SRB: Technical Faculty „Mihajlo Pupin“.

Saman Muhamad Zameri Mat, Feri Afrinaldi, Norhayati Zakuan, Gordon Blount, Jane Goodyer, Ray Jones & Ashraf Jawaid (2010) *Strategic Guidance Model for Product Development in Relation with Recycling Aspects for Automotive Products*. Malaysia: Faculty of Mechanical Engineering, Universiti Teknologi Malaysia. Journal of Sustainable Development.

NOISE AND VIBRATIONS IN URBAN AREAS

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APPLICATION OF SI TECHNIQUE FOR SOURCE SOUND POWER MEASUREMENT IN URBAN AREAS

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ABSTRACT

Possibility for measuring the sound intensity has caused the substantial changes in quantifying the object's sound power. The paper deals with problem that appears with application of this measurement method in determining the entire sound power of the sources in urban areas. Experimental results of the investigation related to the SI measurement of total sound power levels of the noise sources in urban condition were given in the paper.

Keywords: Urban Noise, Sound Intensity, Sound Power.

INTRODUCTION

There are two important applications of the sound intensity (SI) technique in a noise measurements related to the urban areas:

- Determining of the total noise source power and
- Identifying and ranking of the dominant sources through noise mapping.

The first application is essential for the situations where it is not possible to place the noise sources in appropriate acoustic environment like anechoic chamber or absolutely non reversible acoustic free field. It means that noise source has to be measured under the given circumstances i.e. in acoustic ambient where it is installed. To obtain an accurate results of the particular source sound power in urban ambient, a lot of acoustic fields' parameters must be found i.e. measured appropriately. The influence of near reflection surfaces, other sound sources near the source of interest, degree of "steadiness" of the acoustic field, etc. on measuring accuracy is of great importance.

The sound intensity (SI) technique is extremely power approach in solving the noise problems in circumstances given above. The next part of the paper deals with the SI approach in determining of sound power level (Lw) of the source.

The sound source is fully defined by radiated sound power and direction of its emission. The knowledge of the mentioned source's parameters and its position in the acoustically determined space enable prediction of the sound pressure level (SPL) in any point of that area. Consequently, the problem of the source's sound emission is brought to the heart of a matter. From the other hand, the measurement of the sound power measurement and its direction represents relatively complex problem.

DETERMANING SOURCE SOUND POWER BASED ON SI MEASUREMENT

In order to determine the sound energy level of one source, as well as the direction of its radiation, it is necessary to measure the following values (bolt characters define vectors):

- The sound pressure level (p) and
- The particles velocity (**u**)

which comes out from the next elaboration.

Work performed in the stationary fluid through elementary surface defined by its vector δ**S** as presented on Fig. 1, for the elementary time dt, it represents the scalar product of force **F** which dominates among the fluid particles on both (left and right) side of the surface and the particles velocity **u** which "flow" through δ**S** i.e. it is:

$$dW/dt = \mathbf{F}*\mathbf{u} = p\ \delta\mathbf{S*u}$$

$$dW/dt = p\ \delta\mathbf{S*u*n}$$

where:

W is sound power,
F is the force,
u is vector of particles velocity,
u is the intensity of particle velocity,
n is the elementary (unit) vector of the surface,
S is the surface vector,
S is surface size (intensity of the surface vector).

If the flux is reduced to unit area surface then the vector p***u** is called the sound intensity vector (**I**) and it is defined as:

$$\mathbf{I} = p * \mathbf{u}$$

Consequently, the sound intensity represents the energy flux through the unit area surface. It appears that for the determining the source's sound power it is enough to determine the sum of the intensity vectors on the surface that encloses the volume in which the source is placed.

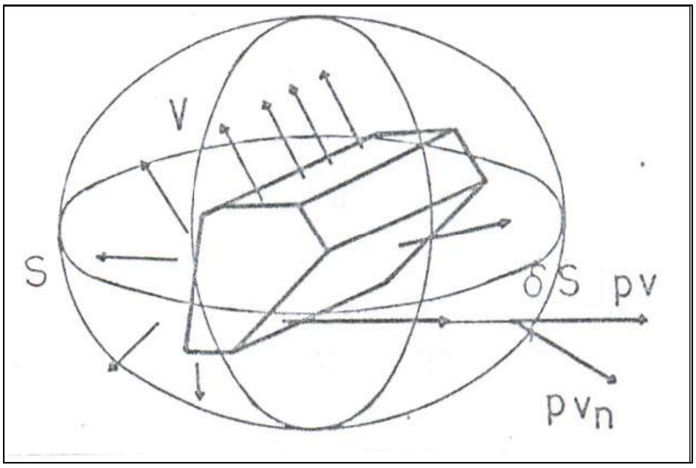

Figure 1. Sound source in free-field (Visualisation of the flux of sound energy).

According to the Gauss's Theorem, the volume integral of the intensity divergence is equal to the integral of the intensity component perpendicular to the surface that forms the volume i.e. it is:

$$W_s = \int_V \mathrm{div}\,\mathbf{I}\,dV = = \int_V \mathbf{I} * \mathbf{n}\,\delta S$$

The above equation shows that measuring of the sound power by determining the intensity is of the same accuracy regardless of the following impacts:

- Presence of the sources not enclosed by the surface S
- Presence of the reflecting surfaces (apart from the volume V) and
- Presence of the ideal reflecting surface (within or outside the volume V).

In fact, all mentioned objects exercise the influence, at some point of the surface S, on the intensity vector, but they do not change the integral’s value.

This point is always emphasized by the producers of the equipment for intensity measurement with the aim of stressing the advantages of determining the noise sound power by measuring the intensity in comparison with the methods based on measuring the sound pressure. However, there are important limits in this regard. Firstly, the source power is measured in not an ideal selected point. It possesses the finite dimensions and it is made out of materials which acoustical characteristics cannot be neglected. Thus, energy dissipation at the object which is measured may often disturb the measurement accuracy. The reflecting surfaces which are close to the object of measuring (outside the volume V) have the same unfavourable influence as the close sources. From the acoustic point of view, the reflecting surfaces can be changed by the sources i.e. they present the mirror images of the basic source. If the source expresses the power in the narrow frequency band then the reflecting surface will act as the coherent source to the basic source which will significantly disturb the integral value over the surface S, that is, the results of measuring the sound power will not be valid.

It is difficult to determine, during the measurement, whether the reflecting surfaces are close or not. Finally, the position of the surface S can be changed and that introduces another degree of uncertainness. The standards treating this field comprise the criteria for experimental defining of this measuring segment (surface), for the estimation of the influence of the reflecting surfaces and external sources (outside V). The criterion is based on the so called “surface pressure – intensity factor”, denoted F2 and “negative partial power indicator” denoted F3.

$$F2 = Lp - 10 \log (1/N(\Sigma\, |I\ \text{measured}| / Iref))$$

$$F3 = Lp - 10 \log (1/N(\Sigma\, I\ \text{measured} / Iref))$$

Where:

Lp is sound pressure level,
N is number of measurements,
Imeasured is measured sound intensity and
Iref is ref. level for sound intensity i.e. 10-12 W/m2.

It is quite clear that if the reflecting surfaces and external sources are large, then, there is a considerable energy flux in the volume V. This cause the significant difference between F3 and F2 due to the differences of sums of absolute and real values of Imeasured. To put it in a simpler way, the second term of the negative power indicator will decrease and indicator value will increase. Hence, for evaluation of measuring the value F3 – F2 can be used. Too great values of the difference between these two indicators point out the fact that there is an impermissible great influence of the external sources or reflecting surfaces. The difference F3-F2 may also indicate the need to get the measuring surface closer to the source of interest.

SOUND POWER REDUCTION IN URBAN AREA

This part deals with sound pressure level reduction in urban area in which the fan for air cooling system was placed and caused increasing of overall noise level. In particular case the telephone exchange building (In left side of the Fig. 2 it is marked with “1”. Photo of the building is given in right side of the Fig. 2) was situated in the residence area. Installing of new equipment asked for installation of the higher power of the cooling fans which increased the sound pressure level. It was found that overall noise made unpleasant effect for residents in surrounding houses especially during the nights when noise emitted by fans become dominant source.

For in detail analyses it was found as necessarily to:

- Identify the total sound power radiated by fans,
- To implement solution which will enable reducing the sound power level radiated by the fans and
- To make a new measurement to identify the level of total sound power level after implementation of measures for noise reduction.

Figure 2. LH side: Marked with 1 is the cooling tower with the fans at the roof of the telephone exchange building,; Marked with 2 is the residential area in which SPL caused by cooling fans’ noise had to be reduced. RH side: Photo of the telephone exchange building.

As it was given in Fig. 2 the position of the nearest resident house from the building where telephone exchange was situated was 32 m. Based on that it was found as workable solution to make a measurement of the total sound power radiated by the cooling fans and to make a precise analyses of the results. It was found as follows:

A) Based on initial measurements of the sound pressure level it was found that nearest building is exposed to the SPL = 53 dB(A) during the night time. This value is found as the maximum SPL for the period of nights when it was not other noise sources (not other than cooling fans).

In particular case it was found inadequate to use “Day-Night Sound Level” approach which is defined as $L_{dn} = 10 \log (1/24 (15 (10^{L_d/10}) + 9 (10^{(L_n + 10)/10})))$. The reason is that the main complaint from theresidents was to the night level (Ln) the sound pressure, and there were no complies to the day level of the sound pressure (Ld) i.e. when the cooling fans noise was masked with other noise sources.

B) It was found that SPL for the night time and for the nearest building has to be reduced to 45 dB(A) which is worldwide accepted level for night time and for resident’s area. The level of 40 dB(A) which is worldwide accepted level for silence zones was found as too radical to be implemented in this case based that traffic and other sources make this city zone non-silent even without presence of cooling fans.

C) The total radiated sound power level of the cooling fans were found as Lw = 82.3 dB(A) ref. 10^{-12}W. The distribution of the radiated noise was analysed through sound intensity mapping on the surface which was oriented toward the nearest resident house as given in Fig. 3. As it was found there were a significant part of the measured area in which the total sound intensity was found at the level above 82 dB(A) and only limited areas with intensity bellow 78 dB(A). Consequently, it was necessary to make reduction. Based on the fact that vertical levels 1 to 6 were with the higher radiated noise (Fig.3 - left) it was decided to introduce insulation material from level 1 to level 6 as it is given in Fig 3 - right (black area from level 1 to level 6). That reconstruction gave significant reduction in radiated noise in insulated zone which reduce the sound power level to Lw = 78.9 dB(A) ref. 10^{-12}W. But, after reconstruction i.e. implementation of insulation the dominant radiation area was shifted to the levels above level 11. In detail analyses shown that SI in those levels were not significantly increased. Simply speaking, they were with the same levels of SI as before reconstruction but, after insulation of zones 1 to 6, levels above 11 became dominant. With intention to reduce radiation from those zones the deflector (blue line on Fig. 3 - right) was introduced and oriented in direction opposite to direction of residential buildings.

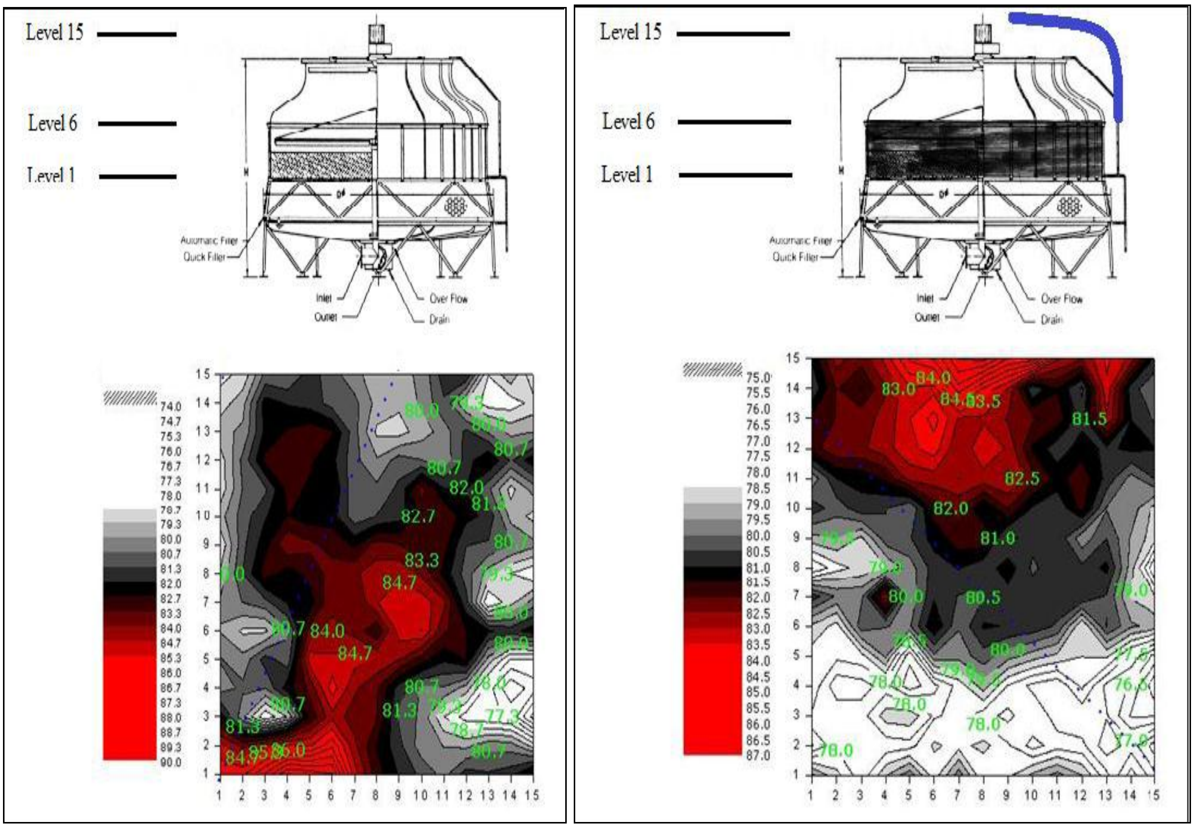

Figure 3. Radiated SI levels in dB(A), ref 10-12 W fromthe cooling fan (LH side -before reconstruction, RH side - after reconstruction and before introduction of deflector (blue lane)).

D) After implementation of all measures noted above the new measurement was done during the night time in the periods when there were no other significant noise sources out of cooling fans. It was found that implemented measures enabled reduction of the SPL to the level of 45 dB(A) i.e. to absolutely acceptable noise level. Fig. 4 presents SPL before and after reconstruction.

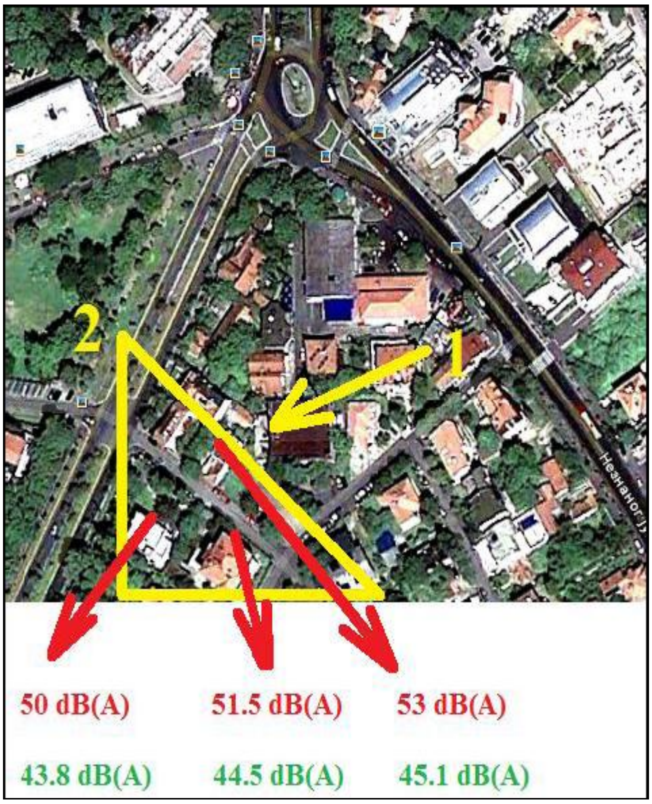

Figure 4. Night time SPL at three locations of residential buildings in zone of interest (triangle mark with 2) before noise reduction (red) and after noise reduction (green).

CONCLUSION

The Sound Intensity (SI) measurement became extremely powerful technique for solving the noise problem in the cases when identification of total sound power has to be done “in site” i.e. where experimental analyses is not possible in semi anechoic chambers or in other acoustical ambient close to free field conditions. In addition, the SI enable precise mapping and identification of dominant sound sources, and in that way, enables source ranking what is the best approach in noise problem solving.

The paper presents results of implementation of SI technique in reduction of noise in residential area where problem with inacceptable SPL started after installation of cooling fans. Through experimental analyses it was found where are dominant sources on the cooling towers, zones were insulated and after that appropriate deflector were implemented for residual areas which were found as critical.

Implemented measures enables reduction of SPL at residential buildings from 53 dB(A) to 45 dB(A) which is worldwide accepted level for “night time” noise.

REFERENCES

Fahy, F.J, Sound Intensity, Elsevier Sc, Pub. Ltd., London 2000.
Beranek L.L., Noise and Vibration Control, Institute of Noise Control Engineering, Cambridge, MA, 2005.

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MANAGEMENT OF NOISE AS AN ECOLOGICAL PROBLEM IN THE CITY

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ABSTRACT

Economic development of a country significantly depends on extensiveness of the transportation network that primarily enables mobility of people and goods. The construction of public infrastructure on the other hand brings with it serious ecological problems, unless special attention was not paid to the protection of the environment through planning, design and construction . One of the severe ecological problems that appears in the urban environment is the traffic noise. Traffic noise has strong influence on people because it causes permanent damage to the organism. In addition to undertaking activities like changing commuting patterns from individual to mass transit and minimizing the need for transportation, technical, physiological and legal measures are also undertaken. Achieving results in the protection of living environment requires that everybody accepts the obligation to cooperate in the management of living environment. The management of living environment is continuous and interactive process which is being coordinated through all the living and working processes. The principles and elements of living environment management are: politics of environmental protection, planning, enforcement, measurement and valuation, revision and improvement, and continuous improvement. In the paper, the model for taking and using the data from monitoring of the traffic, air and noise pollution, which are used by both public and professionals.

Keywords: noise, ecology, living environment, sustainable development, management, regulations.

INTRODUCTION

Permanent or temporary noise exposure of 90dB or more leads to a loss of hearing. According to the National Institute on Deafness and Other Communication Disorders, exposure to strong noise resulted in hearing loss of 10 million people out of 30 million people who lost their hearing in the U.S., and 30 million people are daily exposed to damaging noise from different sources. Noise suppression is one of the most serious challenges in the XXI century. Noise in the cities is derived from many sources, virtually everything that surrounds the man, and that contributes to the overall level of noise in cities. The noise comes from the city streets, with about 80% contribution to the overall noise level. During the past ten years, the level of noise in big cities has increased by 10-12 dBA. Traffic flow on major city roads reaches 2000-6000 vehicles per hour. It is important to bear in mind that noise increases with increased engine power and increasing vehicle speeds.

In Belgrade, the measured noise from traffic, in 2007. only, was greater than the regulations allow for the zones in which it was measured at 85% of the places, and it was concluded that it is necessary to take certain actions to reduce it. To resolve the problem of noise in Serbia, it is necessary to translate the existing European Union guidelines and standards for noise, and besides the analysis and diagnosis of the situation, to take appropriate actions. The paper presents the proposal of a model for the management of noise, which is based on the Directive 2002/49/EU that allows developing an action plan to resolve the problem.

THE MODEL OF NOISE MANAGEMENT IN URBAN AREAS

Ambient noise means unwanted or harmful sound in space, created by the action of man, including noise emitted from the automotive, rail, and air transport, and industry. This noise does not include noise from the households, the neighborhood, noise at the workplace or within the means of transport, as well as noise generated during military activities in military areas. Ambient noise has adverse effects on human health and well-being. The European Directive 2002/49/EU aims to provide assessment and management of ambient noise, by introduction of a system for determining the time of exposure to ambient noise, by providing the information available to the public about the ambient noise and its effects, and by the adoption of action plans.

Action plans should be based on priorities, which can be identified by means of exceeding the important boundary values, or by other criteria chosen by the state, through appropriate legislation and regulations. The process may for example include traffic planning, construction land planning, technical indicators of the origins of the noise, selection of quieter sources, reduction of noise transmission and its control, or as the final step the economic measures or incentives. The aim is to prevent and reduce ambient noise, especially where exposure levels can induce harmful effects on human health and to protect the quality of ambient noise where it's levels are good. Noise abatement policy, at national and local levels are regulated in most countries of the European Union, and in Serbia it is stipulated in the national strategy on the protection of environment and applicable law and standards for allowed noise levels.

In European Union for the protection from the noise, the Program for the development of municipal action programs for environmental protection is provided (Community Environment Action Program), for the period from the Year 2008. to the Year 2014.. This program is provided primarily because through the noise measurements during 2000, the European Union estimated that 100 million people every day are affected by long-term high noise levels, so by the Program are given the successive reductions of noise by 10% by 2010 and by 20% to 2020th. The long term goal is to reduce long-term high levels of noise. In our action plan for reducing the high levels of noise for the observed locations the given reduction is 10% by 2016 and by 20% by the year 2026.

Noise management model that is based on Directive 2002/49/EU, consists of the following:

1. identification of problems by creating noise maps,
2. Noise measurements on the spot,
3. Public polls in places where the measured noise exceeds levels permissible by regulations,
4. assessing the situation,
5. proposals for the development of an action plan for the resolution of problems and
6. monitoring of noise pollution

Identification of problems by creating noise maps

Maps of noise-data content

1. Strategic map of noise contains information about one of the following aspects of noise:
    1. current, previous and forecasted noise situation expressed by the noise indicators,
    2. exceeding the threshold
    3. estimate of the number of apartments, schools, hospitals in designated zones exposed to particular values of noise indicators,
    4. estimate of the number of people in the area exposed to the noise.
2. Strategic noise maps may be presented to the public as:
    - graphic drawing,
    - Numeric data in the tables,
    - Numeric data in the electronic form.

3. The strategic noise maps for agglomerations shows in particular the noise emitted by:
   - road traffic
   - rail transport
   - airports
   - areas of industrial activity, including ports.
4. Strategic map of noise is used for the following purposes:
   - to acquire data that is sent to the Commission, in accordance with Article 10 (2) and Annex VI,
   - as a source of information for the citizens, in accordance with Article 9,
   - as a basis for action plans, in accordance with Article 8

Each of the above applications requires a different type of strategic maps.

5. In strategic noise map, for informing the citizens, in accordance with the development of action plans, additional and more detailed information must be provided, such as:
   - graphic presentation,
   - maps depicting exceeding thresholds,
   - comparative maps in which the existing situation is compared with various possible future situations,
   - maps that show the value of different indicators at an altitude other than 4 m, where appropriate.
6. Strategic noise maps for local or national use must be made for authoritative height of 4 m and Lden and Lnight must be expressed in intervals of 5 dB
7. For agglomerations, strategic noise maps are made especially for road, rail and air traffic noise, and also for industrial noise. Maps for other sources of noise can be added.
8. The Commission might produce guidelines that would provide further guidance for the noise maps, for the charting of maps and software packages for mapping, in accordance with Article 13 (2) of the Directive.

Measurements of noise on the site

Measurements are made at the following locations where:

a) Part of the population is exposed to the prolonged high-levels of ambient noise
b) Noise levels in selected municipal areas: used instead of a) where the data for a) cannot be obtained
c) Action plans are asking for the determination of noise levels (alternatives are given depending on the possibility for obtaining data)

Public polls in places where measured noise exceeds levels permissible by regulations

The survey is done by asking the following questions:

a) What are the values of ambient noise that people are exposed to: from the automotive, rail and air transport, and from industrial sources in their homes, in public parks and other relatively quiet areas?
b) What are the noise levels in selected municipal areas?
c) Have the local authorities prepared and put in use any action plans / programs for noise abatement?

Evaluation with an assessment of the situation

a) Shows the percentage of unprotected population-estimated number of people (in hundreds) living in dwellings exposed to each value of the following groups: L_{den} in dB at 4m above ground on the most exposed façade: 55-59, 60-64, 65-69, 70–74, >75, particularly from automotive, rail or air traffic and noise of industrial origin, and the estimated total number of people (in hundreds) living in dwellings exposed to each of the following group of values L_{night} in dB (A) 4m above the ground on the most

exposed façade: 50-54, 55-59, 60-64, 65-69,> 70, particularly from automotive, rail or air traffic and noise of industrial origin;
b) Shows the percentage of appropriate measures for different values - the proportion of measurements for all the above values of group L_{den} and L_{night};
v) The existence (yes / no) and level of execution of the action plan / program for noise abatement(%)
The figure must be rounded to the nearest hundred (eg. 5200 = between 5150 and 5249, 100 = between 50 and 149; 0 = less than 50). All methods used, methods for assessing exposure to noise must be described and to display the appropriate value of the group L_{den} and L_{night}, for example Table 1:

Table 1: Percentage of inhabitants exposed to noise levels

	50-54	**55-59**	**60-64**	**65-69**	**70-74**	**≥ 75**
L_{den}	10%	25%	53%	10%	2%	0%
L_{night}	69%	17%	11%	3%	0%	0%

L_{den} indicator for the overall noise nuisance,
Night noise indicator L_{night} is the noise indicator for sleep disturbance.
The total amount of measurements taken should be reported.

Limit value represents the value or size L_{den} L_{night}, and where appropriate also L_{day} and $L_{evening}$, as determined by the Member States, when those values are overcome. In our regulations noise is governed by the zones with Leq.

The dose / effect of noise indicates the relationship between the values of noise indicators and adverse effects, *adverse effects* indicate a negative effect on human health. Adverse effects may be assessed using functional dependency on the level of noise defined by the Annex III.; *annoyance* pertains to the level of the annoyance of the population caused by the noise, obtained by examining the site. To assess the effect of noise on the population, must be applied relationship between the dose of noise and the effects of noise. The relationship between dose and adverse effects of noise will be, as given by the Directive, entered into future revisions of the Annex in accordance with Article 13 (2), and will refer in particular to:

- relationship between the *annoyance* and Lden for automotive, rail and air transport, as well as industrial noise;
- relationship between sleep disturbance and Lnight for automotive, rail and air transport, as well as industrial noise. If necessary, a special relationship between dose and effect of noise can be displayed:
  - For apartments with special insulation against noise,
  - For apartments with a quiet façade,
  - For different climatic and cultural conditions,
  - For groups of populations vulnerable to damage from noise,
  - For industrial-noise which contains tones
  - For industrial impulse noise and other special cases.
  - LAmax or *SEL (sound exposure level)* the level of noise exposure for protection from peaks of noise during the night
  - Special protection from the noise on weekends or other special days of the year;
  - Special protection from noise during the day;
  - Special protection from noise during the evening;
  - When the noise comes from multiple sources;
  - For the quiet-zone outside the settlement;
  - When the noise contains strong tonal components, or when the noise has impulse characteristics.

In Serbia the following formula is used to calculate estimates of the harmful effects of noise on people: $L_{NP} = Leq + (L_{10}-L_{90})$ dBA. To determine the noise-level and the bodily reaction to the noise, it is possible to apply the following recommendation which is based on the Regulations of the Republic of Serbia from 1982. as follows:

- Noise of 30 dBA to 65-first-level
- Noise of 65 dBA to 90-second level
- Noise of 90 dBA to 110 third-level
- Noise of 110 dBA to 130 fourth-level

At the first level, the noise causes the general reaction of the body (depending on individual sensitivity). The second level of noise causes a reaction of the neurovegetative system (healthy body withstands it without any consequences for the health). The noise of the third level is the highest bearable noise and it is registered in the entire frequency range, with a detrimental effect on the human sense of hearing and on the whole body. The noise of fourth level is unbearable for human hearing sense and it cannot be tolerated for long. As our bloodstream regulates vegetative nervous system, it is understandable that the noise will cause the disturbances in the functioning of the neurovegetative system, which will respond and disrupt the blood circulation. High intensity noise is accompanied by the vibrations that sensitize even more the sense of hearing.

A proposal for developing an action plan to address the problem of noise

These plans include: condition, measures, assessment of the impact on human health in the case of endangered environment; stakeholders; method, dynamics and resources for implementing the plan. Community action concerning the problem of noise in the environment includes strategies to be implemented: the medium and long term targets for reducing the number of persons affected by adverse environmental noise effect, especially taking into account the climatic and cultural differences; for additional measures to reduce environmental noise emitted by specific sources of noise, especially machines outdoors, means of transport and infrastructure, as well as some categories of industrial activities, adding them to already implemented measures; for the protection of quiet areas outside the settlements.

Content of the Action Plan

1. The action plan must include the following:
   - Description of the agglomerations, major roads, major railways and major airports and other noise sources taken into account,
   - competent authorities,
   - legal basis (legal context),
   - All threshold values in the area, in accordance with Article 5,
   - summary of the results from making the maps of noise-data
   - evaluation of the estimated population exposed to noise, identification of problems and situations that need to be improved,
   - record of consultations of authorities with the public in accordance with Article 8 (7),
   - all measures already taken to reduce noise and all projects under construction,
   - activities that competent authorities intend to take during the next five years, including measures for the preservation of quiet zones,
   - long-term strategy,
   - financial information (if available): the budget, assessment and evaluation of the efficiency of achieved benefits in relation to the costs;
   - provisions envisaged for evaluating the action plan regarding the implementation and the results.
2. Activities that the authorities intend to take within its competences, may include for example:
   - transport planning,

- land use planning,
- technical measures at noise sources,
- selection of quieter sources of noise,
- reduction of sound transmissions,
- the legal and economic measures, or the incentives

Finance. - Determined by each state according to its laws. In Serbia, the establishment and funding of environmental protection at national and local level are regulated by the Law on Environmental Protection.

The public Strategic noise maps and action plans must be made available to the public in accordance with the regulations of the community, especially with the Directive 90/313/EEC of 7 July 1990. for free access to environmental information, and in accordance with Serbian existing laws. Through that, the information about the existence and the level of enforcement of the action plan are made available to all interested parties by the authorities themselves.

Using a table with two columns, be sure to show the relevant figures and percentages for each individual performance measure / action identified in the action plan / program.

Table 2 - Percentage of performance for each measure, the action in the action plan

Measures / Action	**The level of performance (%)**
1.....	
2.....	

Serbia adopted the Strategy for Environmental Protection and in the part related to noise short and medium term objectives for implementing the action plan are given, which are part of environmental management-as follows:

- *Short-term goals Years 2006-2010:* the harmonization of national legislation concerning noise with EU legislation
- *Continuing Goals Years 2006-2015:* The determination of zones and noise monitoring system in rural areas with the highest noise emissions in accordance with Directive 2002/49/ES by the Year 2010. ; establishing a target noise monitoring at the busiest roads, reducing noise emissions in the most affected locations
- *Mid-term objectives Years 2011-2015:* prepare action plans for areas covered by the noise maps in accordance with Directive 2002/49/ES; produce noise maps for agglomerations with over 250,000 inhabitants, major roads with more than 6 million vehicles a year, major railways and the Belgrade airport in accordance with Directive 2002 / 49/ES 2012.

Monitoring noise pollution in cities

In the European Union, several projects on the monitoring of noise pollution are implemented, such as HEAVEN EU project for recording and monitoring of traffic noise in Paris, Rome, Berlin, Prague, Rotterdam and Leicester-based on Directive 2002/49/EU, projects for noise abatement in the cities for the period until the Year 2016 in which certain traffic measures are taken: the change of vehicle speed, evaluating the speed limits, parking and their schemes, and changes of the direction of the street networks. The examples:

London - The Law on the reduction of road traffic from the Year 1997 to limit the traffic was not accepted and estimated damages were in the billions of pounds per year, so the most suitable scenario for repairing the traffic situation was made as follows: collecting the tolls for road use, the solution for slowing the traffic and parking control, and the solutions which give priority to public transport.

Paris - The scenario for noise reduction: the day without a car every 22nd of September and the implementation of independent (special) bus lines of service on the three busiest axis

Berlin - Written by long-term urban scenario 2005, Euro III flow, long-term urban scenario 2010, Euro IV flow, the speed limit (imposed speed limit of 30 km/h from 1st July to 26th of August and the prohibition of trucks including a detour, implemented from 26th of August to 15th September)

Rome - The scenario: access restrictions for cars without catalytic converters and closing of the major roads.

Prague – The scenario: New Transportation master plan from 2010. introducing the alternative bypass route, speed reduction from 70 to 50 km/, and one-way traffic Smichow.

CONCLUSION

Principles of environmental management in planning, including environmental noise, should be based on: protection of natural values and immovable cultural property - an absolute priority; rational use of land, energy, water, natural resources; application of the precautionary principle for the activities that may cause greater environmental risk and uncertainty; the principle of “predict and prevent" rather than "react and cure"; securing the compliance of policies and environmental strategies at all levels; developing training and environmental compliance and environmental control for plans of all levels. Basic methods and instruments for managing the plans and projects should include: a database of environment and space; the assessment of ecological capacity of the area; system of ecological indicators of sustainable development; strategic environmental assessment in the plans; analysis of the impact of projects on the environment; assessing the risk of accidents, and the process of public involvement in decision-making for plans and projects.

REFERENCES

Directive 2002/49/EU.
Directive 90/313/EEC.
Zlatanović, Tomasevic Vesna, Ph.D. - (2008) - Management of environmental noise as a problem in the city, doctoral dissertation, University of Belgrade, Faculty of Architecture.

ELECTRO AND ELECTRO-MAGNETIC POLLUTION IN URBAN AREAS

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WASTE STORAGE FOR ELECTRICAL AND ELECTRONIC EQUIPMENT

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ABSTRACT

Based on physical, chemical and biological properties of waste materials, they can be of organic or inorganic origin. Depending on the contents and the location of their origin, waste material is divided into several categories: industrial waste, mixed communal waste, construction debris, etc. According to the way in which they affect human environment, useful industrial waste used as secondary raw material is classified into: waste material that is harmful for the people’s health and waste material whose polluting effects have an influence on the appearance of the urban, rural and natural environment.

All waste material originating from the process of production and consumption has a material/energetic potential that can be used by applying corresponding chemical-technological procedures, i.e., such a waste material is re-processed into a secondary raw material. Preservation of natural resources and protection of human environment are particularly important in collecting and further treating of waste materials, which can extensively pollute the human environment if they are not re-used.

In accordance with the Law on Waste Materials, these materials are classified into a number of categories and types with corresponding numeration given in the List of Waste Types (“Official Gazette of RM” no. 100/05) according to which, the waste originating from electrical and electronic equipment is indicated by number 1602.

Key words: : industrial waste, electronic waste, noise, radioactivity.

THEORY

Collection and Selection of Electric and Electronic Waste

The collection of this type of waste should comply with the Law on Waste Management (“Official Gazette of RM” no. 68/04) which reads that waste must be selected. However, the provisions of this law have insufficiently been implemented in practice and this waste has been deposited in landfills for communal solid waste along with the communal solid waste. At the moment, there is a small number of capacities for collection and processing of this type of waste. In April 2011, the Ministry for Protection of Human Environment and Physical Planning elaborated a Draft Law on Management of Electrical and Electronic Equipment and Waste Electrical and Electronic Equipment (Alen et al., 2005).

The provisions of this law apply for the following categories of electrical and electronic equipment:

- Big and small household appliances;
- IT and telecommunication equipment;
- Entertainment electronic equipment;
- Illumination equipment;
- Monitoring instruments;
- Automats, etc.

The broader application of the Law will open a greater possibility for the functioning of such type of enterprises, i.e., their extension.

The increase of the scope of collection of such type of waste materials will be achieved by:

- Selection in industrial working media with homogeneous materials which is very easy;
- Establishment of collection points at certain locations in inhabited places, particularly for collection of waste electronic equipment, mainly personal computers, mobile telephones, TV sets, etc.

The consistent application of the law requires greater engagement of the local self-government and the Ministry of Human Environment and Physical Planning in the part of placement of corresponding devices for collection of this type of waste and also control over observation of legal regulations mainly by the bigger enterprises.

The electrical and electronic equipment waste produced by the companies with which KASKA Ltd. association from Skopje will conclude an agreement for taking over the waste, will be collected in metal containers and will be picked up and transported by special vehicles within the circle of the considered branch office for additional selection and trade.

The technology of selection and trade with this type of waste will consist of the following activities:

- Receipt of the collected waste materials;
- Selection (transformers, mobile telephones, PC, TV);
- Distribution of waste materials to the working places where dismantling will be carried out;
- Dismantling and storage;
- Transportation to further users.

The dismantling of the electronic plates will be done manually by means of manual tools. As to the mechanical part, the components of the electronic plates will be separated. Individual components will be collected in wooden or metal boxes or in the so called jumbo bags that will be kept in a storehouse. The remaining metal parts will be selected and sold to other enterprises dealing with buying of waste material. An agreement for cooperation will be concluded with all the companies with which waste material will be traded and these will be licensed companies that will work in accordance with the Law on Waste Management.

The annual purchasing/selling capacity depends on the market demands. There is mainly an equilibrium between purchasing and selling of secondary raw material.

Raw and Accessory Materials

For the planned activity of storage and trade with waste from electrical and electronic equipment, the Association will have available a closed area of 100 м^2 and 35 containers proportioned 1,2 x 1,2 x 1,0 м or a total volume of 50 м^3.

For the storage of electrical and electronic equipment waste, there will be no application and consumption of raw material in the classical sense of the word (Yuan et al., 2007) Energizers of the type of electrical energy, water and liquid oil gas will be used for the vehicles. The planned annual consumption of the stated energizers will depend on the market demands. The annual consumption is planned to amount to:

- Electricity	3.500 kW/hour
Water	100 м^3/per annum
- Liquid oil gas	300 l/per annum

METHODS

Effect of Storehouse upon Environment

In accordance with the Law on Protection of Air Against Pollution, the emissions in the air are categorized as: emissions from boilers, point emissions from stationary and mobile sources and potential and fugitive emissions (Hecht et al., 2001). In the course of everyday operations, there will be no important emissions from the considered structure because:

No combustion devices will be used and no evaporable organic components will be produced from the activities of the branch office.

Since there are no stationary point sources (chimneys) and there is negligible short term emission from mobile sources (vehicles), Table 1.

Table1: of the Rulebook is filled out as follows

Source of emission	Details of emission				Deviation from MAC *(mg/Nm^3)
Revue	Height of chimney (when applicable) Number of mobile sources (when applicable)	Substance /material	Emission (mg/Nm^3)	MAC(mg/ Nm^3)	Exceedance/ Within the frames of MAC
Chimney	Non applicable				
From time to time, mobile sources (vehicles):	At parking of transportation vehicles from time to time	t^o CO CO_2 NO_x SO_2 Smoke code lead dust	/ Negligible Negligible Negligible Negligible Negligible Negligible Negligible	/ * * * * * * *	/ / / / / / /

Maximum allowable concentration

There is only negligible and short term emission of gases and dust during motion of vehicles upon the tamped (non-concreted) part of the courtyard area of the branch office which is not the subject of more detailed analysis since the frequency of the transportation vehicles is low. For the stated emission, inapplicable is the one hour monitoring according to the Decree on Ultimate Values for Levels and Types of Polluting Substances in Ambient Air and Thresholds for Alarm, Terms for Reaching of Ultimate Values, Tolerance Margins, Target Values and Long Term Objectives (Official Gazette of RM, June 2005) that has been applicable since 1.01.2007.

Considering that the Rulebook on Maximum Allowed Concentrations and Quantities and Other Harmful Matters (Official Gazette of RM 3/1990) MAC applies only for stationary inner combustion engines using liquid fuels, given below is the comment on this type of pollution given in literature.

From the inner combustion of oil derivatives-gasolines in the engines of the vehicles, exhaust gases are released in the atmosphere to the amount of cca 180 organic components as harmful matters. The lead content in gasoline amounts up to 0,6 g/l. Approximately 75% of the lead content is emitted through the exhaust gases and approximately 95% of the sulfur content combusts into SO_2, Table 2.

Table 2: reads the contents of part of the emitted harmful matters

COMPOUND	**GASOLINE ENGINES**	**DIESEL ENGINES**
	g/l	g/l
Sulfur Dioxide	0,4	4,5
Nitrate oxides	20	90
Organic volatiles	40	110
Total suspended particles	3	15
Carbon monoxide	220	90
Lead	0,45	0
Benzopyrene	20 mkg/m^3	10 mkg/m^3

Long term exposure to the above stated toxic matters adversely affects human health: the smoke affects the lungs and the skin, the lead affects the respiratory, the nervous and the blood vessel system, the nitrate oxides cause asthma, allergies and malignant diseases, The solid particles resulting from the combustion have cancerous effect.

MAC for the harmful matters given in the table below:

Components	**Emitted quantity**	**Emission concentrations**
	MAC g/h	**MAC ng/m^3**
Lead	25,00	5,00
Nitrate oxides	50000,00	500,00-800,00
Carbon dioxides		500,00
Formaldehyde	100,00	20,00
Solid particles		130,00
Carbon monoxide		650,00
Carbon dioxide (%)		2,50

The use of ecological fuels that are currently being introduced in retail sale of soil derivatives will drastically contribute to the reduction of negative effects upon human environment.

Emissions in Waters and Sewerage

The structures of the branch office are supplied with water for sanitary needs from the town water supply network.

Waste water is not produced from the considered activity of storage of waste from electrical and electronic equipment. The waste sanitary fecal and atmospheric water will be released into the existing town sewerage for fecal and atmospheric water through an appropriate sewerage network.

Considering the planned appropriate isolation of the floors and the structures, it can be concluded that there will be no pollution of surface and underground waters.

Creation of Waste

Liquid waste is not created from the activity of the enterprise reduced to purchase and selling of electrical and electronic waste. A very little quantity of solid waste will be produced from the technological process (dismantling, selection of this waste) as well as communal waste from the everyday working and living of the employees. For the collection of the solid communal waste, a container is placed. The picking up of the communal refuse will be done by the public enterprise – Communal Hygiene from SkopjeTable 3.

Table 3: shows the type and the quantities of waste produced from the operation of the storehouse.

No.	Type of waste	Number from the list of waste types[1]	Waste quantity at annual level (t/L)	Mode of treatment of waste	Method and location of storehouse
1.	Communal solid waste	20 03 01	0,8 т	/	Town landfill
2.	Electrical and electronic parts	16 02	≥ 50 м^3	Selection	Export to private companies for recycling

Emissions in Soil

There will be no pollution of soil due to the operation of the storehouse because:

- The waste will be selected, stored and removed in a safe way;
- The communal solid waste will be deposited in a container and Public Communal Enterprise will regularly transport it to the town landfill;
- There will be no producing of waste technological water. The waste sanitary fecal water will be channeled into the town sewerage system;
- The atmospheric water will be channeled to the town sewerage system for atmospheric waters;
- To prevent possible penetration of harmful matter into the soil, isolation of the floor of the planned structures is anticipated at the site;
- Since the quality of air is not disturbed by the everyday operation of the enterprise, pollution of soil and the surrounding of the structures is impossible.

From the above, it can be concluded that the surrounding soil and vegetation will not be degraded at the considered site.

Noise, Vibrations and Non-ionizing Radiation

Due to the activities performed at the considered waste storehouse of electrical and electronic equipment, emission of noise will be generated during the operation of the vehicles that will perform shipment and driving away of the waste materials within a very short time period from 8 to 16 h. These will be trucks of different types by which the transport of the waste material is anticipated. The emission of noise will take place during the parking of the vehicles to load or unload material which will not take more than 5 minutes, which is a very short time period, and the operations will be, first of all, incidental, due to the fact that shipment and driving away of materials is not anticipated to be done on a daily basis (J.M. 1993).

The works on the site are anticipated to be carried out in accordance with the Law on Protection Against Noise in Human Environment ("Official Gazette of RM" no. 79/07). Namely, this is an area located in an industrial zone belonging to areas of IV degree of protection against noise according to the Rulebook on Locations of Measuring Stations and Measuring Points (Official Gazette no. 120/8). In these areas, the maximum allowable level is 70 dB during the day and 60 dB during the night in accordance with the Rulebook on Ultimate Values of Level of Noise in Human Environment (Official Gazette no. 147/08). Considering the fact that the stated sources of noise represent point sources, their intensity is decreased for 6 dB by the doubling of the distance from the source as presented in Fig. 1.

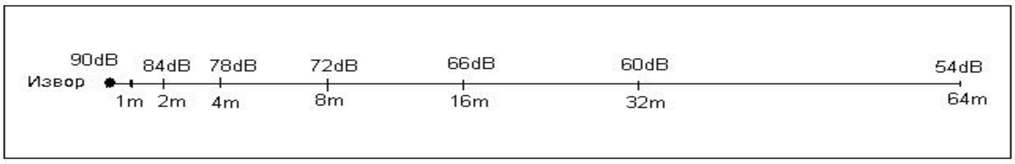

Figure1. Presentation of reduction of noise intensity with distance

The emission of noise generated during the performance of the works under permanent regime will be much lower, namely MAC - 70 dB.

The activities planned to be carried out on the considered site are not expected to produce vibrations and non-ionizing radiation that will negatively affect the human environment (Fig.2).

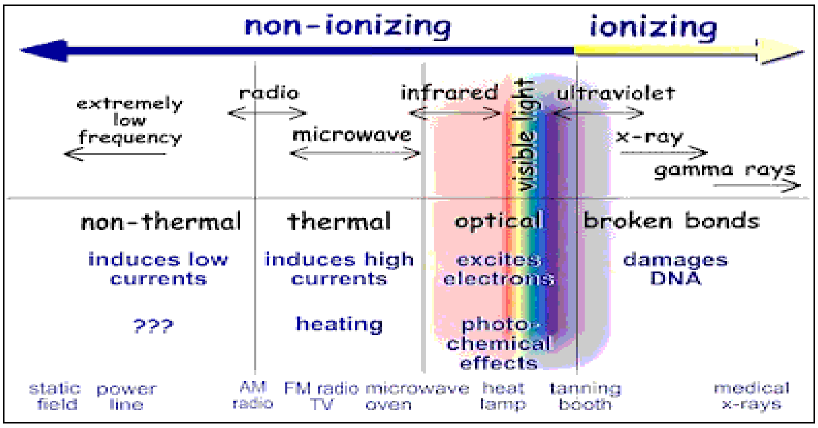

Figure 2.Presentation deferrence of non-ionizing and ionizing radiation

PROGRAMME FOR PROTECTION OF ENVIROMENT

It is an obligation of all legal and physical entities to take care of the human environment in accordance with the Law on Human Environment ("Official Gazette of RM" 53/05) and take measures and activities by which they will reduce the effects upon the environment to the minimum.

From the previously stated, it can be concluded that the effect upon human environment exerted by the storehouse for waste originating from electrical and electronic equipment of the Association for Production, Transport, Trade and Services KASKA Ltd. Skopje is negligible, and, on the contrary, the above activities enable recycling and reuse of the electrical and electronic waste by which it is contributed to the protection and upgrading of the environment. The process of recycling enables saving of natural resources, reduced emission of greenhouse gasses in the atmosphere, saving of energy, and what is the most important for the management of this type of waste, it is its reduced depositing in the communal landfills.

The final estimation of effects is presented in Table 4.

Table 4:

Component	Importance of the effect	Importance of the effect after measures taken	Global importance of the effect upon the components
Climate	Negligible	Negligible	Negligible
Surface waters	Low	Negligible	Negligible
Underground waters	Low	Negligible	Negligible
Landscape	Negligible	Negligible	Negligible
Vegetation	Negligible	Negligible	Negligible
Air quality	Negligible	Negligible	Negligible

Land	Low	Negligible	Negligible
Noise	Low	Negligible	Negligible
Economic effects	Moderate	Moderate	Moderate

Since management of human environment requires permanent upgrading and use of modern technological preliminary solutions, trends, the following measures and activities are proposed:

- Permanent upgrading of the system for sustainable management of waste matter in accordance with the existing legal regulations by which the following objective is achieved: reduction of the quantity of produced waste and its negative effect upon human environment. Utilization of useful fractions of the waste and its energetic potential is enabled;
- Green areas and areas with trees act as natural purifiers of air and soil. The oxygen in the atmosphere is renewed and the effect of noise is amortized.

Therefore, their establishment and permanent upgrading is recommended.

The measures anticipated for the realization of the programme of protection of human environment are presented in Table 5:

Table 5: Measures for the realization of the programme for protection of human environment

No.	Description of the measure	Objective of the measure (expressed via reduction of the effect upon environment)	Time schedule of realization of the plan for upgrading within 5 years		
			Month/year	Month/year	Month/year
1.	Maximum selection of waste matter	Minimization of quantity of waste by obtaining of secondary raw material	Permanent		
2.	Creation of green areas	Natural purifier of air and soil	Permanent		

AVERAGES

The possibility for possible occurrence of averages due to the activities of the storehouse of waste from electrical and electronic eq1uipment (Morgan et al, 2006) is low because the following measures are anticipated:

- There is a good access for the fire fighting vehicles. FF apparata will be placed at points within the structures that are at the greatest risk of occurrence of fire;
- During the placement of the electrical installations, measures will be taken for complete protection against overloading, overheating and mechanical damage to the power supply installations under high voltage;
- There will be a lightning rod installation;
- The channeled outflow of atmospheric waters into the town sewerage will provide protection against showers and floods;
- Since earthquakes as natural phenomena cannot be predicted, the structures will be constructed as seismically resistant ones.

REVIEW OF LEGAL REGULATIONS

The monitoring of the conditions and the level of pollution of environment in each country complies with the laws and the subordinate acts which define the main directions toward preservation of the quality of the media and areas of human environment.

In our republic, the following laws and subordinate acts are applied:

- Law on Environment (“Official Gazette of RM“ no.53/05, 81/05, 24/07, 159/08, 83/09 and 48/10);
- Decree on establishment of projects and criteria on the basis of which the need for effectuation of the procedure of evaluation of effects upon environment is defined (“Official Gazette of RM“ no. 74/05);
- Law on Protection of Nature (“Official Gazette of RM“ no.67/04);
- Law on Protection Against Noise in Environment (“Official Gazette of RM“ no. 79/07);
- Rulebook on Ultimate Values of Noise in Environment (Official Gazette no. 147/08);
- Rulebook on Locations of Measuring Stations and Points (Official Gazette no. 120/08);
- Law on Waste Management (“Official Gazette of RM“ no. 68/04);
- Law on Management of Packing of Waste from Packing (“Official Gazette of RM“ no. 161/09);
- List of Waste (“Official Gazette of RM“ no. 100/05);
- Law on Safety of Food and Products and Materials in Contact with Food (“Official Gazette of RM“ no. 54/2002)
- Rulebook on General Rules of Management of Communal and Other Types of Non-hazardous Waste (“Official Gazette of RM“ no.147/07);
- Rulebook on Detailed Conditions Regarding Management of Hazardous Waste and Mode of Packing and Marking of Hazardous Waste (“Official Gazette of RM“ no. 15/08);
- Law on Quality of Ambient Air (“Official Gazette of RM“ no. 67/04);
- Rulebook on Criteria, Methods and Procedures of Evaluation of Quality of Ambient Air (“Official Gazette of RM“ no. 82/06);
- Decree on ultimate values of levels and types of polluting substances in ambient air and thresholds for alarm, terms for reaching of ultimate values, margins and tolerance of ultimate values, target values and long-term objectives (“Official Gazette of RM” no. 50/05);
- Rulebook on Maximum Allowed Concentrations and Quantities and for Other Harmful Matters that Can be Released from Air from Individual Sources of Pollution (“Official Gazette of SRM“ no. 3/90);
- Law on Physical and Urban Planning (“Official Gazette of RM“ no. 51/2005);
- Physical Plan of Republic of Macedonia (“Official Gazette of RM” no. 39/04);
- Law on Waters (“Official Gazette of RM“ no. 87/08).

CONCLUSION

From the stated above, it can be concluded that the considered activity involving storing waste from electrical and electronic equipment by the KASKA Ltd. Association Skopje is expected not to have any significant effect upon the environment. On the contrary, the activity will enable protection and upgrading of the environment since its main function is to contribute to recycling of the electrical and electronic waste. With the recycling itself, it will contribute to reduction of the need for natural resources and saving of energy. Finally, the activity of the Storehouse will contribute also to the social-economic sphere by creation of new jobs.

According to the above, it can be stated that,. from the aspect of effect upon environment and nature, the Storehouse for storing waste originating from electrical and electronic equipment of the KASKA Ltd. Association Skopje, fulfills the necessary conditions for rational and, from ecological aspect, safe functioning.

REFERENCES

Alen Taflov and Susan C. Hagness (2005). *Computational Electrodynamics: The Finite-Difference Time-Domain Method, 3rd ed.* Artech House Publishers.ISBN 1-58053-832-0.

Hecht, Eugene (2001). *Optics* (4th ed.). Pearson Education. ISBN 0-8053-8566-5.

J.M. Field, *Effect of personal and situational variables upon noise annoyance in residential areas*, Journal of the Acoustical Society of America, 93: 2753-2763 (1993)

Morgan, Russell (2006-08-21)”Tips and Tricks for Recycling Old Computers”

Yuan, C., Zhang, H. C., McKenna, G., Korzeniewski, C., and Li, J. “*Experimental Studies on Cryogenic Recycling of Printed Circuit Board*”, International Journal of Advanced Manufacturing Technology, Vol. 34, 2007, pp. 657-666.

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IMPORTANCE OF DESIGN FOR RECYCLING ELECTRONIC AND ELECTRICAL EQUIPMENT

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ABSTRACT

The importance of design for recycling of electronic and electrical equipment (EEE) will be shown by analysing environmental pressures, impending legislation, increasing disposal costs and business opportunities. Different institutions train their designers in a variety of ways to allow them to successfully carry out design tasks and increase the proportion of products that can be efficiently and economically recycled. Design tool that could be used in such cases is a set of design guidelines. The article gives the guidelines developed by the Manchester Metropolitan University, and examples of using some of them. The importance of this type of guidance is emphasized and it is shown how that can be applied. The paper also presents guidelines of Industry Council for Electronic Equipment Recycling (ICER). The ICER Guidelines provide a basis on which manufacturers can develop a design strategy specific to their company or to a particular product. They are generic and can be adapted for use in most sectors of the electronics industry. They have been produced to help concept designers and design engineers. They will also be useful for anyone with an insight into the design process, particularly those involved with marketing and procurement.

Key words: design for recycling, electronic and electrical equipment, guidelines

INTRODUCTION

What are E-products and E-waste? E-products are a popular, informal name for electronic and electrical products, and E-waste is also a popular, informal name for electronic and electrical products nearing the end of their ‘useful life’. There are a lot of definitions for these terminologies but we think that is quite correct definition from the EU Directives – Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) and Waste Electrical and Electronic Equipment (WEEE). These directives define EEE (or E-products) as "equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields... and designed for use with a voltage rating not exceeding 1000 Volt for alternating current and 1500 Volt for direct current" (European Union, 2003).

What's the problem with waste electrical and electronic equipment (WEEE)? WEEE is made up of many different materials and components, some of which are toxic and hazardous. Each electrical and electronic piece of equipment consists of a combination of several basic building blocks, such as circuit boards/assemblies, plastics containing flame retardants, batteries and mercury switches. Up to now more than 90 % of WEEE was landfilled, incinerated or recovered without any pre-treatment. This means that the pollutants could contaminate air, water and soil. Today, EU citizens are likely to generate between 17 and 20 kg of WEEE per head a year. WEEE is the fastest growing waste stream, growing three times faster than the average waste stream (European Union, 2003; WEEE FAQs, 2011; European Commission Environment, 2011; European Commission, 2006).

The WEEE Directive is the European Community directive 2002/96/EC on WEEE which, together with the RoHS (Restriction of Hazardous Substances) Directive 2002/95/EC, became European Law in February 2003, setting collection, recycling and recovery targets for all types of electrical and electronic goods. The directive imposes the responsibility for the disposal of WEEE on the manufacturers of such equipment. Those companies should establish an infrastructure for collecting WEEE, in such a way that "Users of electrical and electronic equipment from private households should have the possibility of returning WEEE at least free of charge". Also, the companies are compelled to use the collected waste in an ecologically-friendly manner, either by ecological disposal or by reuse/refurbishment of the collected WEEE (European Union, 2003; WEEE FAQs, 2011; European Commission Environment, 2011; European Commission, 2006).

RoHS restricted substances have been used in a broad array of consumer electronics products. Examples of leaded components include: paints and pigments; PVC (vinyl) cables as a stabilizer (e.g. power cords, USB cables); solders; printed circuit board finishes, leads, internal and external interconnects; glass in television and photographic products (e.g. CRT television screens and camera lenses); metal parts; lamps and bulbs; batteries etc. Cadmium is found in many of the above components, examples include plastic pigmentation, nickel-cadmium (NiCd) batteries and CdS (Cadmium sulphide) photocells (used in night lights). Mercury is used in lighting applications and automotive switches, examples include fluorescent lamps (used in laptops for backlighting) and mercury tilt switches (these are rarely used nowadays). Hexavalent chromium is used for metal finishes to prevent corrosion. Polybrominated biphenyls and diphenyl Ethers/Oxides are used primarily as flame retardants (WEEE FAQs, 2011; European Commission Environment, 2011; European Commission, 2006).

The study predicts that across the EU27 E-waste will rise 2.5 to 2.7% per year - from 10.3 million tonnes generated in 2005 (about one-quarter of the world's total) to roughly 12.3 million tonnes per year by 2020 (ScienceDaily, 2007).

Developing countries will be producing at least twice as much electronic and electrical waste (E-waste) as developed countries within the next 6-8 years, according to a new study published in ACS' semi-monthly journal *Environmental Science & Technology*. It foresees in 2030 developing countries discarding between 400 and 700 million obsolete personal computers per year compared to 200-300 million in developed countries (ScienceDaily, 2010).

WHY DESIGN FOR RECYCLING E-PRODUCTS IS IMPORTANT?

All these above mentioned points to the conclusion that today, especially in the near future, product design must be such that the recycling of electronic and electrical equipment is easily feasible in the higher percentage (Holt, 2001).

The EU directive on Waste Electrical and Electronic Equipment (WEEE) requires that nearly all electronic products sold in Europe be put to new good use when they reach obsolescence. Under WEEE, 75 % by weight of an end-of-life product must be remanufactured, reused, or recycled. A maximum of only 20 % can be sent to a landfill. Actually, WEEE permits not just recycling to reach it goals, but also remanufacturing and reuse. However, all require at least some systematic disassembly (also sometimes called demanufacturing or inverse manufacturing) of end-of-life products. Consequently, there has been a surge of interest in a concept called designing for disassembly (DfD), that first sprang up about 15-16 years ago. DfD's purpose, quite simply, is to design products that are quick and easy to take apart (Legg, 2005).

Faster disassembly, according to DfD experts, involves the selection of components, materials, and fasteners. You minimize components so that there are fewer pieces to take apart, and you minimize the number of types of fasteners so that disassembly is faster and requires fewer different types of tools. Minimizing the number of different materials makes it easier to sort the materials for the eventual processes of recovery and recycling. Electronics and electrical engineers will be mostly involved in the selection of electronic and electrical components. Often, they will have few choices, although semiconductor manufacturers, in according with another EU initiative – the Reduction of Hazardous

Substances (RoHS) directive – are at least now producing many components without lead and some other harmful substances. That is important to design for recycling, because separating out harmful substances is often the first step of the recycling process. If there are no harmful substances to remove, the process becomes shorter (Legg, 2005).

Why design for recycling E-products is important? The answer to this question should consider the following facts:

Environmental pressures. Design of E-products is key to recovering value from E-products at the end of its life, conserving resources and minimising the impact on the environment of disposing of used products.

Impending legislation. There will soon be an EU Directive which will require recovery and recycling of e-products at end of life and this will focus attention on the design of e-products.

Increasing disposal costs. Good design can significantly reduce the amount of E-products and material that has finally to be disposed of in landfill sites. This is important because the costs of disposing of E-waste are increasing fast and will continue to do so.

Business opportunities. Suppliers whose products are designed for recycling – using the term in its widest sense to include re-use, re-manufacture and refurbishment – will have a competitive edge as legislation comes into force. Good environmental practice goes hand-in-hand with business efficiency and can provide new business opportunities.

DESIGN FOR DISASSEMBLY AND DESIGN FOR RECYCLABILITY

In recent years, the recycle of discarded products are attracting the most significant concerns than ever by manufacturing industries as the soaring prices of raw materials and landfill. The effectivity of disassembly plays a crucial role in the feasibility of a recycle plan. Design for disassembly (DfD) can not be treated as easy as the reverse of DfA (Design for Assembly). The trade-offs between DfD and DfA is complicated and sometimes even conflicts with each other. A successfully designed product for easy disassembly can be defined as reduced component counts, condensed spare parts and/or raw materials inventories and fewer joints and connectors as well as complied with legislations (Bogue, 2007). Bogue (Bogue, 2007) develops three disciplines which are essential to make the DfD successful: (1) the selection and adoption of raw materials; (2) the design of components and structure; and (3) the selection and adoption of joints, connectors and fasteners. The detailed has been illustrated in Table 1. Bogue (Bogue, 2007) also emphasizes that more attentions should be paid on chemical compositions of substances and physical characteristics and incompatibility between materials such as plastics. Therefore, during the process of DfD, the different type of chemical materials should be adopted as less as possible and each substance ought to compatible mutually.

Some producers of E-products have developed their own technologies to: (1) improve ease of dismantling and disassembling; (2) improve material identification; (3) improve ease of reuse; and (4) improve ease of recycling.

Additionally, the wrong categorisation of returned products may lead to dramatic increase in recovery costs. Hence, effective product data management and return quality monitoring systems are essential to ensure the quality of returned products and the proper categorisations (Zuidwijk and Krikke, 2008).

Design for disassembly guideline, shown in Table 1, can be extended on the base of own research or experiences or on the base of other researchers (Rifer et al., 2009).

Table 1: Design for disassembly guideline (Bogue, 2007)

Factors affecting the disassembly process	**Guides to improve disassembly**
Product structure	Create a modular design
	Minimise the component count
	Optimise component standardisation
	Minimise product variants
Materials	Minimise the use of different materials
	Use recyclable materials
	Eliminate toxic or hazardous materials
Fasteners, joints and connections	Minimise the number of joints and connections
	Make joints visible and accessible, eliminate hidden joints
	Use joints that are easy to disassemble
	Mark non-obvious joints
	Use fasteners rather than adhesives
Characteristics of components for disassembly	Good accessibility
	Low weight
	Robust, minimise fragile parts
	Non hazardous
	Preferably unpainted
Disassembly conditions	Design for automated disassembly
	Eliminate the need of specialised disassembly procedures
	DfD with simple and standard tools

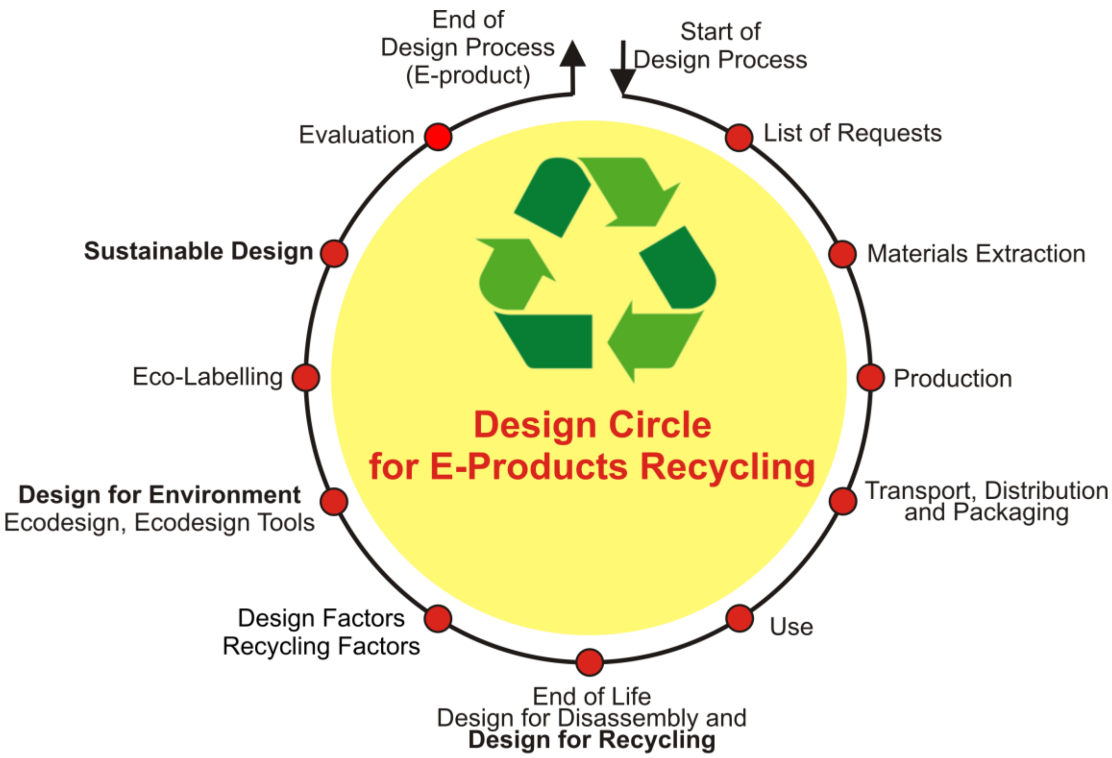

Figure 1. Design circle for E-products recycling

Based on our research, design for recycling can be presented in a process circle shown in Figure 1. The process of E-product design starts with task definition. After that you need to write details in to the List of Requests which contains all important and unimportant requests, information and wishes about product and its data (Pahl & Beitz, 1996). From the List of Requests we suggest to put out the requests in the following categories: Materials Extraction; Production; Transport, Distribution and Packaging; Use; and End of Life, Design for Disassembly and Design for Recycling (Kljajin et al., 2006). These important points of view could be very carefully analysis of guidelines and reasons for design for disassembly and recycling (Srinivas, 2008).

Design for environment (EcoDesign or DfE) attempts to reduce the impact of product design upon the environment of a product or service. It takes into account the whole life cycle - going beyond just the use of recycled materials or proper packaging or disposal.

Interconnection between Sustainable Design, EcoDesign and Design for Recycling and their aims are given in Figure 2.

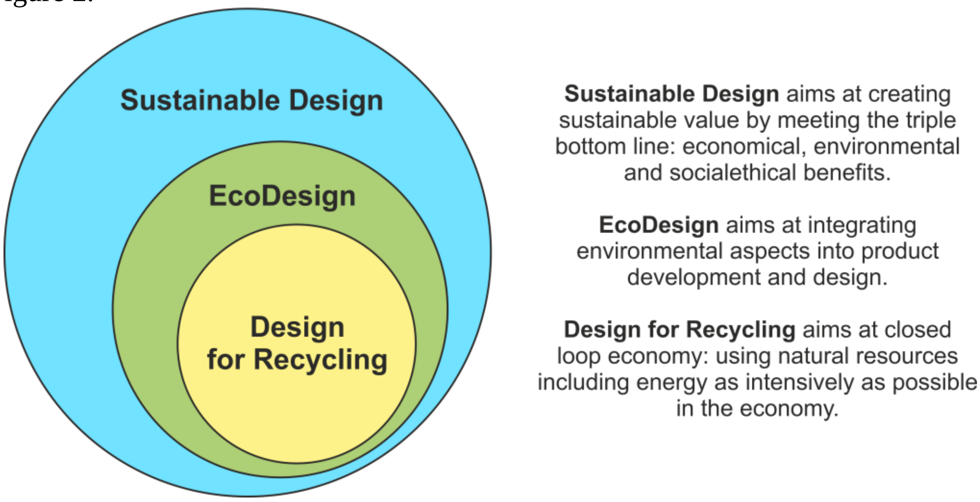

Figure 2. Sustainable design and ecodesign

DESIGN GUIDELINES DISASSEMBLY AND RECYCLING

As designing for disassembly and recycling has gained more recognition so a number of organisations have devised their own sets of suitable guidelines to design practice.

A comprehensive examination of designing for ease of recycling has come from the German Standards organisation VDI, in the form of VDI 2243 (VDI, 1991). The guidelines developed at Manchester Metropolitan University have also been classified according to three areas of the product design: materials, fasteners and connections and product structure (Dowie & Simon, 1994). Other organisations have produced their own guidelines such as ICER (Industry Council for Electronic Equipment Recycling) in the UK (ICER, 1993) who is trying to promote recycling of electronics goods.

The ICER (Industry Council for Electronic Equipment Recycling) Guidelines (ICER, 1993) provide a basis on which manufacturers can develop a design strategy specific to their company or to a particular product. They are generic and can be adapted for use in most sectors of the electronics industry. They have been produced to help concept designers and design engineers. They will also be useful for anyone with an input into the design process, particularly those involved with marketing and procurement. The Guidelines explain how to develop a design strategy, give specific suggestions for design for recycling, look at issues affecting the whole life cycle, suggest tools to help develop a design strategy and evaluate the risks and look in detail at electrical design, focusing particularly on the design of printed circuit boards. The guidelines suggest important points of view which is necessary to implement on design for recycling electronic and electrical equipment (Srinivas, 2008). These important points of view could be by (Srinivas, 2008) as follows in Tables 2, 3, 4, 5 and 6.

Table 2: Materials Extraction (Srinivas, 2008)

Guideline	Reason
Avoid or minimise use of hazardous, toxic or in any other way environmentally unfriendly materials	Decrease toxic and/or hazardous emissions in later life stages and/or decrease harmful emissions during production
Avoid materials with a high energy content (Aluminium)	Decrease the amount of energy used during extraction and/or production
Use materials which are renewable, recyclable and/or recycled, minimise use of thermosets or mixed polymers	Decrease the amount of non-renewable materials to be extracted from the earth
Design products in a way that reduces material use, use better design instead of over-dimensioning	Decrease the amount of materials to be extracted from the earth
Design for minimum waste production during production	Decrease amount of material wasted during production
Minimise the number of different type of materials used	Increase recyclability and ease the sorting process

Table 3: Production (Srinivas, 2008)

Guideline	Reason
Avoid or minimise the use of hazardous, toxic or in any other way environmentally unfriendly materials.	Decrease amount of harmful gaseous, liquid or solid emissions during production
Minimise and recycle residues and waste from production processes, within the manufacturing plant or outside it	Decrease amount of raw material required and the amount of waste created by production processes
Minimise use of energy-intensive process steps, such as high heating differentials, heavy motors and extensive cooling	Decrease the amount of energy used by the production processes
Optimise use of heat exchangers and similar devices to utilise otherwise wasted heat	Optimisation of energy flows in production processes
Minimise losses from production facilities by good construction, service and fast repair. Also provide maximum insulation of walls, pipes and ceilings.	Prevention of losses by leaks, oversized boilers and bad insulation

Table 4: Transport, distribution and packaging (Srinivas, 2008)

Guideline	Reason
Optimise efficiency transport modes following these rules: - transport by container ship or train is preferable over transport by lorry - transport by air is to be avoided	Decrease energy use and emissions from transport and avoid environmentally harmful ways of transport (such as flight)
Minimise long distance transport by maximising work with local suppliers and markets	Decrease long distance transport and all energy use and emissions from such source
Maximise efficiency of transportation by use of standardised transport packaging, bulk packaging, such as Europallets and transport of larger amounts of goods simultaneously	Increase efficiency of transport
Minimise amount of packaging material and the number of (virgin) materials in the packaging.	Decrease amount of material needed for packaging reduce contamnalia to aid the recycling of materials

Maximise use of refillable or reusable containers where appropriate	Decrease amount of material needed for packaging by re-use of containers
Avoid use of non-appropriate materials for packaging such as, PVC and Aluminium	Decrease amount of toxic, hazardous or also valuable materials in waste

Table 5: Use (Srinivas, 2008)

Guideline	Reason
Minimise energy consumption during use by: - using lowest energy consuming components - using default power down mode - the insulation of heating components	Decrease energy consumption during life
Minimise amount of consumables used during the use stage by: - product design e.g. permanent filters instead of paper filters - minimise leakage, e.g. by installing a leak detector - reusing consumables, e.g. reuse water from washing facilities to flush toilets - clear instructions to prevent misuse, e.g. by providing instructions on the product itself - product design to prevent spillage, e.g. provide instructions on how often a product, such as filter cartridges, should be replaced, or by designing the filling inlet large enough to prevent spilling - use of calibration marks to restrict required amounts of consumables, e.g. dosage for laundry detergents - product design that stimulates sustainable behaviour, e.g. only reusable cups and no disposable cups provided at drinks dispenser or double sides copies default option	Decrease the amount consumables used by a product during its life
Optimise life time of product by increasing reliability and durability	Decrease need for new products, hence decrease material and energy use for production
Design for easier maintenance and repair by: - indicate opening instructions for cleaning and/or repair - indicate parts for maintaining by colour codes - make location of wear detectable on parts - make vulnerable parts easy to dismantle and replace	Increase life span of a product by easier repair and maintenance
Design in modular product structure	Enable upgrading, hence prolonging of life time, of products at a later date
Avoid designs with a technical life span which outdates the aesthetic life span	Decrease disposal of operational products because of outdated aesthetic design
Design product to meet possible future needs of users	Extend possible life span of products
Minimise the use of: - periodical consumables such as batteries, cartridges and containers - liquid materials for maintenance such as	Decrease use of consumables in any form during the use stage of the products life span

cooling liquid or lubricants - any consumables containing toxic or otherwise hazardous materials	
Minimise generation of gaseous emissions such as CO_2 and tetraethyl lead, odours or any other undesirable emissions	Decrease emissions during usage stage of life span

Table 6: End of Life, Design for Disassembly and Design for Recycling (Srinivas, 2008)

Guideline	Reason
Stimulate possible reuse of the product by: - classic design - sound constructions that does not become prematurely obsolete technically	Extend possible lifetime of a product, therefore decreasing need for new products
Stimulate possible remanufacturing/refurbishing by: - hierarchical and modular structure - use of detachable points - use of standardised joints - position joints to minimise necessary movement of product during disassembly - indicate opening instructions for non-destructive disassembly	Extend possible lifetime of part and components and therefore decrease need for new products
Stimulate possible recycling of part and materials by: - using recyclable materials with an existing market - use tables on compatibility of metals, plastics and glass and ceramics. - avoiding polluting elements that interfere with the recycling process - mark any part made from synthetic materials with standardised material codes - avoid threaded metal inserts in plastic - avoid plated metal - avoid or minimise painting and fillers	Decrease need for virgin materials
Stimulate safer incineration by concentrating toxic materials and providing easy removal	Decrease hazardous emissions from incineration process

KEY DESIGN FEATURES

Depending on the type of E-product are different possible scenarios of Design for Recycling with the use of assumed or self-developed guides. From the analysis done in this article, we can easy conclude that the Design for Recycling is very complex multicriterial design, so it is very important to have in the design team experts from various fields like engineering, technology, ecology, etc. Two scenarios follow as an example for key design features (Rifer et al., 2009).

1st scenario:

- Ease of identifying and removing components containing hazardous materials
- Use of consistent, limited and uniform set of screws and fasteners; elimination of hidden screws; increased use of press/snap fit connection mechanisms
- Snap, pull or slide in and out components
- Ease of plastics identification and separation

- Increased standardization of components, such as power supplies, particularly for portable equipment
- Easy access to product and component information to assess the resale value and refurbishment potential.

2nd scenario:

- Ease of identifying and removing components containing hazardous materials
- Elimination of adhered-together (laminated, bonded, glued, etc.) materials those are not recyclable or compatible in recycling
- Minimize the variety of materials in any given product, especially those that cannot be easily separated through mechanical systems such as different plastic resins
- Ensure that items containing precious metals such as cables and wires containing copper can be removed easily (i.e., snap out)
- Use of durable materials and robust power supplies/batteries that further product longevity
- Offer warranties and training services for repair and refurbishment of products.

COCLUSION

The design generally and therefore the Design for Recycling (and its parent the Eco-Design) is about better E-products, but designing better E-products for recycling needs appropriate, efficient tools. There are different types of tools, ranging from guidelines and checklists to one-score screening indicators and full life cycle assessment, meaning methodologies, process simulation software and extensive databases on materials and processes. When to use which tool depends e.g. on the development target, the resources you have to undertake such an exercise and availability of tools. This article provides a selection of guidelines specifically for the electrical and electronics sector. These ICER Guidelines (ICER, 1993) provide a basis on which manufacturers can develop a design strategy specific to their company or to a particular E-product or another product. They are generic and can be adapted for use in most sectors of the electronics, electrical or automotive industry.

REFERENCES

Bogue, R. (2007). Design for disassembly: a critical twenty-first century discipline. *Assembly Automation*, 27 (4), p. 285-289.

Dowie, T. & Simon, M. (1994).Guidelines for designing for disassembly and recycling. Design for Environment Research Group. Department of Mechanical Engineering, Design and Manufacture. Manchester Metropolitan University. *DDR/TR18*. September 1994. http://teclim.ufba.br/jsf/ecodesign/dsgn0204.PDF (18.05.2011.)

European Commission Environment (2011). Waste Electrical and Electronic Equipment. http://ec.europa.eu/environment/waste/weee/legis_en.htm (2011-08-12)

European Commission (2006). Implementation of the Waste Electric and Electronic Equipment Directive in the EU. *Technical report series*. EUR 22231 EN. Joint Research Centre & Institute for Prospective Technological Studies – IPTS. European Communities, 2006. http://ftp.jrc.es/EURdoc/eur22231en.pdf (2011-08-12)

European Union (2003). Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE), *Official Journal of the European Union*, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:037:0024:0038:en:PDF (2011-08-11)

Holt, H. R. (2001). End-of-Life Issues for Electronic Systems. http://www.nku.edu/~holthr/eol/eol.htm (2011-08-12)

ICER (1993). *Guidelines:Design for Recycling: General Principles,* November 1993.

Kljajin, M.; Opalić, M. & Pintarić, A. (2006). Recikliranje električnih i elektroničkih proizvoda, Strojarski fakultet u Slavonskom Brodu.

Legg, G. (2005). The Greening of Electronics: Designing for Recycling, http://www.eetimes.com/electronics-news/4196910/The-Greening-of-Electronics-Designing-for-Recycling (2011-07-30)

Pahl, G. & Beitz, W. (1996). Engineering Design – A Systematic Approach. Second Edition. Springer Verlag London.

Rifer, W.; Brody-Heine, P.; Peters, A.; Linnell, J. (2009). Closing the Loop Electronics Design to Enhance Reuse/Recycling Value. *Final Report*. January 2009.

http://www.greenelectronicscouncil.org/documents/0000/0007/Design_for_End_of_Life_Final_Report_090208.pdf (2011-08-12)

ScienceDaily (2007). Recycling of Europe's Electronic Waste Needs Improvement, UN Report Urges. ScienceDaily (Nov. 16, 2007). http://www.sciencedaily.com/releases/2007/11/071115113338.htm (2011-08-11)

ScienceDaily (2010). DEVELOPING WORLD WILL PRODUCE DOUBLE THE E-WASTE OF DEVELOPED COUNTRIES BY 2016, STUDY PREDICTS. SCIENCEDAILY (APR. 29, 2010). http://www.sciencedaily.com/releases/2010/04/100428121451.htm (2011-08-11)

Srinivas, H. (2008). Guidelines Design for Evironment. http://www.gdrc.org/uem/lca/guidelines.html (2011-05-18)

VDI (1991). Design of Technical Products for Ease of Recycling, *VDI 2243*, May 1991.

WEEE FAQs (2011). http://www.complydirect.com/weee/faqs/ (2011-08-12)

Zuidwijk, R. & Krikke, H. (2008). Strategic response to EEE returns: Product ecodesign or new recovery processes? *European Journal of Operational Research*, 191, p. 1206-1222.

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AN INTEGRATED APPROACH ON A WEEE RECYCLING: SPECIAL REFERENCE TO THE PRINTED CIRCUIT BOARDS AND CRT MONITORS

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ABSTRACT

Due to intensive development of the electronics industry, the period of use of electric and electronic equipment is constantly decreasing why amount of discarded electronic equipment (e-waste) represent fastest growing waste stream. All contemporary methods for metals recovery from e-waste are combination of mechanical and pyrometallurgical or hydrometallurgical methods. Printed circuit boards (PCB) represent most important part of e-waste regarding a presence of non-ferrous and precious metals. On the other hand, over 40% of the total e-waste represents high leaded glass from CRT monitors. These are key reasons for defining, developing and improving techniques of recycling e-waste, especially in order to obtain copper and precious metals. This paper shows an innovative synergy of subject wastes in technological framework of extractive metallurgy. A significant attention is focused on the development of hydrometallurgical methods for obtaining metals from the dust and sludge from the treatment of e-waste.

Keywords: waste printed circuit boards, CRT monitors, recycling, metals recovery, hydrometallurgy.

INTRODUCTION

Recent developments in the field of information technology and telecommunications and in the field of electronic industry are the key reasons why amount of waste that comes from used electrical and electronic equipment (e-waste) generates faster than any other kind of waste. Generally, production of e-waste in Europe annually reaches 7.5 million tones, that corresponds to 4% of the total urban solid waste flow, with estimated growth trend of 3–5% annually (Marshal et al, 2001). The period of use of electric and electronic devices is constantly decreasing, witch affects on a constant growth of discarded electronic equipment and devices (Tung-Chai et al, 2011). On average, replacement of obsolete IT equipment is within 2 to 3 years, whereas in the case of other electric and electronic devices, period is 5 years (Reuters, 2007). Modern trends of replacement of cathode-ray tube monitors (CRT) with liquid crystal displays, affect that amount of waste CRT is increasing faster than other types of e-waste. Over 40% of the total e-waste, represents high leaded CRT glass why recycling on an industrial scale is the preferable solution (Dondi et al., 2009, Hui et al., 2011). Apart from the quantitative analysis, problem of e-waste further complicates its complex structure. E-waste contains over 1000 different substances and materials many of which are very toxic (Kaya, 2009). Printed circuit boards (PCB) are the most important part of every electronic product. Despite the high concentration of valuable material, such as base and precious metals, in PCBs are contained substances like lead, mercury, chromium, cadmium and brominated flame retardants, why this kind of e-waste must be processed in an appropriate way (Goosey et al., 2003, Cui et al., 2008). In recent years, much attention is focused on developing and improving techniques of recycling e-waste, especially for obtaining copper and precious metals (Cui et al., 2003, Ogunniyi et al., 2009, Kamberović et al., 2009). All modern methods represent combination of mechanical and pyrometalurgical or hydrometallurgical methods. Pyrometalurgical methods are the traditional methods of obtaining metals from e-waste (Lee et al., 2007). However, the main disadvantage of this method is high investment, why in recent years, much attention is focused on the development of hydrometallurgical processes for obtaining metals from e-waste. In this manner, previous studies of authors (Kamberović et al., 2010) were conducted in order to determine the optimal process parameters of hydrometallurgical treatment, especially focused on recovery of base and precious metals from waste PCBs. In this paper, key aspects of innovative hydrometallurgical recovery of base and precious metals from dust and sludge generated during mechanical treatment of waste PCBs is presented. Further more an overview on a mechanical treatment of waste CRT monitors and possible reuse of dusty fractions generated during treatment is also presented.

RESULTS AND DISCUSSION

As it is already mentioned, PCBs are an essential part of every electrical and electronic device. However, most of waste PCBs, whether isolated or as part of the original components ends up landfilling (over 80%), presenting both, the loss of non-renewable resources and constant increment of total amount of this waste. On the other hand, substantial value of e-waste is contained in the PCBs caused by the presence of precious metals. Table 1 shows the average content of the material and share in the total value of certain types of electrical and electronic equipment.

Table 1: Distribution of value and weight of typical electronic devices/components (Hagelüken, 2010)

Weight share	***Fe***	***Al***	***Cu***	***Plastics***	***Ag***	***Au***	***Pd***
			%			***ppm***	
Mother board	30	15	10	28	280	20	10
PCB	7	5	18	23	900	200	80
Mobile phones	7	3	13	43	3000	320	120
Audio equipment	23	1	21	47	150	10	4
DVD players	62	2	5	24	115	15	4
Calculator	4	5	3	61	260	50	5

Value share	***Fe***	***Al***	***Cu***	***Ag, Au, Pd***
			%	
Mother board	4	14	35	**47**
PCB	0	1	13	**86**
Mobile phones	0	0	6	**93**
Audio equipment	3	1	73	**21**
DVD players	15	3	30	**52**
Calculator	1	4	10	**85**

As it can be seen in presented table, the highest value of the PCB is reflected in the content of gold, over 80% of the total. Providing WEEE as an relatively easily accessible source for gold obtaining and by comparing the values of gold content in the printed circuit boards with an average gold content in conventional ores, which is about 5 g / t, taking into account with other factors related to obtaining gold from mining ores, it is clear that the proper treatment of this "urban-mine" in the context of gold recovery, is significant.

As it is already mentioned, all the modern processes for recycling of e-waste represent a combination of mechanical and pyro and hydrometallurgical methods. Relationship between these methods of operation, from pretreatment to the ending operation of metals recovery, whose implementation is crucial for effective realization of the whole recycling process, is shown on Figure 1.

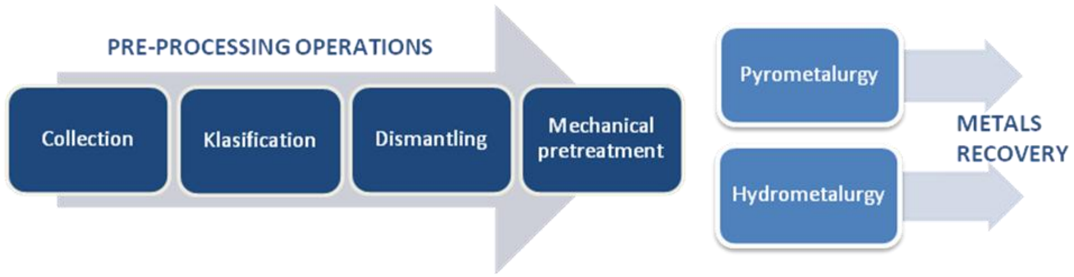

Figure 1. Shematic view of relationship between mechanical and pyro and hydrometallurgical operations

Speaking about the pyrometallurgical treatment of e-waste, excluding "the illegal operation" of simple burning of e-waste, modern methods include sophisticated systems of integrated smelters and refining plants specially designed for large capacities. In this manner, recycling of PCBs and other types of e-waste with a high gold content are carried out in facilities designed for the performance of complex operations in a field of extractive metallurgy, in order to obtain very high purity metals. However, in addition to requirements for large investments, caused by large capacity, achieving of successfully performed recycling operations, among other things, depends on the quality of the interface between operations of the mechanical pre-treatment and ending operations of obtaining and refining of metals from e-waste. In the pre-processing stages, regarding dismantling process and mechanical pre-treatment, specific material fractions, such are waste PCBs, are intended for the right end-process. On the other hand, in pre-processing stages, regarding incomplete metals liberation and formation of dusty fraction after the shredder process, high losses of valuable materials also occur. In that manner, appropriate pyrometallurgical process for metals recovery from e-waste is conditioned with proper pre-treatment of presented waste. Furthermore, existence of such systems imposes the need for enlarging the market and "centralized" e-waste transport, which is one of the key reasons why these systems are not available in many developing countries, nor it is economically realistic to replicate such high investment plants in too many locations.

On the other hand, despite the fact that hydrometallurgical methods for obtaining the base and precious metals from conventional mineral ores are relatively widespread, in recent years, much attention is focused on the development of hydrometallurgical alternatives to pyrometallurgical methods for base and precious metals recovery from e-waste. Although still under-developed hydrometallurgical recycling methods, compared to traditional pyrometallurgical, are more exact, more predictable and less subjected to losses, also characterized with smaller capacities and significantly less demands for investment, as in the case of precious metals recovery from e-waste particularly important. These are key reasons for greater emphasis the importance on the application of hydrometallurgy in the field of metals recovery from e-waste for small and medium enterprises, which by their available capacities are not able to participate equally in the market with a large pyrometallurgical system.

One of the potential alternatives to pyrometallurgical metals recovery from e-waste is derived, based on the results of preliminary tests carried out within the European project "Innovative hydrometallurgical processes for obtaining metals from e-waste, including lamps and batteries - HydroWEEE" (FP 7 - research activities are focused on small and medium enterprises). The main goal of this project was to develop innovative hydrometallurgical process for base and precious metals recovery from the fluorescent powder of used CRT monitors, printed circuit boards, liquid crystal display and lithium-ion batteries.

Based on tests, conducted within this project, application of hydrometallurgical methods of treatment in the field of waste PCBs recycling, has proven to be highly significant and potentially very efficient method for metals recovery from the dust and sludge, generated during pre-processing operations of waste PCBs, from where they cannot be recovered by applying pyrometallurgical recycling methods as described above.

The optimum process parameters of hydrometallurgical treatment of waste PCBs, using the selective leaching agent, are obtained by modeling the various process parameters. Copper recovery from waste PCBs was performed using sulfuric acid as leaching agent. Gold recovery after copper leaching step, was performed using thiourea as leaching agent, in the presence of (Fe_2 $(SO_4)_3$) as an oxidant in sulfuric acid solution. According to obtained results, optimum process parameters for hydrometallurgical treatment of waste PCBs as well as for the process of metals recovery from the solution obtained after leaching are defined, for both, laboratory and pilot plant scale, and presented in previous studies of authors [17, 18].

On the basis of the all obtained results, hydrometallurgical processes for base and precious metals recovery from waste PCBs using a selective leaching agent was developed. Block diagram for hydrometallurgical recovery of base and precious metals, is shown on Figure 2.

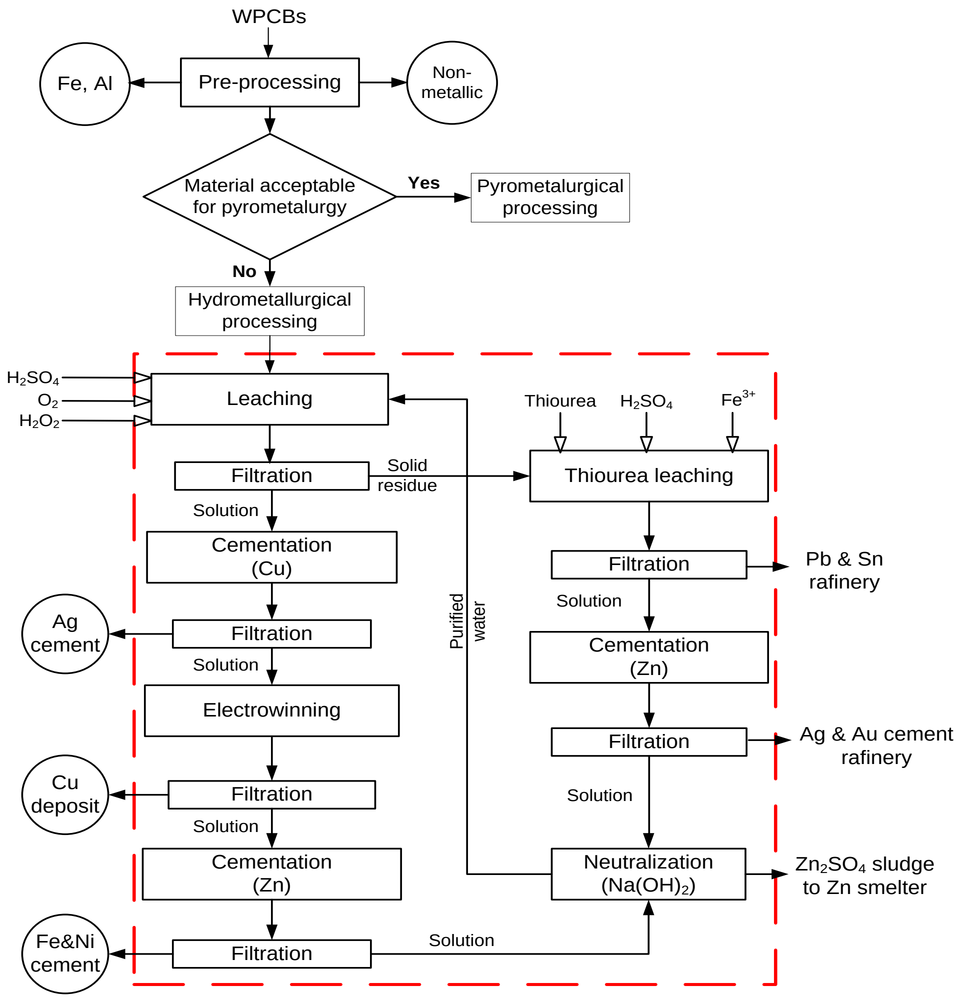

Figure 2. Block diagram for hydrometallurgical metals recovery from waste PCBs

CRT monitors represent over two-thirds of the total weight of the whole TV set or PC monitor and mostly are made of glass, over 85% of the total weight. Within the CRT monitor, there are four types of glass: glass of a panel, funnel, frit, and of an electronic gun. The structure and chemical composition of this glass is very different why it’s recycling and further application is more difficult. In addition to defining the parameters of hydrometallurgical processes for metals recovery from the fluorescent powder of CRT monitors, work on a project was also focused on a defining of possibilities for re-using of waste CRT glass as a raw material, as well as for the other waste streams generated during the processing of CRT monitors, which is of particular importance guided by the fact that over 40% of the total mass of e-waste, represents high leaded CRT glass. Generally, there are two main approaches for CRT recycling:

Closed-loop approach, referred to possible reuse of recycled CRT glass in the manufacturing of new CRT monitors.

Open-loop approach, referred to use of recycled CRT glass in the production of decorative glass and ceramic vessels in the case of glass panels, or in the case of mixed glass of panels and funnel, for the production of ceramic glaze, or as a replacement of aggregate in the clay industry for the production of bricks and roof tiles , as well as for the production of concrete and asphalt.

However, current trends for replacement of CRT monitors with liquid crystal displays, leading to a significant reduction in the production of new CRT monitor, which is why closed loop approach, or so called "glass to glass" recycling is considered obsolete.

On the other hand, main obstacle for open-loop recycling is referred to reduced ability of applications, caused by demand for glass with lower levels of lead oxide and other undesirable metal oxides.

In that manner, one of the economically and environmentally acceptable options for open-loop recycling is "glass to lead" recycling process. In this process, waste CRT glass is used in primary and secondary lead production, as a fluxing agent as well as recoverable lead material for replacing the conventional ores.

This paper reports an overview on processing stages, needed for achieving required properties of all material fractions, obtained during the recycling of CRT monitors, as a material suitable for further reuse. Block diagram for mechanical treatment of waste CRT monitors is shown on Figure 3.

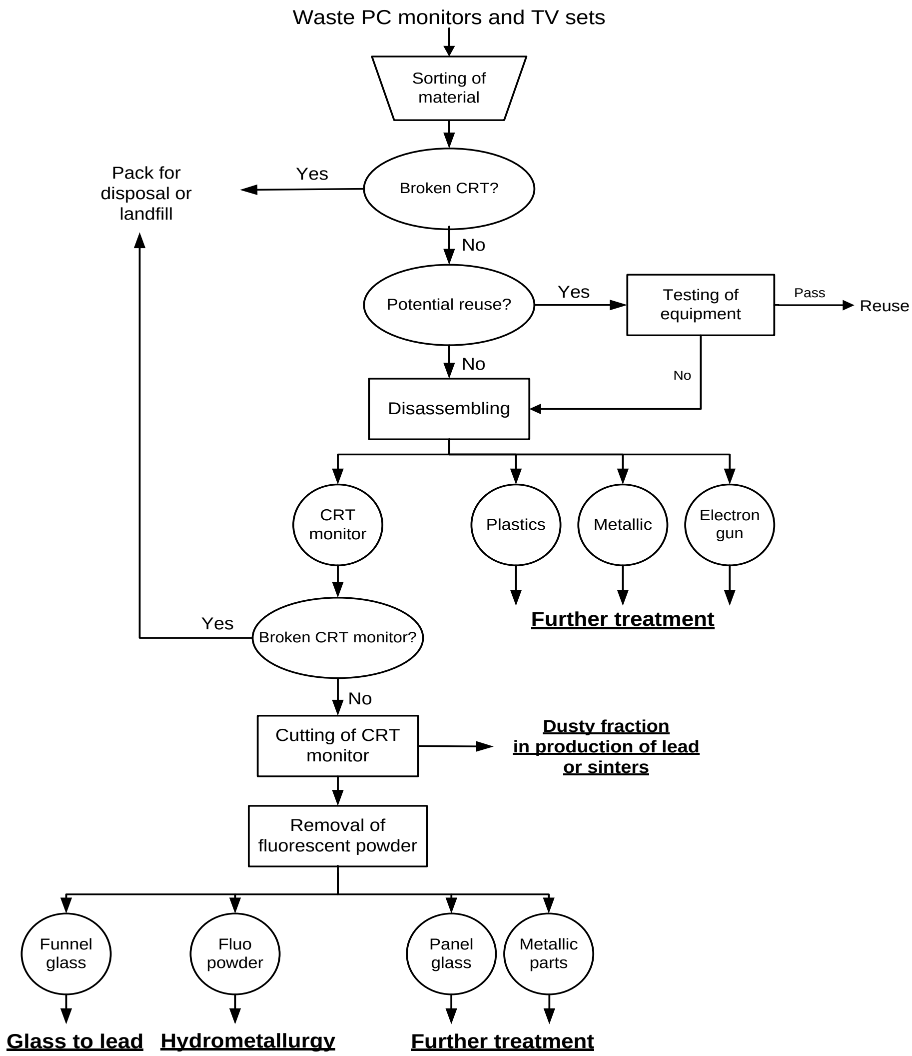

Figure 3. Block diagram for mechanical treatment of waste CRT monitors

CONCLUSION

WEEE represents a major environmental problem, corresponding as a fastest grooving urban waste stream, why recycling on industrial scale, must be considered as most acceptable solution.

Considering complexity of the waste material, linked to its chemical compositions, it is quite clear that efficient treatment, require a very complex and sophisticated recycling operations. Further more, valorization and reuse of all valuable components, contained in input waste material, is not possible without mobilization of complicated equipment and without high cost of processing. In that manner, it is important to note, that storing of waste material, like LCD monitors, for future recycling operations, may be considered as a possible solution.

In presented work, feasibility and possible application of the hydrometallurgical WPCBs recycling operations, has been demonstrated. Presented hydrometallurgical recycling operation is particularly important in case of material inappropriate for pyrometalurgical treatment, regarding to incomplete metals liberation and formation of dusty fraction after pre-processing stages. Also, presented open loop treatment of waste CRT monitors, trough “glass to lead” recycling process, represents, economically and environmentally, most acceptable recycling operation, in order to obtain material suitable for further reuse.

REFERENCE

Marshall, M., Henderson, J., (2001) New approaches to the challenge of CRT recycling, *Proceedings: International symposium on recycling and reuse of glass cullet*,. Dundee, UK

Tung-Chai, L., Chi-Sun, P., (2011) Utilization of recycled glass derived from cathode ray tube glass as fine aggregate in cement mortar, *Journal of Hazardous Materials, Vol. 192 (2), 451-456*

Reuters (2007). Recycling Of Europe's Electronic Waste Needs Improvement, UN *Report Urges, ScienceDaily http://www.sciencedaily.com/releases/2007/11/071115113338.htm*

Dondi, M., Guarini, G., Raimondo, M., Zanelli, C., (2009) Recycling PC and TV waste glass in clay bricks and roof tiles, *Waste Management, Vol. 29, 1945–1951*

Hui, Z., Sun, W., (2011) Study of properties of mortar containing cathode ray tubes (CRT) glass as replacement for river sand fine aggregate, *Construction and Building Materials, Vol. 25, 4059–4064*

Kaya, M., (2009) A Review of Electronic Waste (e-Waste) Recycling Technologies "Is e-Waste an Opportunity or Treat?", *TMS Annual Meeting & Exhibition-Recycling of Electronic Wastes, February 15-19, San Francisco, CA*

Goosey, M., Kellner, R., (2003) Recycling technologies for the treatment of end of life printed circuit boards (PCB), *Circuit World, Vol 29 (3), 33–37*

Cui, J., Zhang, L., (2008) Metallurgical recovery of metals from electronic waste: A rewiev, *Journal of Hazardous Materials Vol 158, 228-256*

Kamberović, Ž., Korać, M., Ivšić, D., Nikolić, V., Ranitović, M., (2009) Hydrometallurgical process for extraction of metals from electronic waste-PART I, *Metalurgija – Journal of Metallurgy, 15 (4), 231 – 244*

Cui, J., Forssberg, E., (2003) Mechanical recycling of waste electric and electronic equipment: a review, *Journal of Hazardous Materials B99, 243-263,*

Ogunniyi, I.O., Vermaak, M.K.G., Groot, D.R., (2009) Chemical composition and liberation characterization of printed circuit board comminution fines for beneficiation investigations *Waste Management, 29 (7), 2140-2146*

Lee, J.-C., Song, H.T., Yoo, J.-M., (2007) Present status of the recycling of waste electrical and electronic equipment in Korea, *Resour. Conserv. Recycl. 50 (4), 380–397*

Kamberović, Ž., Korać, M., Vračar, S., Ranitović, M., (2010) Preliminary process analysis and development of hydrometallurgical process for the recovery of copper from waste printed circuit boards, *8th International Symposium and Environmental Exhibition - Going Green CARE INNOVATION 2010, Vienna, Austria*

Kamberović, Ž., Korać, M., Ivšić, D., Nikolić, V., Ranitović, M., (2010) Process selection for hydrometallurgical WPCBs recycling, *4th International Conference – Processing and Structure of Materials, Palić, Serbia, Proceedings 67-72*

Hagelüken, C., C. Corti, W., (2010) Recycling of gold from electronics: Cost-effective use through ‘Design for Recycling’, *Gold Bulletin, 43 (3), 209-220*

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STANDARDS OF POPULATION EXPOSURE TO ELECTROMAGNETIC RADIATION

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ABSTRACT

At first, a brief history has been given of the development of standards in the field of radio frequency radiation. Threshold power densities of electromagnetic fields in accordance with the standards of individual countries are presented. Standards in the field of protection against electromagnetic radiation are related to the regulations, recommendations and limit values which determine the maximum allowed radiation exposure in order to protect human health.

Key words: Electromagnetic Radiation, Non-Ionizing Radiation, Standards.

INTRODUCTION

In view of expansion of modern telecommunications systems based on wireless transmission, it is necessary to examine comprehensively the biological effects of electromagnetic radiation in the RF and microwave frequency ranges, and through legislation provide adequate safeguards for all population categories. In this section a review of the standards which set limits for exposure to radiation is presented, with special reference to the standards applying in the EU and in the world.

Standards in the field of RF radiation protection are related to the regulations, recommendations and limiting values which determine the maximum radiation exposure in order to protect human health. The established safety limits are generally based on the research concerning heating effects (thermal) and stimulating (non-thermal) effects on human body. Also, the limits are subject to changes and adjustments according to the research and acquired new knowledge, and are divided into two groups:

- limits in the area of increased sensitivity and
- limits in the area of occupational exposure.

Areas of increased sensitivity are the areas where the resident general population exposed to EMF (electromagnetic fields) is not controlled, such as:

a) residential areas where people can stay up to 24 hours a day;
b) schools, preschool education institutions, maternity homes, hospitals, tourist accommodation facilities, and playgrounds (according to the master plan) and
c) undeveloped areas intended by the master plan for building objects a) or b).

The occupationally exposed population consists of adults who are generally exposed under known conditions and are trained to be aware of potential risk and to take appropriate precautions. By contrast, the general public comprises individuals of all ages and of varying health status, and may include particularly susceptible groups or individuals. In many cases, members of the public are unaware of their exposure to electromagnetic fields.

Moreover, individual members of the public cannot reasonably be expected to take precautions to minimize or avoid exposure. It is these considerations that underlie the adoption of more stringent exposure restrictions for the public than for the occupationally exposed population.

DEVELOPMENT OF STANDARDS IN THE RF RADIATION

Based on extensive research, the governments of some countries adopt certain standards and recommendations in order to create safety from the harmful effects of RF / MW radiation on human population. The first of those recommendations appeared half a century ago, namely in l953. They limit the value of power density of incident EM waves set the 10 mW/cm^2 , as a result of the experiment with a thermal model in which the internal temperature rise of human body is limited to a maximum of 1° C, assuming that about one half of the incident energy is absorbed. This value was adopted since some studies have shown that RF radiation power density even below 100 mW/cm^2 could cause eye cataracts.

In the period after that, different standards emerged in different countries. E.g. in 1975. there was a huge gap between the limits in the U.S. (10 mW/cm^2) and the Soviet Union (10 $\mu W/cm^2$). The use of Specific Absorption Rate (SAR) values is proposed in the U.S. by the NCRP (National Council of Radiation Protection and Measurements) and adopted by the American National Standards Institute (ANSI) in 1982. Nine years later, the IEEE (Institute of Electrical and Electronics Engineers) Committee SCC-28 (Standards Coordinating Committee 28) announced the new IEEE C95.1-1991 standard, which in 1992. the ANSI has adopted for the American National Standard.

ANSI / BEEE standard was based on detailed interpretation of the results of contemporary scientific research, taking into account the laboratory, epidemiological, and other studies. Based on these estimates within the range from 100 kHz to 6 GHz the value of 4 W / kg was adopted for the SAR value averaged over the whole body, as a working limit above which it has been established that harmful biological effects arised.

Table 1:

Exposure limits forRF fields (450MHz)	
0,000.23 W/m^2	BUND recommendation 1997
0,001 W/m^2	"Precautionarv limit" in Austria
0.02 W/m^2	Exposure limit in Russia
0.023 W/m^2	ECOLOG recommendation 1998 (Gcrmany)
0,1 W/m^2	Exposure limit in Poland
0.16 W/m^2	Exposure limit in Italv
0,24 W/m^2	Exposure limit in CSSR
2 W/m^2	Exposure limit in New Zealand
3 **W/m^2**	**Exposure limit in Germany** and ICNIRP recommendation 1998
3 W/m^2	Exposure limit in Canada (Safety Code 6, 1997)
Exposure limits for RF fields (900MHz)	
0.000.45 W/m^2	BUND recommendation 1997
0,001 W/m^2	"Precautionarv limit" in Austria
0,02 W/m^2	Exposure limit in Russia
0,045 W/m^2	ECOLOG-recommendation 1998 (Germanv.)
0.1 W/m^2	Exposure limit in Poland
0.16 W/m^2	Exposure limit in Italv
0,24 W/m^2	Exposure limit in CSSR
2 W/m^2	Exposure limit in Ncw Zealand
3 W/m^2	Exposure limit in Canada (Safetv Code 6, 1997)
5 **W/m^2**	**Exposure limit in Germanv** and

	ICNIRP recommendation 1998
Exposure limits for RF flelds (1800MHz)	
0,000.9 W/m^2	BUND recommendation 1997
0.001 W/m^2	"Precautionarv limit" in Austria
0,02 W/m^2	Exposure limit in Russia
0.09 W/m^2	ECOLOG recommendation 1998 (Germanv)
0,1 W/m^2	Exposurc limit in Poland
0,16 W/m^2	Exposure limit in Italy
0.24 W/m^2	Exposure limit in CSSR
2 W/m^2	Exposure limit in New Zealand
3 W/m^2	Exposure limit in Canada (Safcty Code 6, 1997)

In order to take into account the potential uncertainty of scientific results, and biological diversity in the human population, the security margin is set by a factor of 50 to make sure that the limit is set far below the level at which radiation could cause harmful biological reactions.

In addition to the ANSI, among the best known and most competent institution in this area is one of the ICNIRP (International Commission on Non-Ionizing Radiation Protection). This organization cooperates with other organizations dealing with similar problems, and is in constant contact with the World Health Organization (WHO).

The big problem is that there is no single standard that binds all countries of the world. The current situation is such that the standards differ from country to country, and there are countries that have no defined standards concerning intensity of RF radiation.

As an example, Table 1 serves to show how different standards are for the basic restrictions, depending upon the country where the standards are adopted.

EUROPEAN STANDARDS

In Europe during nineties, extensive activities on standardization have also been performed . They were based mainly on the recommendations of WHO (World Health Organization). In 1993, WHO published a document which established the boundaries for the possible occurrence of biological effects in the field of SAR values from 4W/kg.

Here are some of the reference standards for radio frequency radiation.

N 50360:2001
Product standard to demonstrate the compliance of mobile phones with the basic restrictions related to human exposure to electromagnetic fields(300 MHz-3 GHz)[2].

EN 50364:2001
Limitation of human exposure to electromagnetic fields from devices operating in the frequency range 0 Hz to 10 GHz, used in Electronic Article Surveillance (EAS), Radio Frequency Identification (RFID) and similar applications

EN 50371:2002
Generic standard to demonstrate the compliance of low power electronic and electrical apparatus with the basic restrictions related to human exposure to electromagnetic fields(10 MHz - 300 GHz) - General public[3].

EN 50385:2002

Product standard to demonstrate the compliance of radio base stations and fixed terminal stations for wireless telecommunication systems with the basic restrictions or the reference levels related to human exposure to radio frequency electromagnetic fields (110 MHz - 40 GHz) -General public

Numerous studies have shown particular sensitivity of the eye for exposure to RF radiation. Based on these observations CENELEC (European Committee for Electrotechnical Standardization) in 1995 proposed the limit of 2 W / kg averaged over 10g of tissue for a partial body exposure. Until 1999. this was also the accepted SAR limit for the heads of mobile phone users in most of European countries.

The same limit was set by ICNIRP (International Commission on Non-Ionizing Radiation Protection), which in 1998. published an important paper concerning recommendations for limiting exposure to EM radiation frequencies up to 300 GHz.

The European Committee for Electrotechnical Standardization CENELEC has issued several documents which contain the basic guidelines for protection of human population against radio frequency radiation.

ICNIRP STANDARD

International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an independent scientific organization whose task is the adoption of regulations on health risks due to exposure to non-ionizing radiation. ICNIRP regulations have been adopted by the Council of Europe as a valid standard for all EU member states.

In the ICNIRP standards are defined:

1. Fundamental limitations that must always be respected and
2. Reference levels that can be exceeded if the basic restrictions are not exceeded.

The main constraints are expressed in terms of the quantities which characterize the phenomenon within the human body and cannot be directly measured, for example SAR. On the other hand, the reference levels such as electric fields, can be measured in the absence of human beings.

Basic Restrictions

This action limits for exposure to electric, magnetic and electromagnetic fields are based directly on established health standards and biological effects of these field observations.

Depending on frequency range, the physical quantities used to specify the basic restrictions are: magnetic flux density (B), current density (J), specific absorbed power (SAR) and power density (S).

The basic restrictions (see Table 2) are based directly on established health effects and these restrictions must not be exceeded in order to protect against adverse health effects of exposure to EMF. Depending on frequency, the physical quantities used to specify the basic restrictions on exposure to EMF are current density (mA/m^2), specific absorption rate *or* SAR (W/kg), and power density (W/m^2).

Various scientifi c bases have been used in the determination of the basic restrictions for various frequency ranges:

- for the range from 1 Hz to 100 kHz, the current density (mA/m^2) has been determined as the relevant value for preventing disorders in the function of the nervous system,
- for the range from 100 kHz to 10 MHz, the current density (mA/m^2) and SAR (specifi c energy absorption rate, W/kg) have been determined as the relevant values for preventing

disorders in the functioning of the nervous system. SAR restriction is also anticipated for preventing heat stress of the entire body and excessive heating of the local tissue,
- for the range from 10 MHz to10 GHz, the basic restriction is expressed as SAR,
- between frequencies of from 10 GHz to 300 GHz, power density S (W/m^2) has been determined as a relevant value. This restriction prevents excessive heating on or near the tissue surface,
- for impulse magnetic fi elds in the range of from 300 MHz to 10 GHz, specifi c energy absorption per unit of tissue mass SA (J/kg), has been determined as a relevant value.

In the frequency range between several Hz and 1 kHz, the current density value of 100 mA/m2 has been determined as the sensory threshold for acute changes in the central nervous system, based upon the previously mentioned confi rmed effects. The confi rmed effects of very low frequency fi elds are of brief duration because they result in acute reactions by the body to electric and magnetic fi elds, which are manifested in seconds or fractions of seconds. From the safety standpoint, for the frequency range from 4 Hz to 1 kHz it has been decided that the limit value for current density is 10 mA/m^2 for occupational exposure with a security factor of 10. For the general population, an additional factor of 5 has been determined, so the limit value for the general population amounts to 2 mA/m^2. Accordingly, the total safety factor for the general population is 50. For the frequency range over 1 kHz, the limiting factor is becoming increasingly stringent for higher frequencies and sensitivity thresholds.

For the determination of the biological and health effects of electromagnetic fi elds in a frequency range of from 10 MHz to several GHz, a 1 ^0C rise in body temperature is used. This level is achieved under average environmental conditions when the specifi c energy absorption rate, SAR, for the whole body of an individual is 4 W/kg for 30 minutes. For safety reasons, a safety factor of 10 is applied for occupational exposure and the determined value limit is 0,4 W/kg. For the general population, with an additional safety factor of 5, we obtain the average SAR level for the whole body of 0,08 W/kg. For the heating of the body surface in the extremely high frequency (EHF) range of 10 GHz to 300 GHz, power density is relevant, as previously mentioned. The value limit for occupational exposure is $50 W/m^2$, and for the general population is 10 W/m^2.

Lower basic restriction values for the exposure of the general population also take into consideration the differences in the age and health status of the general population in comparison to workers. In the low frequency range, there is much information on the effects of transient currents on health. The ICNIRP recommends taking the peak values of transient currents for determining the induced current density, and not the average current strength during the period of the duration of the phenomenon.

Table 2: Basic restrictions for time varying electric and magnetic fields for frequencies up to 10 GHz[4]

Exposure characteristics	Frequency range	Current density for head and trunk (mA m^{-2}) (rms)	Whole-body average SAR (W kg^{-1})	Localized SAR (head and trunk) (W kg^{-1})	Localized SAR (limbs) (W kg^{-1})
Occupational exposure	up to 1 Hz	40	—	—	—
	1–4 Hz	40/*f*	—	—	—
	4 Hz–1 kHz	10	—	—	—
	1–100 kHz	*f*/100	—	—	—
	100 kHz–10 MHz	*f*/100	0.4	10	20
	10 MHz–10 GHz	—	0.4	10	20
General public exposure	up to 1 Hz	8	—	—	—
	1–4 Hz	8/*f*	—	—	—
	4 Hz–1 kHz	2	—	—	—
	1–100 kHz	*f*/500	—	—	—
	100 kHz–10 MHz	*f*/500	0.08	2	4
	10 MHz–10 GHz	—	0.08	2	4

Notes for Table 1:
1. f is the frequency in Hz (hertz).
2. Because of electrical inhomogeneity of the body, current densities should be averaged over a cross section of 1 cm^2 perpendicular to the current direction.
3. For frequencies up to 100 kHz, peak current density values can be obtained by multiplying the rms value by (~1.414).
4. For frequencies up to 100 kHz and for pulsed magnetic fields, the maximum current density associated with the pulses can be calculated from the rise/fall times and the maximum rate of change of magnetic flux density. The induced current density can then be compared with the appropriate basic restriction.
5. All SAR values are to be averaged over any 6-minute period.
6. Localised SAR averaging mass is any 10 g of contiguous tissue; the maximum SAR so obtained should be the value used for the estimation of exposure.
7. For pulses of duration tp the equivalent frequency to apply in the basic restrictions should be calculated as $1/(2t_0)$ For pulsed exposures in the frequency range 0.3 to 10 GHz and for localised exposure of the head, in order to limit or avoid auditory effects caused by thermoelastic expansion, an additional basic restriction is recommended i.e. the SA should not exceed 10 mJ/kg for occupational and 2 mJ/kg for general public exposure, averaged over 10 g of tissue.

Reference Levels

The reference levels are measurable levels of radiation of electromagnetic fields through which virtually determines the fundamental limits exceeded. The reference levels are derived from relevant basic restrictions using measurements and / budget are, or are related to established and indirect impacts of exposure to harmful effects of electromagnetic fields.

The reference levels can include the following physical quantities: electric field (E), magnetic field strength (H), magnetic induction (B), power density (S), the current branch (IL), the current contact (IC) and, pulsed electromagnetic fields, specific energy absorbed (SA).

Current density and the specifi c energy absorption rate are highly unsuitable values, as are their units, in ordinary daily application because they are fairly diffi cult to determine. This was one of the signifi cant reasons for determining the strength of electric fi elds, magnetic fi elds and magnetic inductions that would produce the same current density or SAR from the table of basic restrictions for each suitable frequency range, using computer programs, modeling and various calculations. Today, the strength of electric fields, magnetic fi elds and magnetic induction in a given place is simply measured with the suitable instruments. Based upon this, the ICNIRP[5] has recommended reference levels for restricting exposure to electromagnetic fields for occupational exposure and the general population [6]. These permit effective supervision of the exposure of persons to electromagnetic fields.

Table 3 presents the reference levels (permitted values) of exposure to electromagnetic fi elds for occupational exposure with an average working time of up to 8 hours daily. Regarding occupational exposure, another highly interesting question arises regarding the possible regeneration of eventually damaged cells of the body tissue during the remaining 16 hours of the day when there is no exposure. Until now, there is no unambiguous answer to this question, either.

Table 4 presents the reference levels (permitted values) for individual types of radiation from 0 Hz to 300 GHz that the general population can be exposed to for up to 24 hours daily.

Table 3: Reference levels for occupational exposure to time-varying electric and magnetic fields (unperturbed rms values).[4]

Frequency range	E-field strength ($V\ m^{-1}$)	H-field strength ($A\ m^{-1}$)	B-field (μT)	Equivalent plane wave power density S_{eq} ($W\ m^{-2}$)
up to 1 Hz	—	1.63×10^5	2×10^5	—
1–8 Hz	20,000	$1.63 \times 10^5/f^2$	$2 \times 10^5/f^2$	—
8–25 Hz	20,000	$2 \times 10^4/f$	$2.5 \times 10^4/f$	—
0.025–0.82 kHz	$500/f$	$20/f$	$25/f$	—
0.82–65 kHz	610	24.4	30.7	—
0.065–1 MHz	610	$1.6/f$	$2.0/f$	—
1–10 MHz	$610/f$	$1.6/f$	$2.0/f$	—
10–400 MHz	61	0.16	0.2	10
400–2,000 MHz	$3f^{1/2}$	$0.008f^{1/2}$	$0.01f^{1/2}$	$f/40$
2–300 GHz	137	0.36	0.45	50

Table 4: Reference levels for general public exposure to time-varying electric and magnetic fields (unperturbed rms values)[4]

Frequency range	E-field strength ($V\ m^{-1}$)	H-field strength ($A\ m^{-1}$)	B-field (μT)	Equivalent plane wave power density S_{eq} ($W\ m^{-2}$)
up to 1 Hz	—	3.2×10^4	4×10^4	—
1–8 Hz	10,000	$3.2 \times 10^4/f^2$	$4 \times 10^4/f^2$	—
8–25 Hz	10,000	$4{,}000/f$	$5{,}000/f$	—
0.025–0.8 kHz	$250/f$	$4/f$	$5/f$	—
0.8–3 kHz	$250/f$	5	6.25	—
3–150 kHz	87	5	6.25	—
0.15–1 MHz	87	$0.73/f$	$0.92/f$	—
1–10 MHz	$87/f^{1/2}$	$0.73/f$	$0.92/f$	—
10–400 MHz	28	0.073	0.092	2
400–2,000 MHz	$1.375f^{1/2}$	$0.0037f^{1/2}$	$0.0046f^{1/2}$	$f/200$
2–300 GHz	61	0.16	0.20	10

Notes for Tables 2 and 3:

1. f is the frequency as indicated in the frequency range column.
2. For purposes of demonstrating compliance with the basic restrictions, the reference levels for the electric and magnetic fields should be considered separately and not additively, because the currents induced by electric and magnetic fields are, for protection purposes, NOT additive.
3. For frequencies between 100 kHz and 10 GHz, $Seqv, E^2, H^2$ and B^2 are to be averaged over any 6-minute period.
4. For frequencies exceeding 10 GHz, $Seqv, E^2, H^2$ and B^2 are to be averaged over any $68/f^{1.05}$-minute period (f in GHz).
5. No E-field value is provided for frequencies ,<1 Hz, which are effectively static electric fields. Electric shock from low impedance sources is prevented by established electrical safety procedures for such equipment.

In the case that a value is measured that is greater than those presented in Table 3 or 4, this does not necessarily mean that the basic restriction has been exceeded. It is then necessary to calculate precisely the current density or SAR. When the reference levels were developed (Tables 3 and 4), the principle of prudent avoidance was respected.

CONCLUSION

In order to properly assess the upper limit of the allowable radiation, we should know the very nature of biological effects, then the distribution of electromagnetic energy in biological systems, as well as the characteristics of the radiation source. All these need to be confirmed by a number of experiments constituting a statistically significant sample. The experiment is very difficult to be carried out on people because it cannot be done without inflicting tissue or health damage. Therefore, measurements are carried out on animals or models of biological systems, so called phantoms, and the data are extrapolated to humans. The problem with extrapolation is due to different physiology or morphology of tissues and biological systems, and due to the effects of certain resonance frequencies that need not be at the same for humans and for models (or small animals).

REFERENCES

Council Directive 98/34/EC of 22 June 1998, laying down a procedure for the provision of information in the field of technical standards and regulations (Official Journal L 204 of 21.07.98) (former Directive 83/189/EEC).

EN 50360:2001 Product standard to demonstrate the compliance of mobile phones with the basic restrictions related to human exposure to electromagnetic fields (300 MHz - 3 GHz).

EN 50371:2002 Generic standard to demonstrate the compliance of lovv power electronic and electrical apparatus with the basic restrictions related to human exposure to electromagnetic fields (10 MHz - 300 GHz) -General public

Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz)- ICNIRP guidelines, Health Ph)4S., 1998;74(4): 494-522.

International Commission on Non-Ionizing Radiation Protection (ICNIPvP) Guidelines. 1998. Guidelines for limiting exposure to time-varving electric, magnetic, and electromagnetic fields (up to 300 GHX). Health Physics 74 (4): 494-522, April 1998.

Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz Environmental Health Directorate Health Protection Branch 99-EHD-237, Canada.

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EXPOSURE OF HUMANS TO ELECTROMAGNETIC FIELDS

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ABSTRACT

The paper analyzes sources of electromagnetic radiation, their intensities and frequency ranges where they are manifested. It also gives the biological effects of electromagnetic fields. At the international level are given guidelines for limiting exposure to time-varying electric, magnetic and electromagnetic fields by the International body for the protection of non-Ionizing radiation. It is important to determine whether, in situations of simultaneous exposure to fields of different frequencies, these exposures are additive in their effects.

Key words: Electromagnetic Radiation, Non-Ionizing Radiation, Biological effects.

INTRODUCTION

Over the recent decade an extensive application of electric and radio communication devices and a rapid growth of mobile phone users were observed, thus a massive population exposure to non-ionizing electromagnetic fields took place. Non-ionizing radiations are defined as electromagnetic (EM) radiations having photon energy less than 12.4 eV. These include: ultraviolet or UV radiation (wavelength 100-400nm), visible radiation (wavelength 400-780nm), infrared radiation (wavelength 780nm-1mm), radio-frequency radiation (frequency 10kHz - 300GHz), low field electromagnetic frequency (frequency 0-10kHz), and laser radiation. Non-ionizing radiation includes ultrasound, or sound having a frequency greater than 20kHz, even though it is not an EM radiation. Any house contains various sources of non-ionizing radiation: wireless phones, computers, TV sets, irons, microwave ovens, extension cables, electric cooking ranges, refrigerators, freezers, and other electric home appliances [1].

The environment also contains various sources of non-ionizing radiation. These include: power lines, cable and satellite communications, power stations, electric transportation vehicles (electric trains, trams and trolleybuses), TV and radio repeaters. As a result there is an interaction between the electromagnetic fields and biological tissue. The effects of these fields can be harmful to humans if the field strength exceeds certain threshold value. This value is defined by the corresponding standards and it is determined on the basis of reaching the threshold of harmful effects. In order to analyze the biological effects of electromagnetic radiation and assess the associated hazards in a particular situation, it is necessary to know value of the field for each frequency which is present and compare it with the corresponding allowed value. The field values can be reached by applying analytical calculations, numerical methods, or by using the appropriate measurement equipment. Despite the fact that the non-ionizing electromagnetic phenomena have been well studied, interactions between electromagnetic fields and organic matter, and especially human body, are still not fully clarified.

NON-IONIZING RADIATION SOURCES

By definition, non-ionizing radiation source is a device, installation, or facility that transmits or can transmit non-ionizing radiation. Such devices are sources of happiness in everyday life, from the space where we live and work to the modern means of communication.

Electric and magnetic fields are created by the earth with its magnetism, solar activities, and the atmosphere during the creation of lightning and electrical storms. The earth produces a static magnetic field, oriented in the south-north direction. The flux density of the earth's magnetic field varies from 20 μT to 60 μT, depending upon the geographical latitude and the composition of the earth's crust, e.g. magnetic conductive ores or local mountains. The average magnetic flux density of the earth's magnetic field is 40 μT. It is interesting to note that a person's movements within the earth's magnetic field induce an electric field within the body. For example, running at a speed of approximately 8 m/s creates an internal electric field of 400 μV/m. Such an electric field can be induced by a low frequency magnetic field of 20 μT. To all of this, we can also add how natural biological processes create electric and magnetic fields within human or animal bodies. These fields are primarily the result of cardiac activity, as well as muscles, and to a much lesser extent depend upon the activities of the brain or nerves. All living cells create electric fields. Generally, the strength of the electric field of the heart is up to 50 mV/m, and that of the brain and other vital organs up to 5 mV/m.

Figure 1.Sources of non-ionizing radiation in the household[1]

Typical intensities around electrical equipment in flat (Fig.1) on the removal of 30 cm from the source are as follows: electric bulb 2 V/m, electric hour 15 V/m, vacuum cleaner 16 V/m, hair dryer 40 V/m, electric mixer 50 V/m, fridge 60 V/m. The average strength of magnetic fields near the most common sources (appliances for a distance of 30 cm) (2): refrigerator 0.25μT, electric stove 4.0μT, hair dryer 7.0μT, electric iron 1-10μT, electric mixer 10μT, electric furnace 17μT, vacuum cleaner 20μT, electric razor (to 3 cm from the source) 1500μT.

Mobile telephones are low-strength microwave devices that receive and transmit signals from/to the base stations of relatively high power. The majority of mobile telephones operate at frequencies between 800 MHz and 2 GHz. The application of higher frequencies will be used in the near future. In the vicinity of mobile telephone antennas, which are located on tall columns or on the tops of tall buildings, it is possible to be exposed to electromagnetic fields of higher strengths than the permitted limits. In the area of customary and normal access around antenna columns, the permitted limits will not be exceeded but it is necessary to limit access by the general population to the roofs of buildings where antennas are installed.

Figure 2. Sources of non-ionizing radiation in the environment [1]

Electrical energy produced in power plants (Fig.2) is distributed to consumer areas via high voltage power lines from 110 kV to 400 kV. The voltage is reduced by transformers to 400/230 V for local distribution. The general population is exposed to magnetic fields at the network frequency, 50 Hz, via three individual sources: high voltage transmission power lines, the local system for the distribution and low voltage electricity at home and at work, and electrical household appliances.

The high voltage transmission power lines (Fig.2), and the local system for the distribution and low voltage electricity at home and at work create basic, so-called background magnetic radiation, known as the magnetic flux density of the environment. Them average value of background induction reaches 200 nT in residential and commercial buildings. Below high-voltage overhead power lines, magnetic flux densities have been measured from 5 μT to 20 μT, but at distances from 50 m to 100 m this value rapidly decreases to the background value of the magnetic flux density. With an electric field, the situation is entirely different. Measured values of electric field strength E below high-voltage overhead power lines, at a height of 1 m above the ground, are from 600 V/m to 10 000 V/m.

Figure 3. TV radio repeaters, base stations [1]

The non-ionizing radiation sources and include base stations for mobile telephony (Fig.3) which have become topical in recent years the rapid development of mobile telephony[1].

Figure 4. Non-Ionizing Radiation Sources in the traffic [1]

A locomotive (Fig.4) crew is exposed to electromagnetic, fields from the electric motors and other electrical equipment. Passengers are generally exposed to electromagnetic fields that are created by the high voltage alternating current from the overhead power supply line above the railway tracks. The magnetic flux density in cars is up to 50 μT, and the electric field strength is up to 300 V/m. The population living in the immediate vicinity of railway tracks may be exposed to the electromagnetic effects of the overhead supply line, as with high-voltage overhead transmission lines, but the level of exposure is significantly lower and depends upon the power supply system of the railway tracks and varies from country to country. Local trains, subways and trolley cars are supplied with alternating or direct current via overhead lines or special direct current tracks. Electric motors and track equipment are frequently located below the floors of passenger cars. Passengers are exposed to static and time-varying magnetic fields. The magnetic fl ux density at the floor level of these means of transportation can be very high, from 2 mT to 3 mT. The upper parts of the body can be exposed to magnetic flux densities of up to 30 μT.

BIOLOGICAL EFFECTS OF ELECTROMAGNETIC FIELDS

There are three established basic coupling mechanisms through which time-varying electric and magnetic fields interact directly with living matter: coupling to low-frequency electric fields, coupling to low-frequency magnetic fields and absorption of energy from electromagnetic fields.

The interaction of time-varying low-frequency electric fields with the human body results in the flow of electric charges, the polarization of bound charge, and the reorientation of electric dipoles already present in tissue. The relative magnitudes of these different effects depend on the electrical properties of the body—that is, electrical conductivity and permittivity (governing the magnitude of polarization effects). Electrical conductivity and permittivity vary with the type of body tissue and also depend on the frequency of the applied field. Electric fields external to the body induce a surface charge on the body; this results in induced currents in the body, the distribution of which depends on exposure conditions, on the size and shape of the body, and on the body's position in the field.

The physical interaction of time-varying to low-frequency magnetic fields with the human body results in induced electric fields and circulating electric currents. The magnitudes of the induced field and the current density are proportional to the radius of the loop, the electrical conductivity of the tissue, and the rate of change and magnitude of the magnetic flux density. For a given magnitude and frequency of magnetic field, the strongest electric fields are induced where the loop dimensions are greatest. The exact path and magnitude of the resulting current induced in any part of the body will depend on the electrical conductivity of the tissue. The body is not electrically homogeneous; however, induced current densities can be calculated using anatomically and electrically realistic models of the body and computational methods, which have a high degree of anatomical resolution.

Exposure to low-frequency electric and magnetic fields normally results in negligible energy absorption and no measurable temperature rise in the body. However, exposure to electromagnetic fields at frequencies above about 100 kHz can lead to significant absorption of energy and temperature increases. In general, exposure to a uniform (plane-wave) electromagnetic field results in a highly non-uniform deposition and distribution of energy within the body, which must be assessed by dosimetric measurement and calculation. As regards absorption of energy by the human body, electromagnetic fields can be divided into four ranges:

1. frequencies from about 100 kHz to less than about 20 MHz, at which absorption in the trunk decreases rapidly with decreasing frequency, and significant absorption may occur in the neck and legs;
2. frequencies in the range from about 20 MHz to 300 MHz, at which relatively high absorption can occur in the whole body, and to even higher values if partial body (e.g., head) resonances are considered;
3. frequencies in the range from about 300 MHz to several GHz, at which significant local, non-uniform absorption occurs; and
4. frequencies above about 10 GHz, at which energy absorption occurs primarily at the body surface.

In tissue, SAR is proportional to the square of the internal electric field strength. Average SAR and SAR distribution can be computed or estimated from laboratory measurements. Values of SAR depend on the following factors:

- the incident field parameters, i.e., the frequency, intensity, polarization, and source–object configuration (near- or far-field);
- the characteristics of the exposed body, i.e., its size and internal and external geometry, and the dielectric properties of the various tissues; and
- ground effects and reflector effects of other objects in the field near the exposed body.

But in the final can be said that exposure to low frequency electromagnetic fields do not cause significant energy absorption and measurable increase in body temperature. However exposure to electromagnetic fields at frequencies above 100 kHz may cause a significant increase in energy absorption and temperature. In general, homogeneous exposure to electromagnetic fields leads to very inhomogeneous distribution of energy within the body which can be determined dosimetric measurements and calculations.

LIMITS FOR EXPOSURE TO EMF

At the international level are given guidelines Guidelines for Limiting Exposure to Time-Varying Electric, Magnetic and Electromagnetic Fields (up to 300 GHz) [2],[3],[4] by the International Body for the Protection of Non-Ionizing Radiation Protection (ICNIRP, International Commission on Non-Ionizing Radiation Protection) which are defined limits on the amount of time-varying electric and magnetic fields in open space, especially for general and working population. The occupationally exposed population consists of adults who are generally exposed to EMF under known conditions during the normal course of their particular employment, and who are trained to be aware of the potential risk and to take appropriate precautions.

The general public comprises individuals of all ages and of varying health status, and may include particularly susceptible groups or individuals. In many cases, members of the public are unaware of their exposure to EMF. Moreover, individual members of the public cannot reasonably be expected to take precautions to minimize or avoid exposure. It is these considerations that underlie the adoption of more stringent exposure restrictions for the public than for occupationally exposed persons. The basic restrictions (see Table 1) are based directly on established health effects and these restrictions must not be exceeded in order to protect against adverse health effects of exposure to EMF. Depending on frequency, the physical quantities used to specify the basic restrictions on exposure to EMF are current density (mA/m^2), specific absorption rate or SAR (W/kg), and power density (W/m^2).

- Between 1 Hz and 10 MHz, basic restrictions are provided on current density to prevent effects on nervous system functions;
- Between 100 kHz and 10 GHz, basic restrictions are provided on SAR to prevent whole body heat stress and excessive localized tissue heating; in the 100 kHz to 10 MHz range, basic restrictions are provided on both current density and SAR;
- Between 10 and 300 GHz, basic restrictions are provided on power density to prevent excessive heating in tissue at or near the surface of the body.

Table 1: Basic restrictions for time-varying electric, magnetic, and electromagnetic fields for frequencies up to 10 GHz[2]

Exposure Characteristics	Frequency Range	Current density (head and trunk) (mA/m^2) (rms)	Whole-body average SAR (W/kg)	Localised SAR (head & trunk) (W/kg)	Localised SAR (limbs) (W/kg)
Occupational	Up to 1 Hz	40	---	---	---
	1 – 4 Hz	$40/f$	---	---	---
	4 Hz – 1 kHz	10	---	---	---
	1 – 100 kHz	$f/100$	---	---	---
	100 kHz – 10 MHz	$f/100$	0.4	10	20
	10 MHz – 10 GHz	---	0.4	10	20
General Public	Up to 1 Hz	8	---	---	---
	1 – 4 Hz	$8/f$	---	---	---
	4 Hz – 1 kHz	2	---	---	---
	1 – 100 kHz	$f/500$	---	---	---
	100 kHz – 10 MHz	$f/500$	0.08	2	4
	10 MHz – 10 GHz	---	0.08	2	4

Notes for Table 1:
1. f is the frequency in Hz (hertz).

2. Because of electrical in-homogeneity of the body, current densities should be averaged over a cross section of 1 cm^2 perpendicular to the current direction.

3. For frequencies up to 100 kHz, peak current density values can be obtained by multiplying the rms value by (~1.414).

4. For frequencies up to 100 kHz and for pulsed magnetic fields, the maximum current density associated with the pulses can be calculated from the rise/fall times and the maximum rate of change of magnetic flux density. The induced current density can then be compared with the appropriate basic restriction.
5. All SAR values are to be averaged over any 6-minute period.

6. Localized SAR averaging mass is any 10 g of contiguous tissue; the maximum SAR so obtained should be the value used for the estimation of exposure.

7. For pulses of duration tp the equivalent frequency to apply in the basic restrictions should be calculated as $1/(2t_0)$ For pulsed exposures in the frequency range 0.3 to 10 GHz and for localized exposure of the head, in order to limit or avoid auditory effects caused by thermo-elastic expansion, an additional basic restriction is recommended i.e. the SA should not exceed 10 mJ/kg for occupational and 2 mJ/kg for general public exposure, averaged over 10 g of tissue.

Once you have set limits current density and SAR, as determined by the strength of the incident electromagnetic field necessary to reach the body of the main constraints. Thus, the obtained limits given electric field or electromagnetic waves power density. These are called derived limitations and are presented in Tables 2 and 3.

Table 2: Reference levels for OCCUPATIONAL exposure to time-varying electric, magnetic, and electromagnetic fields for frequencies up to 300 GHz[2]

Frequency range	E-field strength (V/m)	H-field strength (A/m)	B-field flux density (μT)	Power density S_{eq} (W/m^2)
Up to 1 Hz	---	1.63×10^5	2×10^5	---
1 - 8 Hz	20 000	$1.63 \times 10^5/f^2$	$2 \times 10^5/f^2$	---
8 - 25 Hz	20 000	$2 \times 10^4/f$	$2.5 \times 10^4/f$	---
0.025 - 0.82 kHz	$500/f$	$20/f$	$25/f$	---
0.82 – 65 kHz	610	24.4	30.7	---
0.065 - 1 MHz	610	$1.6/f$	$2/f$	---
1 - 10 MHz	$610/f$	$1.6/f$	$2/f$	---
10 – 400 MHz	61	0.16	0.2	10
400 – 2 000 MHz	$3f^{0.5}$	$0.008f^{0.5}$	$0.02f^{0.5}$	$f/40$
2 – 300 GHz	137	0.36	0.45	50

Table 3: Reference levels for GENERAL PUBLIC exposure to time-varying electric, magnetic, and electromagnetic fields for frequencies up to 300 GHz[2]

Frequency range	E-field strength (V/m)	H-field strength (A/m)	B-field flux density (μT)	Power density S_{eq} (W/m^2)
Up to 1 Hz	---	3.2×10^4	4×10^4	---
1 - 8 Hz	10 000	$3.2 \times 10^4/f^2$	$4 \times 10^4/f^2$	---
8 - 25 Hz	10 000	$4\,000/f$	$5\,000/f$	---
0.025 – 0.8 kHz	$250/f$	$4/f$	$5/f$	---
0.8 – 3 kHz	$250/f$	5	6.25	---
3 – 150 kHz	87	5	6.25	---
0.15 - 1 MHz	87	$0.73/f$	$0.92/f$	---
1 - 10 MHz	$87/f^{0.5}$	$0.73/f$	$0.92/f$	---
10 - 400 MHz	28	0.073	0.092	2
400 – 2 000 MHz	$1.375f^{0.5}$	$0.0037f^{0.5}$	$0.0046f^{0.5}$	$f/200$
2 - 300 GHz	61	0.16	0.2	10

Notes for Tables 2 and 3:

1. f is the frequency as indicated in the frequency range column.

2. For purposes of demonstrating compliance with the basic restrictions, the reference levels for the electric and magnetic fields should be considered separately and not additively, because the currents induced by electric and magnetic fields are, for protection purposes, NOT additive.

3. For frequencies between 100 kHz and 10 GHz, $Seqv, E^2, H^2$ and B^2 are to be averaged over any 6-minute period.

4. For frequencies exceeding 10 GHz, $Seqv, E^2, H^2$ and B^2 are to be averaged over any $68/f^{1.05}$ -minute period (f in GHz).

In Figures 5 and 6 give a graphical display of limit values of electric and magnetic fields depending on the frequency of occupational and general population, according to the literature [2]. Red Line indicated by occupational exposure levels for a black line for the general population..

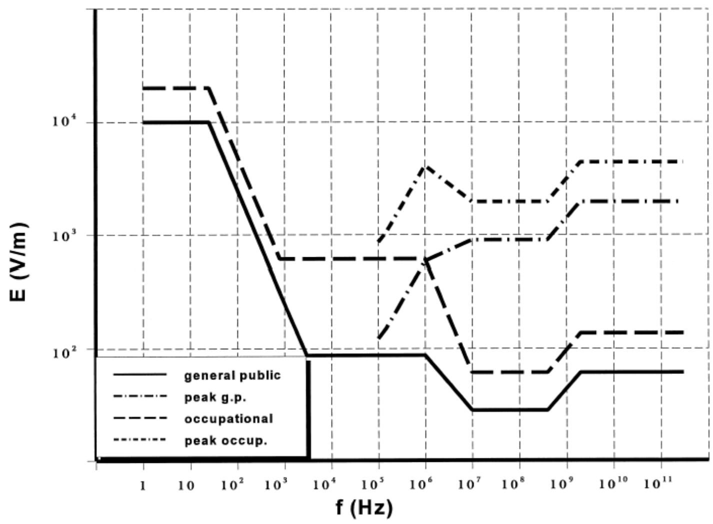

Figure 5. Reference levels for exposure to time varying electric fields (compare Tables 2 and 3)[2]

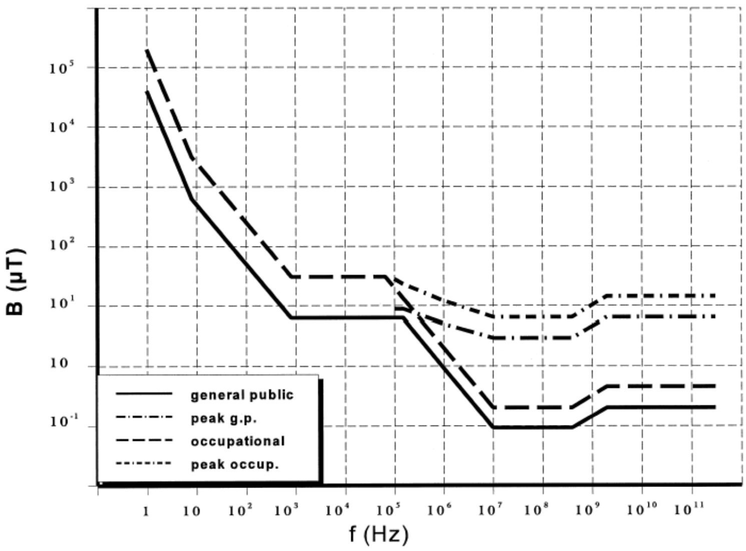

Figure 6. Reference levels for exposure to time varying magnetic fields (compare Tables 2 and 3)[2]

It is important to determine whether, in situations of simultaneous exposure to fields of different frequencies, these exposures are additive in their effects. Additivity must be examined separately for the electrical stimulation effects and thermal effects, and the basic restrictions set out below must be met. The formulae below apply to the relevant frequencies under practical exposure conditions. For electrical stimulation, relevant for frequencies up to 10 MHz, induced current densities must be added according to:

$$\sum_{i=1Hz}^{10MHz} \frac{J_i}{J_{L,i}} \leq 1$$

where:

J_i = induced current density at frequency *i*; $J_{L,i}$ = induced current density basic restriction at frequency *i* as given by Table 1.

For thermal effects, relevant above 100 kHz, SAR and power density values must be added according to

$$\sum_{i=100kHz}^{10Ghz} \frac{SAR_i}{SAR_L} + \sum_{i>10GHz}^{300Ghz} \frac{S_i}{S_L} \leq 1$$

where:

SAR_i = SAR caused by exposure at frequency *i*; SAR_L = SAR basic restriction at frequency *i as* given by Table 1;

S_i = power density at frequency *i*; S_L = power density basic restriction at frequency *i as* given by Table1.

For electrical stimulation effects, relevant up to 10 MHz, the following two requirements should be applied to the field levels:

$$\sum_{i=1Hz}^{1Mhz} \frac{E_i}{E_{L,i}} + \sum_{i>1Hz}^{10Mhz} \frac{E_i}{a} \leq 1$$

and

$$\sum_{j=1Hz}^{65KHz} \frac{H_j}{H_{L,j}} + \sum_{j>65kHz}^{10MHz} \frac{H_j}{b} \leq 1$$

where:

E_i = electric field strength at frequency *i*;

$E_{L,i}$ = electric field strength reference level at frequency *i* as given by Table 2 or 3;

H_j = magnetic field strength at frequency *j*;

$H_{L,j}$ = magnetic field strength reference level at frequency *j* as given by Table 2 or 3;

a = 610 V/m for occupational and 87 V/m for general public exposure;

b = 24.4 A/m (30.7 mT) for occupational and 5 A/m (6.25 mT) for general public exposure. The constant values ***a*** and ***b*** are used above 1 MHz for the electric field and above 65 kHz for the magnetic field, because the summation is based on induced current densities and should not be mixed with thermal considerations.

For thermal effects, relevant above 100 kHz, the following two requirements should be applied to the field levels:

$$\sum_{i=100kHz}^{1MHz} \left(\frac{E_i}{c}\right)^2 + \sum_{i>1MHz}^{300GHz} \left(\frac{E_i}{E_{L,i}}\right)^2 \leq 1$$

and

$$\sum_{j=100kHz}^{1MHz} \left(\frac{H_j}{d}\right)^2 + \sum_{j>1MHz}^{300GHz} \left(\frac{H_j}{H_{L,j}}\right)^2 \leq 1$$

where:

E_i = electric field strength at frequency *i*;

$E_{L,i}$ = electric field strength reference level at frequency *i* as given by Table 2 or 3

H_j = magnetic field strength at frequency *j*;

$H_{L,j}$ = magnetic field strength reference level at frequency *j* as given by Table 2 or 3;

c = 610/*f* V/m (*f* in MHz) for occupational and 87/*f*0.5 V/m for general public exposure;

d = 1.6/*f* A/m (*f* in MHz) for occupational and 0.73/*f* A/m for general public exposure.

The above summation formulae assume worst-case conditions among the fields from the multiple sources. As a result, typical exposure situations may in practice require less restrictive exposure levels than indicated by the above formulae for the reference levels.

CONCLUSION

Human body should not be unnecessarily exposed to action of EM fields, but one should not suffer from phobias when in need to make use of electric home appliances, mobile phone, computer or similar. Also, long-term exposures to these fields are not recommended, and even if they are of negligible intensities, since if they have some biological effects, it is better not to allow them to become irreversible! For the jobs where the presence of significant electromagnetic field intensity is confirmed, all appropriate measures of protection should be implemented.

REFERENCES

Instructions for the construction and use of non-ionizing radiation, the Ministry of Environment and Spatial-Planning Department for the control and supervision, Belgrade, May 2010.

International Commision on Non-Ionising Radiation Protection (ICNIRP) Guidelines: Guidelines for Limiting Exposure to Time Varying Electric, Magnetic and Electromagnetic Fields (up to 300 GHz), Health Physics, Vol. 74,4 (1998) 494-522.

Directive 2004/40/EC of the European Parliament and of the Council of 29 April 2004 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields),Official Journal of the European Union L 159 of 30 April 2004.

Council Directive 98/34/EC of 22 June 1998, laying down a procedure for the provision of information in the field of technical standards and regulations (Official Journal L 204 of 21.07.98) (former Directive 83/189/EEC).

CLIMATE CHANGES AND URBAN POLLUTION

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ECOLOGICAL RIVERFRONT DESIGN AND CLIMATE CHANGE

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ABSTRACT

Riverfronts are specific urban areas where the needs of the river, the city, and its inhabitants come together. After decades of neglect, in last decades of 20th century they came into focus of various urban policies. Post-industrial restructuring and urban competitiveness made them interesting for new investments as well as for planning and design experiments aimed to create additional urban amenities and new city image. Climate change adaptation policies create a new lens for examining possibilities for urban riverfront development. Two issues related to the riverfronts are of particular significance in this field: flood adaptation and greening of the city. We argue that ecological approach to riverfront planning and design can contribute to climate change adaptation urban policies while at the same time enabling various economic, social and cultural goals to be achieved. This paper brings together ecological design theory and climate adaptation policies. Using case study methodology possibilities and constraints of ecological approach to riverfront design as a tool for climate adaptation are examined in order to create some recommendations for riverfront development in Serbian cities and towns.

Key words: urban riverfront, ecological design, climate change

INTRODUCTION

Last decades of the 20th century brought urban riverfronts at the forefront of various urban development policies. After decades of neglect, post-industrial restructuring and urban competitiveness made them interesting for new investments as well as for planning and design experiments aimed to create additional urban amenities and new city image.(ULI, 2004; Montag Stiftung Urbane Raume and Regionale 2010, 2008; Kibel P. S ed. 2007)

At the same time, many cities, facing different environmental problems, recognized the importance of natural elements in the city as a basis for more sustainable and integrated urban development. Perceived as the city area where the needs of the river, the city, and its inhabitants come together, urban riverfronts gained special attention in environmental regeneration policies. Their importance was based on the fact that they are perceived as a part of environmental problems but also as a part of their solution in different areas: quality of water, ecological diversity, flooding...

Previous research on riverfront design follows these two lines. On the one hand, it evaluates urban riverfront regeneration and new development through their contribution to socio-economical urban regeneration goals. (Marshall R. ed., 2001; ULI, 2004; Kibel P. S ed. 2007) On the other hand it examines possibilities of ecological revitalization of urban riverfronts and their contribution to local, regional and global environmental improvement and ecological sustainability. (Otto B. McCormick K, Leccese M., 2004, Hough M. , 1995)

Climate change creates a new lens for examining possibilities for urban development. It is at the same time global and local, environmental and developmental problem. It poses new constraints to urban development by introducing globally acknowledged demands for minimizing carbon emissions and adapting to climate change. (Kamal-Chaoui, L., Alexis R., eds., 2009, The World Bank, 2010). But it also opens new possibilities for the cities to improve different environmental features and so to become better place to live and invest (CABE, 2008). Later assumption forms the basis for this research. It sets the need for co-benefits approach to urban development. Though it is recently highlighted to address climate change mitigation concerns, co-benefits approach in general means "the benefits of policies that are implemented for various reasons at the same time" (EPA, 2011). In this paper we are going to explore it while analyzing approaches to urban riverfront development.

How to develop urban riverfronts to meet the needs of climate adaptation urban policies is a basic question asked in this paper. But we want to sharpen it further in order to examine possible co-benefits - so to know if it is possible to ecologically improve urban riverfronts and at the same time develop them to meet the needs of climate adaptation. To answer that question we bring together ecological design theory, ecological riverfront design principles and climate adaptation policies for urban areas. We argue that ecological design approach, based on integrating natural and human processes, can help in adapting cities to climate change. This is based on the presumption that ecological riverfront planning and design principles and various climate adaptation policies are related and can co-benefit each other. Ecological approach to riverfront design is examined using case study methodology. Two cases of ecological riverfront design are examined and evaluated on the basis on both ecological and climate adaptation issues.

THEORY

Theory of ecological design was introduced by Sim Van Der Ryn and Stuart Cowan in their seminal work "Ecological Design". Their work is based on presumption that present forms of agriculture, architecture, engineering, and technology are deeply flawed and if we are to create a sustainable world we must transform these practices. This can be done by infusing the design of products, buildings, and landscapes with a rich and detailed understanding of ecology. They lay the basis for a new philosophy and practice of design - ecological design - which can be defined as "*any form of design that minimizes environmentally destructive impacts by integrating itself with living processes*." (Van Der Ryn S., Cowan S. 1996, p. x). Facing the sustainability issues, this theory aims to provide specific ways of minimizing energy and materials use, reducing pollution, preserving habitat and fostering community, health and beauty. Theory of ecological design responds to the shared quest of various design disciplines by providing a new way of thinking about design. This is not a method based but a problem based approach to design. It begins with the richest possible understanding of the ecological context of a given design problem and develops solutions that are consistent with cultural context.

Actually, ecological design is not a new idea and it can be traced in various cultures and design disciplines. What makes this design theory unique is that the authors managed to synthesize various approaches of integrating human purpose with nature's own flows, cycles and patterns from different cultural and disciplinary traditions into five basic principles:

1. *Solutions grow from place:* Ecological design begins with the intimate knowledge of a particular place. It is small-scale and direct, responsive to both local conditions and local people. Possibility to "*inhabit without destroying*" starts with sensitivity to the nuances of place.
2. *Ecological accounting informs design:* It is important to trace the environmental impacts of existing or proposed designs and to use this information to determine the most ecologically sound design possibility.
3. *Design with nature:* Recognition that we are part of nature and engaging in processes that regenerate and enhance the livability of the environment. By working with living processes, we respect the needs of all species while meeting our own.
4. *Everyone is a designer:* Honoring the special knowledge that each person can bring broadens the basis for the design. Ecological design process is a learning and participatory process and therefore it is important listen to every voice. *"No one is participant only or designer only: Everyone is a participant-designer "*(Van Der Ryn S., Cowan S. 1996, p.146)
5. *Make nature visible:* Eco-revelatory is the basis for ecological design since de-natured environments ignore our need and our potential for learning. *"Making natural cycles and processes visible brings the designed environment back to life. Effective design helps inform us of our place within nature".*(Van Der Ryn S., Cowan S. 1996, p.160)

Ecological design is at the same time vision and pragmatic tool. It can be applied at all levels of scale to create sustainable forms of buildings, landscapes, cities and technologies.

Urban dimension of ecological design was examined through different approaches. We'll illustrate it in brief through the work of Michael Hough who expresses the essential need for a view that is grounded in natural processes that will inform the theory and practice of urban design at the city and urban region scale.(Hough M.1995) This approach is based on viewing a city not as opposed but as an integral part of nature and its processes. In that view, the processes which shape the land and complexity of life forms provide the indispensable basis for shaping human settlements. Integration of urbanism and ecology is supposed to be achieved through an ecological view that encompasses the total urban landscape and the people who live there. It starts with a premise that the environmental view is an essential component of the economic, political, planning and design processes that shape cities and that natural processes provide us with an alternative basis for urban form. Some basic principles are formulated to form a frame of reference for evaluation and future urban development. They include: 1. Process, 2. Economy of means, 3. Diversity, 4. Connectedness, 5. Environmental education begins at home, 6. Making the most of opportunities, 7. Making visible the processes that sustain life (Hough M.1995,p.15).Though not explicitly connected, these principles can be related to Van Der Ryn's broader principles of ecological design. They are also site specific, process and life-cycle oriented, they acknowledge the importance of connectivity, economy of means, visibility of nature, and broad public participation and education.

METHODS

Relationship between theory of ecological design and climate adaptation strategies and policies was examined using qualitative content analysis and tested using case study methodology. The theoretical basis for the research was established by introducing ecological design theory. Then, the content analysis research was carried out on two sets of documents. First set considered ecological riverfront planning and design principles. Second set considered climate adaptation policies for urban areas. Climate change issues were distilled from the various climate change adaptation general recommendations and strategies on national and local level.

Assumption that climate change adaptation policies can benefit form ecological riverfront design approach are analyzed on two case studies: 1. Don River , Toronto, Canada, and 2. Quaggy River in Sutcliffe Park, Lewisham, Great Britain. Both cases are the examples of ecological design approach. In the first case riverfront planning and design was motivated by river and riverfront improvement and rehabilitation. In the second case actions were taken on the basis of the flood related improvements. Each case will be presented through urban - river context and design strategy and analyzed through implementation of ecological riverfont planning and design principles and climate adaptation policies.

FINDINGS

Ecological Riverfront Planning and Design Principles

Urban river health is determined by the chemical, physical and biological properties. Human activities influence urban river health steadily. But it has declined dramatically in 20th century due to massive physical alterations of riverbanks, over harvesting of fish and dumping of large volumes of sewage and industrial pollutants into river. In last decades we saw a growing interest in restoring damaged urban rivers and protecting those river reaches that have not yet been affected by negative impacts form human development. Based on thorough research, analysis, and best practices American Rivers and American Planning Association formulated general, planning and design principles for ecologically sound urban riverfronts in "Ecological Riverfront Design" publication . Their approach is based on thesis that "*urban riverfront planning must reconcile development, flood control. and recreation with environmental designs and strategies that enhance the river's ecological systems"* (Otto B. McCormick K, Leccese M., 2004, p.31 . As a consequence, every riverfront requires a unique combination of environmental strategies that reflect: a) the intensity of current development, b) the nature and intensity of planned development or redevelopment, c) the geometry and constraints of the riverfront and d) the intended riverfront purposes and management, preferably defined as and outcome of a community planning process.

General Principles for urban riverfront development are (Otto B. McCormick K, Leccese M. , 2004, p.34):

- Ecological goals and economic development goals are mutually beneficial
- Protect and restore natural river features and functions
- Regenerate the riverfront as a human realm
- Compromises are necessary to achieve multiple objectives
- Make the process of planning and designing riverfronts broadly participatory

These principles reflect aforementioned ecological design principles for they establish the relation between natural and cultural values and interdependences in riverfront development. Valuing and revealing nature and including natural processes into riverfront development in away that acknowledge riverfront as a part of cultural, social and economical processes that drive urban development - needs to be conducted through broad participatory process in which compromises are necessary. This forms the basis for urban riverfront planning and design principles that are seen as mutually dependant, both having an influence on ecological riverfront enhancement on different spatial levels.

Planning Principles for urban riverfront development are (Otto B.McCormick K, Leccese M. , 2004, p.41):

P1. Demonstrate characteristics of the city's unique relationship to the river in the riverfront design
P2. Know the river ecosystem and plan for a scale larger than the riverfront
P3. Because rivers are dynamic, minimize new floodplain development
P4. Provide public access, connections and recreational uses
P5. Celebrate river's environmental and cultural history thorough public education programs, riverfront signage and events

Design Principles for urban riverfront development are(Otto B. McCormick K, Leccese M. , 2004, p.47):

D1. Preserve natural river features and functions
D2. Buffer sensitive natural areas
D3. Restore riparian and in-stream habitats
D4. Use nonstructural alternatives to manage water resources
D5. Reduce hardscapes
D6. Manage storm water on site and use nonstructural approaches
D7. Balance recreational and public access goals with river protection
D8. Incorporate information about a river's natural resources and cultural history into the design of riverfront features, public art and interpretive signs

The use of ecological riverfront planning and design principles will be examined in case studies in order to evaluate potential to achieve multiple (ecological and climate adaptation) objectives.

Cities and adaptation to climate change

Climate change is a fundamental challenge facing the world. There is general consensus amongst experts that our global climate changes and will continue to change in future. Due to increasing levels of greenhouse gases in the earth’s atmosphere temperatures will increase, there will be more dramatic events such as floods and storms, summers will be warmer and drier, winters will be warmer and wetter, and sea levels will rise. (NCRA, 2007)

Cities and towns are vulnerable to the impacts of climate change due to their high population density and physical structure (EEA, 2009). Urban areas, where the majority of the population live, will warm more than rural ones because buildings absorb heat. There are significant temperature differences between city centers and their surrounding countryside. Surface temperatures can be up to $6^{o}C$ greater in high density suburbs compared to low density suburbs. The concentration of buildings and hard surfaces leads to the formation of a specific climate characterized by higher night time temperatures, restriction of wind which disperses pollutants and increased run-off, i.e. 'urban heat islands'. (NCRA, 2007) This means that the built environment is not only exposed to climate change risks but also has an impact on it - which relates urban design to climate adaptation policies and measures.

Exposure units to climate change in urban areas

Though there are many documents at the global level, considering both mitigation and adaptation policies development of climate adaptation, principles and recommendations at the local level are at its infancy. In recent years more and more cities are integrating climate mitigation and adaptation policies into their strategic documents (London, Toronto, Rotterdam...). In general, both global documents and local strategies recognize three main exposure units to climate change in urban areas: *building integrity, urban green space and human health and comfort* (Handley J., Carter J. , 2006).

Building integrity: Increased coastal, fluvial and pluvial flood risk stimulated by sea level rise, increased storminess and increased winter precipitation, are the key threats of climate change to building integrity. Both buildings and infrastructure are at risk. These impacts are increased by type of urbanization, which alter natural hydrological regimes through reducing the infiltration capacity of the ground. Though it is clear that flooding has the potential to damage the built fabric of urban environments (Handley J., Carter J., 2006) some other risks also exist. Ground conditions can change too due to climate change: shrinking and swelling of the ground can become the most damaging geohazards as well as the erosion.

Urban green space Urban green spaces can make a contribution to mitigating and adapting to climate change but they can also be affected by it. Climate change is expected to lead to more droughts in summers. Longer and more intensive use of green spaces due to hotter and drier summer climate can be expected, especially in high density areas. This will mean a greater need for urban green spaces to be watered. Yet it can be expected that limited water resources will cause the problem in managing and effectiveness of urban green space. Dried out grassed areas are less effective at cooling through evaporation (Gill.S, J.Handley,Ennos R,Pauleit S.,2007) Planting drought resistant plants is just a part of the solution (Barber, A., 2006) Methods which allow rainwater harvesting, the re-use of grey water and making use of water in rising aquifers under cities should also be employed.(Gill.S, J.Handley,Ennos R,Pauleit S.,2007). On the other hand, increased and more intense winter precipitation can cause more storm damage in urban green spaces. Greater soil erosion due to more intense rain will reduce the mineral content of soil which will impact on biodiversity.

Human comfort and health: Human comfort and health in urban areas are threatened by climate change due to two main reasons - rising temperatures and more intense rainfall events with associated flooding. The urban heat island effect has the potential to accelerate and compound temperature rises in urban centers and intensively built up areas. Though people feel comfortable across a wide range of outdoor conditions and can adapt to different climate conditions (Handley J., Carter J., 2006), with the prospect of climate change, people will need to be aided in their efforts to adapt to the different expected new climatic conditions within urban areas. The adaptive capacity of different communities and groups also varies. Vulnerable groups, such as elderly and poor inner-city residents will be disproportionately affected. It can be expected that climate change will affect peoples demand for, use of, and experience of open space. (Cabe, 2008) Natural venting and shading, accessibility, quantity and quality of green and blue space areas, which can moderate temperatures and enhance human comfort, are for that reason of main importance

Adaptation policies and measures for climate change

Considering main exposure units to climate change in urban areas, content analysis of general adaptation recommendations and specific local urban climate adaptation strategies indicates three main adaptation policy areas: flood, overheating and droughts/water management (TCPA, 2007; Kamal-Chaoui, L., Alexis R.(eds.)2009; The World Bank, 2010). Though this policies and measures can be realized at conurbation, neighborhood and building scale, for the purpose of this paper only spatial measures at conurbation and neighbourhood scale were distilled and will be considered, since they are relevant for riverfront development. Policies and measures presented in this paper are mainly based on The Town and Country Planning Association (TCPA) (2007) "Climate Change Adaptation By Design" publication and will be used for case study analysis.

Flood (F)

Increases in average winter precipitation and in the frequency, duration and intensity of heavy downpours will increase flood risks. Measures for reducing and managing flood risks include:
1. *Safeguard land* that is required for current and future flood risk management - holistic approach
2. *Creation of hard, permanent flood defences* and barriers where necessary.
3. *Reduce flood risks* to new development through location, layout and flood resilient design and taking opportunities to relocate existing buildings that will be vulnerable to flooding.
4. *Use sustainable drainage systems* (SUDS) to manage and slow down surface water run-off and release it to the natural water cycle. SUDS can deal with flood, water quality and resource risks while also bringing ecological and amenity benefits.
5. Understanding flooding pathways in urban environments - *making space for water*
   a) *Use green infrastructure* for flood storage, conveyance and SUDS, re-create functional floodplains.
   b) *Provision of temporary water storage capacity* during flood events to reduce peak flows: creation of flood retarding basins and areas that flood during extreme events.
   c) Upland land management though *storage (e.g. reservoirs) and planting* to reduce runoff.
   d) *Diversion of flood flows away from vulnerable areas* or constructing a second flood channel.

Overheating (O)

Since average annual and seasonal temperatures are likely to continue to rise, adapting cities to overheating is necessary. Planning and design should aim for integration of water, open space and built form through green space and blue space strategies. Though some measures are important to be taken at a higher scale, local microclimate is essential for human health and wellbeing. Related policies and measures are:
1. *Good quality green infrastructure*. High quality accessible green space, made up of a linked network of well-irrigated open spaces has ecological, recreational and flood storage benefits. They provide evaporative cooling effects from a matrix of green corridors, smaller open spaces, street trees, and green or living roofs and walls. Planning for green space need to take account of changing patterns of precipitation and availability of water.
2. *Making blue space accessible*, such as open bodies of water, including rivers, lakes and urban canals. Increased use of ponds, roadside swales, flood balancing lakes, swimming pools and fountains is expected as the outdoor temperatures arise.
3. *Shading and orientation* to reduce excessive solar gain (e.g. through narrow streets, canopies of street trees). Efforts to maximize shade in summer will need to take account of the need for light and warmth in winter.
4. *Passive ventilation* captured through location, orientation and morphology of buildings streets, green and blue areas. Efforts to catch breezes and increase canyon ventilation paths must also consider the need for winter warmth.
5. *Cool pavement materials* on roadways or large parking areas – to increase surface reflectivity or increase rainfall permeability to benefit from

Droughts/water management (D)

Changing patterns of rainfall will have a significant impact on water resources and water quality. In the summer, warmer temperatures will mean that demand for water grows just as supply declines due to lower rainfall. Low river flows during dry summers can lead to restrictions on water abstractions, with consequences for cooling processes when the need for cooling is highest. Also urban areas have little capacity to store drinking water and are more likely to experience shortages during droughts. Spatial policies and measures for managing droughts and water shortage include:

1. *Creation of upland and lowland reservoirs*, both natural and manmade to ensure sufficient water supplies during summer while reducing the potential for flooding downstream during heavy rainfall. They also have important aesthetic, recreation, ecological and flood storage roles.
2. *Providing space for treatment of storm water and waste water* (e.g. by lagooning and micro-filtration) and increasing use of reclaimed and recycled water. This results in high quality water suitable for irrigation and non-drinking water uses such as toilet flushing.
3. *Use of sustainable drainage systems* SUDS for groundwater recharge.
4. *Greater use of separate drainage systems* for surface and foul water, to send surface water runoff directly back to the watercourse and significantly reduce the treatment burden.
5. *Use of low water use planting and underground storage and accessing new supplies* of lower grade ground water in order to sustain the evaporative cooling function of vegetation in times of drought.

Ecological design approach to riverfront development: case studies

1. Case: Don River , Toronto, Canada

The 38-kilometer long Don runs through one of the most urbanized river watersheds in Canada. From the founding of Toronto in 1793, the Don was a "working" river. Mills, quarries, factories, gas works, petrochemical plants and other heavy industries lined the river's lower reaches. Much of the pollution from these industries found its way into the river Don. To halt the flooding, to provide a shipping channel and to create additional industrial land near the lake, "the Don Improvement" project was launched toward the end of the 19th century. The project straightened the sections of the river, creating room on either side for railroads, roads and other urban infrastructure. Marshes were drained and filled providing acres of new industrial land. The natural mouth of the river was diverted into the concrete-lined channel. After the World War II new parkways and avenues were built to serve new communities. These roads restricted access to the valley for city residents and added to environmental degradation. (Wilson M., 2001; The Task Force to Bring Back the Don , 2011). After the big flood event in 1954, the Ontario government restricted future development on floodplains, thereby preserving much of the remaining natural space in the Don Valley. New land was purchased through the land acquisition program for flood control purposes. Much of this land has been turned over to the parks department and provides an integrated parks system. The second stage was the flood control works, designed to construct as many structures as necessary to control flooding. The works consisted of dams, reservoirs, channel improvements, and other infrastructure. (TRCA, 2011; Wilson M., 2001)

By 1989 'citizen-driven' advisory body - the Task Force to Bring Back the Don- was formed committed to 'bringing back' a clean, green and accessible Don River within the City of Toronto. They envisioned restored Don River as a showpiece for a new approach to city planning - one that works with rather than against nature. In the years since, many planting (over 40,000 trees) and restoration projects were delivered. Several wetlands have been created and many degraded sites have been restored to health. Two basins were excavated adjacent to the river and these periodically flood with river water. The green space along the watercourse not only provides recreation opportunities, but also an area for wildlife to flourish. Today, thousands of people annually use the Don's many trails for cycling and hiking and the Don river for canoeing. (Wilson M., 2001, Hough M., 1995)Despite the progress made, the fight to bring back the Don is far from over. During every major rainstorm, the river is fouled when combined sewers in older parts of the city overflow.Flooding is another serious problem. Therefore the new flood protection project was launched. It is aimed to solve the flooding problem while at the same time naturalizing and rehabilitating the mouth of the Don River (on a ecosystem basis) and encouraging additional compatible recreation, cultural heritage opportunities and public accessibility. (TRCA, 2011) The Summary of ecological riverfront design principles and climate change adaptation policies applied is presented in Table 1.

Table 1:Ecological riverfront principles and climate change adaptation policies - Don river

Don River , Toronto, Canada					
Ecological riverfront design principles (P - planning, D - design)			**Climate change adaptation policies (Policy areas: F - flood, O - overheating, D - droughts/water management)**		
P1	Demonstrate characteristics of the city's unique relationship to the river	+	F	Safeguard land -holistic approach	+
P2	Know the river ecosystem and plan for a scale larger than the riverfront	+	F	Creation of hard, permanent flood defences	+
P3	Minimize new floodplain development	+	F	Reduce flood risks	+
P4	Provide public access, connections and recreational uses	+	F+D	Use sustainable drainage systems (SUDS)	
P5	Celebrate river's environmental and cultural history	+	F+O	Good quality green infrastructure	+
D1	Preserve natural river features and functions	+	F	Provision of temporary water storage capacity	+
D2	Buffer sensitive natural areas		F+D	Upland and lowland storage and planting to reduce runoff	+
D3	Restore riparian and in-stream habitats	+	F	Diversion of flood flows away from vulnerable areas	
D4	Use nonstructural alternatives to manage water resources	+	O	Making blue space accessible	+
D5	Reduce hardscapes	+	O	Shading and orientation	
D6	Manage storm water on site and use nonstructural approaches	+	O	Passive ventilation	
D7	Balance recreational and public access goals with river protection	+	O	Cool pavement materials	
D8	Incorporate information about a river's natural resources and cultural history into the design	+	D	Treatment of storm water and waste water	+
			D	Greater use of separate drainage systems	
			D+O	Use of low water use planting and underground storage	

2. Case : Quaggy River in Sutcliffe Park, Lewisham, GB

The River Quaggy is an urban river, 17 km in length, passing through the south-east London boroughs of Bromley, Greenwich and Lewisham. Over the years, it has suffered considerable flooding problems caused primarily by development on the natural floodplain. By 1990 much of the river flowed lifelessly in concrete channels and culverts when a scheme was proposed to prevent the Quaggy flooding by enlarging and channelising the entire river. It was dropped after local people argued that it would be unsightly and have a negative impact on the river environment. A wider study identified river restoration opportunities. A new scheme was put forward that took a catchment-wide approach to water management.This meant that floodwater could be stored in upstream areas, to prevent flooding downstream. The objectives were to reintroduce the floodplain as a natural flood storage area as part of a larger catchment flood alleviation plan; to enable the river to become accessible to the public; to create an environment where native fauna and flora could colonise and allow for natural channel processes. (CABE, 2011) A multi-disciplinary team of experts worked, with local people on the design and development of the scheme to ensure that opportunities for major visual, social and ecological enhancements were optimized at the same time as managing the flood risk. Baseline surveys were conducted of the river’s flora, trees, bats, fish, birds and mammals. The information gathered helped to inform the design and the environmental impact assessment. This in turn helped to ensure that important environmental features already in existence were protected during the improvements.

The final scheme combines the creation of flood storage areas linked by channel improvements and environmental features such as raised areas and aquatic plants. The first phase of the work was at Sutcliffe Park, where the Quaggy was brought out of its culvert and restored along an alignment similar to its historic course. Natural regeneration and replanting has created attractive landscape that increased biodiversity. Boardwalks, bridges and footpaths have been installed, avenues of trees and wildflower meadows, wetland areas, reed beds, lakes and ponds arranged, new seating areas throughout the park and an outdoor classroom created. CABE (2011)When water levels rise, the park acts as a storage area to help prevent flooding further downstream. As flows reduce again the water flows back into the culvert. The next phase took place at sports fields that are available for use as sports pitches, but in times of flooding a channel in the river diverts water into the site, which is capable of holding up to 65,000m3 of water. Reed beds were added where the storm water joins the river, to improve water quality. The final phase was the stretch of river that runs into Lewisham town centre. This part of the scheme involved changing the riverbed to create more natural meanders and areas of deeper and shallower water. This has improved the habitat for wildlife. Where possible, hard defences were replaced by soft defences. Where the Quaggy runs through a local Manor park, wetland areas were introduced, along with better access to the river. The local community and schools took an active role in transforming their park.(Environment Agency, 2011).The Summary of ecological riverfront design principles and climate change adaptation policies applied is presented in Table 2.

Table2:Ecological riverfront principles and climate change adaptation policies-Quaggy river

Quaggy River in Sutcliffe Park, Lewisham,GB					
Ecological riverfront design principles (P - planning, D - design)			**Climate change adaptation policies (Policy areas: F - flood, O - overheating, D - droughts/water management)**		
P1	Demonstrate characteristics of the city's unique relationship to the river	+	F	Safeguard land -holistic approach	+
P2	Know the river ecosystem and plan for a scale larger than the riverfront	+	F	Creation of hard, permanent flood defences	
P3	Minimize new floodplain development	+	F	Reduce flood risks	+
P4	Provide public access, connections and recreational uses	+	F+D	Use sustainable drainage systems (SUDS)	
P5	Celebrate river's environmental and cultural history	+	F+O	Good quality green infrastructure	+
D1	Preserve natural river features and functions	+	F	Provision of temporary water storage capacity	+
D2	Buffer sensitive natural areas		F+D	Upland and lowland storage and planting to reduce runoff	+
D3	Restore riparian and in-stream habitats	+	F	Diversion of flood flows away from vulnerable areas	+
D4	Use nonstructural alternatives to manage water resources	+	O	Making blue space accessible	+
D5	Reduce hardscapes	+	O	Shading and orientation	
D6	Manage storm water on site and use nonstructural approaches	+	O	Passive ventilation	
D7	Balance recreational and public access goals with river protection	+	O	Cool pavement materials	
D8	Incorporate information about a river's natural resources and cultural history into the design	+	D	Treatment of storm water and waste water	+
			D	Greater use of separate drainage systems	
			D+O	Use of low water use planting and underground storage	

DISCUSSION

Though the initiatives for actions were different - river health in Don River case, flood protection in Quaggy River case - both riverfront development cases took the ecological design approach in which: a) solutions grew from place: designs began with deep knowledge of particular place, its inhabitants and processes; development was based on natural and cultural history of the place, b) ecological accounting informed design - both cases had watershed approach and sensitive areas were protected c) design with nature - natural elements were used) everyone is designer - participatory process was conducted, e) make nature visible - natural features and processes were exposed and celebrated .

All ecological riverfront planning and design principles were implemented in both Don River and Quaggy River case with an exception of buffering sensitive areas, for which we had no relevant information. These results were expected for Don River case, that was motivated by river health problem and explicitly aimed at restoring habitat, open space and delta/marsh while integrating natural processes into overall planning and design scheme. On the other hand the application of ecological planning and design measures can be seen as and additional value for combating flooding problem in Quaggy River case.

Climate adaptation policies and measures were not the in the focus of Don River restoration activities but some benefits in that area can be identified. They are specially related to development of good quality green infrastructure, improvement of the access to bluespace, provision of water storage capacities and planting to reduce a runoff. Besides their biodiversity and cooling function, new wetlands also have a water management function.

Since basically motivated by flood protection, which is itself a climate adaptation problem, Quaggy river development project fully addressed climate adaptation policies and measures in flood policy area. Due to introducing river restoration goals into development scheme that resulted in natural regeneration and replanting significant - improvements were made also in overheating policy area. Use of reed beds and creation of water storage capacities contributed to the droughts/water management policy area.

Taking this into account, relation between ecological approach to riverfront design and climate change adaptation policies can be established and co-benefits achieved - if holistic approach, improvement of green infrastructure, better accessibility of green and blue spaces and improvement of waterstorage and cleaning capacity of natural elements were used.

CONCLUSIONS AND IMPLICATIONS

Urgent and serious threat of climate change presents a new challenge to urban development. It is inevitable and yet it provides opportunities as well as threats for urban spaces. How to develop urban riverfronts to meet the needs of climate adaptation urban policies was a basic question asked in this paper. The specific goal was to understand the possibilities for co-benefits approach in urban development, applied at the urban riverfronts in context of adapting cities to climate change. For that reason, theory of ecological design, ecological riverfront design principles and climate adaptation policies for urban areas were brought together.The central argument was that ecological design approach, based on integrating natural and human processes, can help in adapting cities to climate change while at the same time improving ecological values of the rivers and riverfronts. This was based on the presumption that ecological riverfront planning and design principles and various climate adaptation policies are related and can co-benefit each other.

Possibilities and constraints to use ecological design approach for climate adaptation issues was examined by introducing ecological design theory and analyzed on two case-studies of riverfront development based on ecological design approach: 1) Don river - Toronto, CA , 2) Quaggy River in Sutcliffe Park, Lewisham, GB. Framework for analysis was formed on the basis of content analysis of ecological riverfront design principles and climate change adaptation policies for urban areas with a purpose to generate some conclusions about their relation.

Analysis showed that, though the initiatives for actions were different - river health in Don River case, flood protection in Quaggy River case - both riverfornt improvement cases managed to include both ecological and climate adaptation policies and measures, due to ecological design approach used. Implementation of ecological riverfront planning and design principles was complete (with exception of buffering sensitive areas for which no relevant information was available). Implementation of flood climate change policy area was strongest in both cases, but due to approach that aimed as natural restoration and affirmed use of natural elements and processes in design schemes - implementation of overheating and in slightly less droughts/water management way was also achieved. This enables us to initially confirm the starting presumption that ecological riverfront planning and design principles and various climate adaptation policies are related and can co-benefit each other. Co-benefits can be achieved if a holistic approach, improvement of green infrastructure, better accessibility of green and blue spaces and making space for water based on improvement of waterstorage and cleaning capacity of natural elements - were used.

All this leads us to the general conclusion that, while using ecological design approach to improve urban rivers, we can help cities to adapt to climate change. On the other hand, climate change adaptation measures can be used to enhance the relation between natural and cultural forms and processes on urban riverfronts that enhances ecological as well as cultural sustainability of our cities and towns. Therefore, the use of the problem oriented and locally specific ecological approach can be a useful tool for Serbian cities and towns to adapt to climate change, while at the same time developing their riverfronts as a good place for both people and nature in the city.

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REFERENCES

Barber, A (2006) A real response to climate change, *Green Places*, November 2006

CABE (2008) *Adapting Public Space To Climate Change*, www.designcouncil.org.uk/.../Publications/CABE/ adapting-public-space-to-climate-change.pdf (accessed, 21.3. 2011)

CABE (2011) *Quaggy River in Sutcliffe Park, Lewisham*, http://www.cabe.org.uk/case-studies/quaggy-river

Environment Agency (2011) *Case study River Quaggy makes a comeback*, http://www.environment-agency.gov.uk/static/documents/Business/casestudyrecreation_1514776.pdf

EPA (2011) Glossary of Climate Change Terms, http://www.epa.gov/climatechange/glossary.html

European Environment Agency (EEA) (2009) *How Will European Cities Adapt To New Climate Conditions*? http://www.eea.europa.eu, (accessed, 25.5.2011)

Gill. S, J. Handley, Ennos R, Pauleit S. (2007) *Adapting cities for climate change: the role of the green infrastructure*' Built Environment, Vol 3, No 1, pages 115-133

Handley J., Carter J. (2006) *Adaptation Strategies For Climate Change In The Urban Environment*, ASCCUE Report Draft Final Report To The National Steering Group

Hough M. (1995) *Cities and Natural Processes*, London, Routledge,

Kamal-Chaoui, L., Alexis R. (eds.) (2009), *Competitive Cities and Climate Change*, OECD, Regional Development Working Papers N° 2, 2009, OECD publishing

Kibel P. S ed. (2007) Rivertown: Rethinking urban rivers, MIT Press, Cambridge, Massachusetts, London,

Marshall R. ed. (2001) Waterfronts in Post-Industrial Cities, SPON Press, London and NY

Montag Stiftung Urbane Raume Regionale 2010 (2008) *Riverscapes*, Birkauser Verlag AG,

Neighbourhoods, Cities and Regions Analysis Division (NCRA) (2007) *Climate change and Urban Green Spaces*, www.communities.gov.uk, (accessed, 25.5.2011)

Otto B. McCormick K, Leccese M. (2004) *Ecological Riverfront Design*, APA, PAS, AR ,USA

Quaggy Waterways Action Group (2011) *Bringing An Urban River To Life*, http://www.qwag.org.uk/home/

The Task Force to Bring Back the Don (2011) *Bring Back the Don*, http://www.toronto.ca/don/(30.6.2011)

The Town and Country Planning Association (TCPA) (2007) *Climate Change Adaptation By Design*, http://www.tcpa.org.uk/pages/climate-change-adaptation-by-design.htm l (accessed, 28.5. 2011)

The World Bank (2010) *Cities And Climate Change - An Urgent Agenda*, http://wbi.worldbank.org (21.3. 2011)

Toronto and Region Conservation (TRCA) (2011) *Don Mouth Naturalization and Port Lands Flood Protection Project*, http://www.trca.on.ca (accessed, 30.6.2011)

ULI (2004) *Remaking the Urban Waterfront*, ULI, Washington DC

Van Der Ryn S., Cowan S., (1996) *Ecological Design*, Island Press, Washington DC,

Wilson M.(2001) *Don Watershed Regeneration* , http://www.mwilson.on.ca, (accessed, 30.6.2011)

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RENEWABLE ENERGY AS A SOLUTION FOR CLIMATE CHANGES

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ABSTRACT

The climate changes are a real problem and renewable energy sources are a real solution. Protection of global climate, valuable sources saving and feasible development in the whole world are important challenges which must be overcome in this century. Renewable energy is a promising alternative solution because it is clean and environmentally safe. Serbia have enough potentials available to abandon using fossil and nuclear reserves as energy sources. Strategies and tactics needed to begin with RES exploitation should be considered, because only RES can guarantee long-term feasible development and survival of life on the Earth and can provide energy independence.

Key words: global warming, sustainability, renewable energy.

INTRODUCTION

Variations in the behavior of the weather over long periods, such as from one century to another, is referred to as climate change. Climate variation occurs as a response to climate forcing which can cause either a warming or a cooling of the atmosphere. Over most of the Earth's history, the forcing have been entirely natural, caused by continental drift, variability in solar radiation, changes in the Earth's orbit, and volcanic emissions. However, since the Industrial Revolution, human activity has had an effect on the global climate system, increasing the amount of greenhouse gases in the atmosphere, trapping heat and contributing to an overall global warming.

GLOBAL WARMING

A blanket of air that traps heat from the sun covers our Earth. Without this blanket, the Earth would be so cold people could not live here. But too much trapped heat would make it too hot to live here as well. Sometimes this blanket can act like the glass on a greenhouse when light from the sun hits the Earth and changes into heat, and the blanket traps the heat. Light can pass through the atmosphere (or glass), but heat cannot escape as easily. This causes a slow warming on our planet as heat builds up. This is called global warming. It can change the fragile balance for life on Earth. We add to the problem by burning fossil fuels. They produce gasses like carbon dioxide (CO_2) that trap more heat and cause more global warming. Some scientists suggest that we change the way we use energy. They say that we could cut our energy use in half just by making lights, machines, buildings and cars more efficient. In addition, half of this reduced amount could come from renewable resources such as the sun and wind.

Possible Consequences of Global Warming

Most scientists agree that the Earth is in fact experiencing increasing temperatures, and many believe that humans are enhancing this overall warming trend. The likely effects of global warming will not be limited to one country? or even one continent? and will permeate almost every aspect of the environment and of life for all living things. Potential effects listed here are just a handful of those discussed in the Intergovernmental Panel on Climate Change's (IPCC) 2007 report.

Rising sea levels are the most common concern; taking place with a thermal expansion of the oceans? a result of water molecules expanding in warmer temperatures, increased precipitation, and the melting of mountain glaciers. Because all bodies of water have varying shapes and ocean water tends to "swell" differently depending on its starting temperature, the change in sea level is not uniform over the surface of the Earth. In the 20th century alone, sea levels rose 0.17 meters predictions for the next century range anywhere from 0.18 to 0.59 meters. While smaller projections would likely have only relatively modest impacts, the higher projections could have dramatic effects on low-lying coastal communities.

Currently, the Arctic summer sea ice is about half as thick as it was in 1950. Just like an ice cube melting in a glass of water, the melting Arctic sea ice does not contribute to sea-level rise, except for the expansion of seawater with increasing heat. However, melting Arctic sea ice may lead to global changes in ocean circulation. Water from melted ice forms a layer at the sea surface that is less dense than the underlying water since it is less salty, potentially preventing the pattern of deep ocean currents from rising to the surface. Additionally, melting sea ice speeds up the warming of the Arctic since water absorbs 80% of sunlight, about the same amount that the cover of sea ice used to reflect.
While the idea of swimming in a warmer ocean is pleasant to most human beings, increasing ocean temperatures could cause serious ecological damage. Approximately one quarter of the world's coral reefs have died over the last few decades, many of them affected by coral bleaching? a process directly tied to warming waters which weakens the coral animals.

An increase in global temperature will likely enhance the ability for severe weather, which could mean stronger and more frequent storms. Warmer temperatures cause more evaporation of water, which, as part of the water cycle eventually leads to increased precipitation and further increasing the potential for flooding. While some parts of the world are projected to experience increased precipitation, others may experience higher levels of drought as places that are typically dry? such as the centers of continents? experience even more evaporation as global temperatures climb. Scientists, however, are trying to determine whether drought is actually increasing or if we are experiencing a shift in areas of drought.

Warmer winters mean that many deaths related to cold temperatures might be avoided and that the growing season will last longer, a possible upside to global warming. More people around the world die because of winter cold than because of summer heat. A decrease in winter deaths could offset a potential increase in summer heat-related deaths, or even lead to more lives saved as a result of the changed temperatures. With respect to longer growing seasons, there is already evidence in Europe that their growing season has been extended since the 1960s, with spring plants now blooming about 6 days earlier and fall colors coming 5 days later.

With drought affecting some regions and heat intensifying in the tropics, many areas will become unsuitable for agriculture. In tropical areas that are already dry and hot, the ability to harvest food will likely decrease even with small increases in warming. However, warmer temperatures and increased precipitation can also make previously marginal land more suitable for farming. Therefore, it is likely that, with a changing climate, a global change in the agricultural pattern will occur. Yet, it is unknown as to whether or not the increase in the usefulness of marginal lands will counterbalance an increase in drought and desertification.

In addition to potential environmental changes, the human health implications of increased global warming are very concerning. Extreme heat waves in 2003 and 2006 led to thousands of deaths in Europe, North America, and India and are likely to increase. We are also witnessing a renewed spread of diseases, likely to increase if temperatures continue to rise, including a spread of illnesses that were previously limited only to tropical areas.

Other species are also affected by global warming, most often by changes in migration patterns, shorter hibernation times, relocation to new areas, and extinction due to lack of adaptation. For example, many animals accustomed to living in the arctic regions, such as polar bears and penguins, have been forced further out of their native habitat in search of more accommodating habitat closer to the poles. Animals that migrate, such as birds and butterflies, have begun extending their migratory range closer to the poles, arriving sooner and departing later.

For several reasons, the world needs an adapted energy system to accommodate its growing population: Climate change, depletion of natural resources and a growing dependence on only a few energy suppliers are a threat to our current system. Renewable energy sources are therefore necessary for a sustainable balance.

Increasing awareness of the environmental impact of CO_2 and NOx emissions and CFCs triggered a renewed interest in environmentally friendly cooling, and heating technologies. It was therefore considered desirable to reduce energy consumption and decrease the rate of depletion of world energy reserves and pollution of the environment. One way of reducing building energy consumption is to design building, which are more economical in their use of energy for heating, lighting, cooling, ventilation and hot water supply. Passive measures, particularly natural or hybrid ventilation rather than air-conditioning, can dramatically reduce primary energy consumption. However, exploitation of renewable energy in buildings and agricultural greenhouses can, also, significantly contribute towards reducing dependency on fossil fuels. Therefore, promoting innovative renewable applications and reinforcing the renewable energy market will contribute to preservation of the ecosystem by reducing emissions at local and global levels. This will also contribute to the amelioration of environmental conditions by replacing conventional fuels with renewable energies that produce no air pollution or greenhouse gases (Lambić, 2009).

SUSTAINABILITY

The term "sustainability" has taken on many different meanings, depending on the area of life that is under consideration (e.g., population, cities, ecology, etc.). In a very broad sense, sustainability can be considered the ability or capacity of a service or entity to survive into the future. Water supply, wastewater management, and solid waste management are environmental services that are fundamental to the quality of life in a modern society. In the context of these services, sustainability involves finding new approaches that can be used to reduce: (1) the use of resources, (2) the consumption of energy, and (3) the carbon footprint of these activities, while providing the same or enhanced level of service, so that these services can continue to function effectively into the future with minimal environmental impact.

The age of new energy

Ensuring healthy air and a stable climate for our children and grandchildren requires that we make responsible decisions about our energy sources. Renewable energy resources such as wind, solar, geothermal, and bioenergy offer a swift, practical, and affordable path away from the polluting fossil fuels that are leading contributors to global warming. A strong requirement to significantly reduce heat-trapping emissions in all sectors of the economy is essential to avoid the most dangerous effects of global warming. But it alone is not sufficient to overcome the unique barriers to the widespread adoption of renewable energy. Fully unlocking the potential of these resources and their benefits will require a policy such as a national renewable electricity standard. Combining these and other well-designed policies in a comprehensive approach offers the best opportunity to meet our emission reduction goals efficiently and economically.

With the agreement in 2009 on the Energy and Climate Package which contains the European Directive on the promotion of the use of energy from renewable sources with its binding target of at least 20% renewable energy in final energy consumption by 2020, the EU has made a strong and ambitious commitment towards renewable energy (Re-thinking, 2010).

Renewable energy is a promising alternative solution because it is clean and environmentally safe. They also produce lower or negligible levels of greenhouse gases and other pollutants when compared with the fossil energy sources they replace (Demirbas, 2009). Promoting innovative renewable applications and reinforcing the renewable energy market will contribute to preservation of the ecosystem by reducing emissions at local and global levels (Abdeen, 2008).

Non-renewable energy sources were formed millions of years ago, when dinosaurs walked the Earth. Oceans covered most of the Earth. They were filled with tiny sea plants and animals. When the plants and animals died, they sank to the bottom and were covered by sand and mud. Layers of dead plants, animals, sand and mud built up over time. Heat and pressure turned these layers into fossil fuels such as: coal, oil, natural gas. Eventually, we will run out of non-renewable energy supplies like coal, oil and natural gas. Long before that happens, the pollution caused by using these energy sources will become a serious problem. Sustainability means that we make sure we meet our energy needs now without stopping the people in the future from meeting theirs. Renewable energy sources are sources that we will not run out of. They are always being re-made by nature.

New sources of energy are being used every day. Many types of energy (Figure 1) that we use today were not on hand 20 years ago. Instead of getting electricity from a power plant that burns coal, your home may have a roof with special shingles or panels that change sunshine into electricity.
Although today we rely mostly on fossil fuels coal, oil and natural gas things are changing. There is only a limited supply of fossil fuels. Once they are used up, they are gone forever. In other words, coal, oil, and natural gas are non-renewable resources. Fossil fuels also create pollution when they are burned. Pollution is harmful to plants, animals, and people.

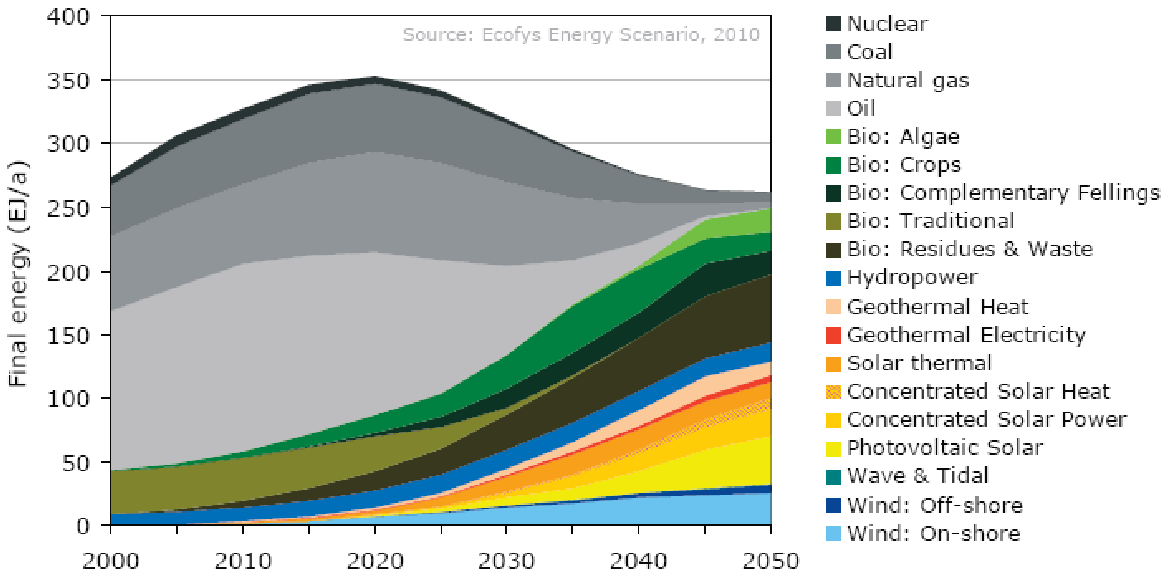

Figure 1. Overall energy supply in the Energy Report

RENEWABLE ENERGY POTENTIAL IN SERBIA

Projections are important tools for long-term planning and policy settings (Demirbas, 2009). RES are the chief support of energy independence of Serbia in the future. Technically usable energy potential of the said RES in Serbia is very important and has been estimated to over 4.3 million tons of equivalent oil (Mtoe) per year, which makes about 20% of total primary energy consumption. At the moment the share of energy from RES in Serbia is about 6% (including big hydro power stations). Beside hydro energy and limited quantity of geothermal energy and biomass, other renewable energy sources are not used. Serbia is considered to have potential to produce 4.89 Mtoe from renewable energy sources. Having in mind that the domestic energy production in 2009 was 8.79 Mtoe, it can be concluded that Serbia could produce a half of its primary energy from RES (MME, 2010).

CONCLUSION

By 2050 renewable electricity will provide for 100% of the world´s power demand and certainly top it in the "aggressive efficiency" scenario. Considering the detailed analysis of potentials and objective restrictions in using RES in Serbia, it can be concluded that there are enough potentials available to abandon using fossil and nuclear reserves as energy sources. Strategies and tactics needed to begin with RES exploitation should be considered, because only RES can guarantee long-term feasible development and survival of life on the Earth and can provide energy independence (Pekez, 2011). Further technological development and market introduction of renewable energies is the challenge of the future. International cooperation is important to make such a policy successful for the benefit of mankind (Palz, 1994). Exceptionally rigorous government measures, involving strong financial incentives and/or regulations, would be needed to effect a rapid expansion of renewables-based generation (GES 2007).

REFERENCES

European Renewable Energy Council (EREC) 2010. RE-thinking 2050, A 100 % Renewable Energy Vision for the European Union.

Lambic, M. (2010). Contribution to environmental pollution reduction, *Energy technologies* 7: 1, 22 – 27.

Abdeen, M. O. (2008). Energy, environment and sustainable development. *Renewable and Sustainable Energy Reviews* 12 (9), 2265-2300.

Demirbas, A. (2009). Global Renewable Energy Projections. *Energy Sources*, *Part B,* 4 (2), 212 – 224.

Ministry of Mining and Energy (MME) 2010. Strategy of energy development in the Republic of Serbia until 2015. Available from www.mem.gov.rs (accessed on December 2010).

Pekez, J. Radovanović, Lj. Desnica, E. Lambić, M. (2011). Increase of exploitability of renewable energy, *Energy sources*, *Part B*, *paper in print*.

Palz, W. (1994). Role of new and renewable energies in future energy systems, *International Journal of Sustainable Energy 14: 3*, 127 – 140.

Global Energy Survey (GES) (2007). World Energy Council, Korn/Ferry International, London.

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CLIMATE CHANGE AND SUSTAINABLE TOURISM DEVELOPMENT– SOME OF THE IMPACTS OF CLIMATE CHANGE ON THE PLANNING OF MOUNTAIN TOURIST CENTERS

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ABSTRACT

The paper describes research related to sustainable tourism development. The research has been conducted within two scientific projects of the Ministry of Education and Science of RS: *Spatial, environmental, energy and social aspects of developing settlements and climate change – mutual impacts* and *Sustainable spatial development of the Danube in Serbia* (2011-2014 period). The paper points to the trends, problems and modern approaches to sustainable tourism development, especially from the viewpoint of the impact of climate change on the planning of mountain tourist centers. European experiences have been analyzed together with the standards and criteria in the planning and implementation of sustainable tourism development. We have also demonstrated the possibilities of implementing the European experiences into the sustainable development management in order to reduce the impact of this industry on climate change. Renewable energy use and energy efficiency implementation contribute to sustainable production and energy consumption, thus having a significant impact on climate change. On the other hand, climate change will affect the future development of tourism, particularly the location of mountain resorts. Research related to the mutual influences of tourism and climate change will be presented in this paper.

Key words: climate change, mountain tourist centers, urban development, renewable energy, energy efficiency

INTRODUCTION

Climate change on Earth and the global warming of the atmosphere together with the changes of its physical and chemical composition are all consequences of the overuse of fossil fuels and inefficient technologies. Mankind has caused large disorders over the past two centuries in the most complex and sensitive system on our planet – global climatic system, where, the most dramatic changes are actually occurring in the atmosphere (Spasova, 2001).

Uncontrolled industrial development and accelerated exploitation of classic energy sources have created many problems, from an energy crisis, environmental catastrophes, the ruin of the ecosystem and endangered species to economic problems. The Earth’s atmosphere, due the current living conditions, is changing its composition because of the concentration of gases that have a significant impact o climate conditions on the planet and threaten to endanger our survival on it (Pucar, 2002a).

The global temperature on Earth has increased for about 0.74±0.18°C over the past century, which is greatly a consequence of the increase of greenhouse gases into the atmosphere: water vapor, carbon-dioxide, methane, nitrous oxide etc. Scientists predict that global warming and the increase of CO2 in the atmosphere, together with temperature rises and uneven global precipitation distribution will continue in the 21st century, which is confirmed by the data provided by the Intergovernmental Panel on Climate Change (IPCC)[1].

[1] IPCC Fourth Assessment Report: Climate Change 2007 (AR4)

Climate change will cause the expansion of subtropical deserts, the rise of the sea level and lack of quality water. It will also have an impact on people's health, forest vitality and other ecosystems, the rise in the intensity of weather storms, the rate of ice melting and the retraction of the snow to higher altitudes, the extinction of some species etc. Due to a higher level of water in the atmosphere, there will be more rain, snow, and other storms will cause floods, soil erosion and other changes that are harmful. This will have an impact on all the economic sectors, mostly agriculture and tourism, which is why it is necessary to undertake serious measures for preventing their consequences.

At the first International Conference on Climate Change and Tourism held in Tunisia (in Djerba) and organized by the World Tourist Organization in April 2003, opinions were exchanged on the topic of possible consequences and risks in the tourist sector resulting from global climate changes. As a result of the conference, the Djerba Declaration recognized the mutual complex relationship between climate change and tourism. On one hand, tourism is under the impact of climate change, particularly when tourist destinations on coastal, mountain, dry and flooded areas are in question; on the other, it is also the cause of these changes, especially due to harmful gas emissions from traffic and tourist facilities.

Climate change particularly threatens to endanger the ecosystems of mountains, which will lead to harsher conditions of living. The opinions that mountains will become more attractive for living are unilateral and do not perceive all the consequences of global warming, which will force the inhabitants and many animal species to seek out other habitats on higher altitudes, thereby increasing the density of population and altering the natural ambience. The changes in the ecosystem, uncontrolled forest and water exploitation will reduce the tourist offer on mountains.

Natural conditions on mountains more than in other climatic conditions cause greater consumption of energy, which is necessary for heating traditional and tourist settlements. They are only one of the factors that influence the profitability of mountain resorts, which are even more threatened if no attention is paid to energy efficiency during the site selection, design and construction. Unfortunately, this aspect has been neglected when it was believed that there was sufficient energy. Nowadays, the situation has changed, energy is expensive and there is more awareness of the fact that classic energy sources are limited, polluting and have an impact on the climate (Pucar, 2002a).

Global climate change, rising demand for mountain tourism, the population's needs, industry and agriculture are only some of the mutually related issues that should be considered in order to fully understand the problem with mountains (International Year of Mountains, 2002b).

The concept of sustainable tourism implies the optimal use of energy sources and reduction of the negative impact of their consumption. Within the scientific projects of the Ministry of Education and Science of RS: *Spatial, environmental, energy and social aspects of settlement development and climate change – mutual impacts*, and *Sustainable spatial development of the Danube in Serbia* (period 2011-2014), the problem of sustainable tourism is researched from the aspects of: tourism as part of the total development; tourism and climate change; energy use in tourism (for transportation, cable cars and heating etc.).Technological advancement in general and in tourism as well, should not encourage energy consumption. In fact, in finding a balance between tourism development and environmental protection is the problem of sustainability. The potentials for reducing energy use in the field of tourism lie in the application of the energy efficiency principles and a greater use of renewable energy sources (hereinafter, RES).

Sustainable development of mountains can be defined as development that meets our current needs, but in no way endangers the possibility for future generations to satisfy their needs and live in harmony and in accordance with Nature. The natural component, especially in mountain areas, has priority and thereby, attention should be given to its reproductive capacities and potentials. Appropriate water control and consumption, and reliable energy supply are the prerequisites of the sustainable development of mountains (Pucar, 2002b).

It is necessary that energy, economic and environmental policies and programs take into consideration sensitive mountain ecosystems and communities. When intervening in space that implies a change in the landscape and ambience, attention must be paid to sustainable development. Being familiar with these problems and making preparations beforehand for what the future will bring provides better energy independency and a more balanced development of mountains.

The Impact of Climate Change on the Tourist Industry

During the second half of 20th century, tourism bloomed and has become one of the most significant branches of economy on the global level. According to the data provided by the World Tourism Organization (UNWTO), the total global tourist trade in 2010 counted one billion tourists, and it is predicted that this number will rise to 1.6 billion tourists in 2020. The tourism sector employs around 250 million people and has demonstrated high adaptability during the crisis, still continuing to grow. As an exporting category, on the global scale, tourism accounts for 83%, and is the main source of foreign currency in 38% of the world countries.

In the total industry of the European Union, the tourism sector is present with 9% and employs around seven million inhabitants. According to the data of the World Tourist Organization, the number of tourists in the European Union will double in comparison to the current level by 2020.

The tourism sector is also greatly hit by climate change, globally and locally. Adjusting to the possible changes and reducing the negative impact of tourism on climate change is the main global concern for the tourist industry. By initial exchange of opinions on climate change, most nations have started identifying their potentials for reducing greenhouse gas emissions (GGE) within this sector, but also minimizing the potential harm caused by weather storms.

Many tourist activities demand specific weather conditions. Only a small increase in the winter temperatures, for example, will eliminate ski centers on the lower slopes of the Alps. The tourist may respond to this climate change with a negative impression of the attractiveness of this destination. It is believed that the winter tourism of Europe will experience significant changes, especially in terms of producing artificial snow, which has an impact on nature and demands additional energy use. Germany, Austria and Switzerland, where Alpine tourism represents one of the significant sources of income, are among the countries predicted to be the most affected. The thickness of snow on the Alps will drop for 20-30% by 2020, while droughts that are more and more frequent in summers will divert the travel of tourists from the Mediterranean to the North, or move annual vacations to springtime. According to the data of climatologists, the average temperatures confirm that the six hottest years in the history of temperature measuring were in the period after 1997; while the hottest summer was the summer of 2003. If this tendency continues, the tourists from the North will have no need to travel to warmer parts, which will further reflect negatively on tourism (Gain et al., 2009). Climate change will alter the habits of tourists and make new travel patterns, and in a way harm some destinations that live off tourism.

Climate change reflects onto the economic aspects. So the number of annual disasters caused by weather storms and the climate in Europe has risen for about 65 % in the period 1998-2007, in comparison with the annual average for 1980, which causes significant economic losses. This requires increased investments into the technical-technological systems so that they could be dimensioned for optimal functioning in the predicted new climatic conditions (Popover at al., 2009).

Climate change influences energy use in tourist facilities. Thereby, a redistribution of electric power consumption can occur during the year. If winters are warmer, the „degree day“ figure can drop during the heating period, which will enable energy saving. On the other hand, hotter summers have led to greater electric power consumption in that period due to massive use of air-conditioning.

All of this shows that it is necessary to start resolving the problem of climate change in an adequate manner, by implementing appropriate management strategies and systems in extreme situations (Simpson et al. 2008). To implement adequately the strategy of adjusting to climate change in the sector of tourism, it is necessary, among other things, to introduce a sustainable tourism, which represents a branch of economy that has a minimal impact on the environment and local culture, at the same time providing profit, new jobs and the protection of local ecosystems.

IMPACT OF CLIMATE CHANGE ON MOUNTAIN TOURISM DEVELOPMENT

Mountain tourism represents one of the fastest growing market segments of tourism, which can be illustrated by the data that, today, over 50% of the income comes from mainland tourism in Europe. Instigating the development of mountain areas would result in the construction of complex and very attractive tourist centers regarding their tourist offer, within the traditional settlements or in collaboration with them, on higher mountain areas and with strict control of the area capacity and environmental protection. In the development process of mountain areas, provisional degradation of some parts of the mountain area is inevitable, in terms of constructing infrastructure and developing immobile capacities and it cannot be avoided but it can be planned and guided. Until now, in the European mountain regions, over 600 mountain centers have been built, of which 70% are in the area of Alpine countries, and 60 to 80 million tourists visit them every year. The development of mountain tourist centers must be integral, with special attention to economic limitations regarding financial support, natural limitations and climatic conditions.

Due to the differences in regional characteristics of the countries and approaches to planning, the previous development of urban structures in mountain destinations has had different concepts. In Alpine countries, the concept of tourism development has changed over time, adjusting to the demands of the market and the characteristics of natural conditions. The first phase in the development of mountain destinations, which took place at the end of XIX and the beginning of XX century, originated in the traditional rural and mixed settlements at the foot of the Alps, where transformations of rural into tourist economies took place (examples of Courmayeur in Italy, Chamonix, La Clusaz, Megeve in France etc). The position of the first mountain tourist centers was mainly conditioned by their potentials to access transportation, which influenced their siting on the lower and middle altitudes. The development of transportation systems (especially vertical transport by means of cable cars) was enabled by forming typical Alpine centers in the altitude zones of the most attractive ski resorts. Between the 40s and 70s of the XX century, the development of mountain centers was oriented towards a suitable unsettled terrain above the traditional settlements, on the sites from 1200 to 1500m altitude (examples of Sestriere in Italy, Coursheval in France, etc.); then the period between the 70s and 80s of XX century by construction on sites from 1500 to 2000m altitude (examples of Tignes, Flaine, Les Arcs, La Plagne, Avoriaz and Izola in France, Kopaonik in Serbia etc.). Since the eighth decade of the XX century, there was a revival in the trend of building on lower locations and submountain villages at around 1000m altitude with links to the ski-altitude zones of the mountain by vertical systems of transportation (examples of Pila, San Sicairo, Bielmonte in Italy etc.). At the beginning of XXI century, it is trendy again to develop mountain centers with ski resorts at the altitudes above 1600m, as a result of technical progress in energy efficient construction and the decision on how investment finances are directed due to climate change.

Global warming could lead to the drop in the number of mountain centers with a dominantly winter offer in the next few decades, particularly on those locations and ski resorts in lower altitude zones. The estimate is that the rise in the average temperature by two degrees would lead to a 40% reduction, while a rise in temperature by four degrees (which is expected by the end of 21st century) would reduce the number of mountain centers that are able to provide winter offer in the area to around 200 (Milijić S., Dabić D., Krunić N., 2006). Such changes will lead to the re-planning of the existing and the development of new generations of mountain centers, that is, the reduction in the number and the specialization of high mountain destinations with a dominantly winter offer, and an increase in the number of mountain centers with a dominantly summer offer within the space.

At the beginning of their development, mountain centers have earned most of their income from their winter offer. With the tourist industry the offer started to develop tourist programs outside the winter season as well. Nowadays, the situation is such that the traditional mountain-tourist centers make around 60% of their tourist intake in the summer period, thus making them all-year-round destinations.

In accordance with the newer trends of development, the selection of location is more delicate, because it has to answer to climate change, satisfy all the strict environmental conditions and demands of all categories of visitors, and enable all-year-round functioning of the centers. Determining the site of the mountain center requires analysis of: (1) natural conditions and micro-climatic changes (temperature scales, degree of humidity, precipitation, periods of sunny intervals, snow cover, the prevailing wind direction and its strength, monthly variations etc.), geomorphology (regarding micro-climate, sport and recreational activities, landscape, natural surroundings etc.); (2) available space for construction in direct contact with space (especially with ski resorts); (3) nature protection regimes; (4) potentials for rational water supply and waste water sewage; (5) potential for rational access to transportation etc.

Mountains cannot be observed just as spaces for holiday and recreation, but also as „economies – enterprises“, which are organized and function as smaller or bigger entities, that is, as spaces that require appropriate urbanization suited to them, which will guide construction towards an authentic ambience; the use of local materials, energy efficiency; and, in a way, urban and architectural-engineering typization (Marić I., 2002). Urbanization of mountain areas can be described as concentrated or dispersive, of which each one has certain limitations. Concentrated construction leads to the creation of big urbanized surfaces that can have an impact on the natural balance; its realization takes a long time, thus, having an impact on Nature because of these works, etc. Dispersive construction has the following flaws: greater soil erosion and costs for infrastructural equipment; a greater number of pollutants in the heating season; a bigger number of waste disposal sites and the problem with is transportation; coverage of big stretches of land etc. A possible solution could be limited urbanization in the most attractive parts of the altitude zone and activation of a larger number of smaller sites in the lower parts and submountain villages.

Contemporary organization of mountain regions involves constructing new tourist centers and settlements and reconstructing, rehabilitating and equipping the existing ones on the principles of polyvalent functions with an all-year-round offer within the space, together with improving the utility equipment of the space, the facilities, distribution of primary infrastructure, of which the most important are external accesses and traffic connections, energy and telecommunications infrastructure that link the mountain with the surroundings, nature preservation and direct contact with tradition and local population that is put into the function of tourism development and its complementary activities.

Activities on promoting and implementing sustainable development of mountain regions include; directing the processes of implementation towards resolving the key regional and local problems that limit the development of mountain regions (modification of the functions and offer of mountain tourism due to climate change and higher altitudes of snow lines, activities regarding the prevention of deforestation, erosion and soil degradation, loss of biodiversity, water pollution etc).

Mountain areas, which are the main source of energy on the planet, have so far been exhausted the most from the aspect of natural resources, as well as the aspect of surroundings (Sustainable Energy, 1997). Energy sources on mountains range from conventional renewable, like wood, agricultural rubbish and manure, to non-renewable like gas and coal. Climate conditions on mountains cause the energy needed for heating to be used much more than in other climate conditions. Because of their physical characteristics, mountains are rich with other RES, like hydro, solar, wind and geothermal energy; which are important not only to the population that lives on mountains, but for those who live in the plains as well. Such a great energy potential of mountains could lead to the shift in global energy use from classic, fossil sources that are the main cause of the planet’s global warming, to RES that are environmentally clean, and whose use can contribute to sustainable development (International Year of Mountains 2002a).

The most attractive tourist destinations in Serbia are mountains and spas. Climate change threatens to endanger their ecosystems, which will lead to harsher conditions of living. Mountains of Serbia are endangered in many ways. Their plant and animal worlds are being destroyed, ecosystems are disrupted, and energy sources on the mountains are exploited profusely and without control. Mountains of Serbia are rich in natural beauty and some of them are declared as territories of national parks and nature parks, with certain environmental protection regimes. Unfortunately, we are witnesses that there is more degradation of soil and pollution of air and water on mountains today. Certain plant and animal species are disappearing; surfaces under forests are reducing (Pucar 2004).

TOURISM AND ENERGY USE

Energy use in tourism has a big impact on a country's economic and energy balance. Tourist facilities mainly meet their energy needs in the classic way. In the cost structure of tourist facilities, almost 40% accounts for energy (heating the space and water, lighting, system maintenance etc). The part of energy used for heating water in these facilities is somewhere between 13- 15%, which is a big item for hotels, for example, with many beds.

In USA, roughly 76 billion kWh per year are consumed for accommodation and recreation (of which roughly 73% accounts for accommodation). This energy is used for heating and cooling the facilities, heating water and pools, food preparation and lighting, which accounts for 5 to 10%. Transportation in the tourism sector accounts for around 790 billion (EPA). On the global level, the tourism sector uses around 5.000 million kWh annually, which represents around 80% of the yearly primary energy of Japan (Perera et al., 2003).

In Serbia, the tourism sector is a huge consumer of energy as well, which is largely used for inefficient heating of space and transportation. There is a high rate of electric power consumption as well, that is why this problem is becoming more topical and important. Additionally, heat loss in tourist facilities is very high, and RES, particularly those from local sources, are not implemented enough (Maksin et al., 2011).

In the following period, with the construction of new tourist facilities and an expected growth of this industry in Serbia, energy use will increase. The problem is that the domestic coal reserves, with the current production level of electric power, shall last another 50 years. Serbia, in all the fields of energy use, in view of energy efficiency and RES is greatly behind developed countries, and in the future will have to pay more attention to these segments of development that have a great impact on the environment. The costs of energy could be greatly reduced, if energy systems were to be adequately managed, and if some of the many ways were to be applied, which could provide a much more efficient approach to the use of energy resources.

IMPACT OF ENERGY USE IN TOURISM ON CLIMATE CHANGE AND ENVIRONMENT

The growing problem of energy shortage in the world and a sequence of negative implications due to the irrational use of non-renewable energy resources have necessarily conditioned new knowledge in the field of energy supply and awareness of the environment.

Research results of potential climate change point to significant changes between northern and southern Europe, not only regarding changes in temperature regimes, but also regarding other climatic elements. In some parts of south-eastern Europe, precipitation will drop up to 20%. In southern Europe, it can be expected that there will be a thinning of the snow cover, shifting of climate zones, and smaller yields in agriculture. Because of these problems the food production, energy and water supply, human health and biological diversity will be endangered, this region is considered to be in a great threat of climate change. The analyzed climate extremes on the Balkan Peninsula in the last decade of the 20^{th} century are only some of the latest in a sequence of serious antropogen climate changes in the region of southern Europe. (Spasova, 2001).

Research indicates that Serbia belongs to the region that is very vulnerable to climate change (UNECE, 2007). The average annual air temperature in Serbia shows a rising trend, while a sudden drop in precipitation during summer is predicted, together with more frequent droughts (PPRS, 2010).

Tourist activities significantly contribute to the global production of carbon-dioxide, by means of transportation, heating, cooling of tourist facilities and other forms of energy use. According to the sources of the European Environment Agency (EEA), tourism is responsible for 5-7% of total CO_2

emission in Europe. The forecast is that by 2035, tourism's contribution to climate change will rise even more. In less than thirty years, if something is not done, CO_2 emissions generated from tourism will be three times higher than they are today.

When speaking of mountain tourist destinations, in which the natural ambience is very important, the overuse of energy is not only an economic, but also an ecological problem that can have very long-term consequences. If there are tourist facilities that use only fossil fuels that pollute air and water in such regions, this can make them less attractive.

To reduce the negative impact of tourism, it is necessary to accept new management techniques and technologies and adopt different strategies that advocate greater energy efficiency and the use of RES.

ENERGY USE IN MOUNTAIN TOURIST CENTERS

The costs of heating on mountains are far greater than at other destinations, family houses, as well as in the secondary and tertiary sector in rural and urban settlements and tourist centers. Fuel from biomass provides more than 90% of energy in mountain areas, and the largest part is based on wood. The use grows with the increase in population and this has a negative impact on nature (Pucar, 2003).

There is practically no use of RES for heating space and water on the mountains of Serbia. With the rise in energy prices and the reduced reserves of wood, the awareness of the need to save energy is slowly rising among the mountain communities.

Tourist facilities on mountains resolve their energy supply problems primarily in the classic manner. In the cost structure of tourist facilities practically 40% accounts for energy (heating space and water, lighting, system maintenance etc.) The part of energy used for heating water in these facilities is somewhere between 13- 15%, which is a big item for hotels, for example, with many beds.

POTENTIALS OF ENERGY SOURCES

When speaking of mountain areas, RES include solar energy, biomass, wind, small hydro-systems, geothermal energy, biogas energy, heat pumps, waste heat etc. Each of these sources has its characteristics and conditions under which they could be used in mountain areas

Thanks to the altitude, incline and other physical properties, the mountains are the global moving force for the production of cleaner, renewable energy. But only few mountains in the world are equipped so that they use the power of RES. Although RES have been familiar to us for ages, only until after the "energy crisis" in 1974, they gain in importance. Nowadays, the opinion prevails that more attention needs to be given to RES; because they are our chance to reduce the consumption of conventional energy sources and increase the use of domestic energy supply potentials.

In the past three decades, in the world, there has been significant progress in the field of research and implementation of a large number of technologies for the use of RES in mountain areas and tourist complexes. Serbia has favorable conditions and potentials for renewable energy use. The development of new technologies that refer, primarily, to low temperature energy supply needs.

STATE OF ENVIRONMENT

Many energy sources that are used in the mountain regions today have a negative impact on sensitive mountain eco-systems. The rise in energy needs and fuel prices has forced many mountain communities to return to non-renewable energy sources, which are harmful to the environment. Nowadays, on mountains, there is more and more polluted and degraded soil, water and air. Many plant and animal species are disappearing, and the surfaces under forests are reducing etc (Pucar, 2004).

Wood will still remain for quite some time the main source of energy for heating, food production and preparation. However, this surpasses sustainable supply. Although wood belongs to RES, its renewal is much slower than its consumption, especially if it is used without control; and deforestation is carried out without planning and professional control. Smoke from fireplaces or stoves used for cooking and heating pollute the environment and harm human health. As the rooms are not aired since this would increase the consumption of fuel, the air is polluted and has a harmful effect on people's health. Medical research and statistics tell about the rise in the number of respiratory illnesses and eye diseases among the inhabitants living on mountains, which is a kind of paradox. Cutting trees in an unsustainable manner leads to erosion, landslides and conditions for the occurrence of avalanches and flooding. Deforestation causes fertile land to disappear along rivers. The consequences are the disappearance of some plant species and the extinction of fish and animals.

SUSTAINABLE TOURISM DEVELOPMENT AND ENERGY

The concept of sustainable tourism implies the interdisciplinary approach in adopting and assessing development strategies and an active participation of all the parties involved in the tourist offer, starting from interested parties, small entrepreneurs, and local home-rules to the society as a whole. The concept of sustainable tourism involves many topics: environmental protection (protection of resources, natural and cultural goods), reduction of greenhouse gas emissions (hereinafter, GGE), application of the principles of energy efficiency and use of RES etc.

The World Summit on Sustainable Development (WSSD) in Johannesburg recognized that the tourism sector is one of the main consumers of energy and, thereby, has set some requirements for the states in which tourism plays a significant role, such as, to improve energy efficiency and adjust their strategy and plans to new development policies. Implementation plans that followed after the Summit are devoted to sustainable tourism development, energy conservation, GGE control, with emphasis on efficient preservation and management of natural resources, especially in sensitive and endangered areas.

Resolving the energy problem in the tourist sector has also become important from the aspect of ecology. It is necessary to reduce any over consumption of fossil energy obtained by the combustion process, with the aim of preventing excessive contamination of an area.

Tourism is one of the most growing industries and businesses in the world. As a big global industrial sector with a significant ecological impact, tourism offers many possibilities for the use of RES and the application of the energy efficiency principles. Environmental awareness is starting to become a component on which can be counted, and tourists often choose destinations in which, in addition to the well-preserved nature also have programs that demonstrate to them that awareness and responsible behavior are on a high level. Preserving the natural component of tourist areas must be a priority in all strategies and development plans, that is why the capacities of the environment are necessary, together with the potentials of the reproduction of natural resources. Therefore, adequate and reliable energy supply is a prerequisite of sustainable development.

It is necessary that energy, economic, and environmental policies and programs take into account, often, sensitive ecosystems and the nature of tourist areas. During every intervention in space that implies a change in landscape or ambience, attention must be given to sustainable development.

A big tourist intake in mountain areas is a burden to the environment; it pollutes air, soil and water. The ruin of natural, and often cultural resources, irresponsible behavior of tourists etc, are only some of problems of the mountains. On the other hand, tourism contributes to the employment of local population and can stimulate development and create better conditions of living for the inhabitants, and it can help preserve nature as well. In the recent years, tourist organizations and individuals have become aware of the importance of environmental protection and the importance of a sustainable tourism concept.

The awareness of the need to substitute fossil fuels and protect the environment is more and more present on all levels of social structure. In the sector of mountain tourism, there is a growing movement named „ecotourism”, which advocates cleaner nature, organic food, water and air, lower energy use for transportation and buildings and the return to Nature. A responsible tourism is tourism which conscientiously manages natural and cultural resources, promotes social and economic development of local communities and protects the environment.

CONCLUSION

Mountains are becoming more and more interesting for the inhabitants living in plains, especially big cities. However, this interest is reflected, above all, in the wish for gaining profit from exploitation of natural goods and resources, without the intention of return and evenly distributing it together with the locals living on the mountains. On mountains, the population is mainly poorer than that in the plains, and it has little power and influence. By returning the power of decision-making to the mountain population and with a protection policy and practice that would provide a fairer approach to the distribution of goods (forests, water and ores), a big step would be made towards reducing the poverty of mountain communities, and finally, a big contribution to the protection of mountain resources.

The development concept of mountain tourism has changed with time, adjusting to the market demands and particularities of natural conditions. Now, there is a trend of developing mountain centers at altitudes above 1600m, as a consequence of technical progress in energy efficiency construction and the decision on how to direct investment funds due to climate change.

The energy potential of mountain areas has been destroyed for a long time, especially in the past century, by excessive use of natural resources and degradation of the ecosystem. Potentials for rationalizing energy use exist, and they imply increasing energy efficiency and using bioclimatic principles of planning and design, as well as returning to local sources and RES, which can be found on the mountains. These sources enable a decentralized energy production, which for mountain communities has a special meaning. Cheaper and more accessible energy would have long-term positive consequences for the population, especially in terms of an increase in the standard and comfort of living. The application of these technologies would also open new jobs and stop the population from moving.

The problem of determining and managing the limit capacity of a tourist area and the impact of climate change on the sustainable and competitive development of tourism is still insufficient, or is not at all present in directing and managing tourism development of Serbia. The mountainous areas cover around 34% of Serbian territory, but only a small part of its different resources has been activated. Because of the many various limitations that exist on the mountain areas of Serbia. There is no systematic and continual scientific research and transformation monitoring, organization and management of mountain area development. Such research should be the base for establishing the norms and standards in planning tourism development and improving management of sustainable tourism development of mountain tourist destinations in Serbia.

One of the key questions is to enable sustainable development of mountain areas and the survival of their local communities by developing tourism and complimentary activities in Serbia. This imposes a responsibility to perceive all the previous mistakes and analyze a partial approach to tourism development on the mountain areas of Serbia, so that factual, not only declarative support could be given to the sustainable development of mountain tourist destinations.

REFERENCES

International Year of Mountains (2002a). Doc.: Energy

International Year of Mountains (2002b). Doc.: Mountains matter

Maksin M., Pucar M., Milijić S., Korać M. (2011). Održivi razvoj turizma u Srbiji i Evropskoj uniji, Monografija, special edition br.67, IAUS, Beograd

Marić I. (2002). Izgradnja u planinskim područjima, raubovanje resursa, odsustvo razvoja, odlazak stanovništva, Konferencija o razvoju planinskih područja Planina 2002, Savez inženjera i tehničara Srbije i Institut za arhitekturu i urbanizam Srbije, Kopaonik, 103-105.

Milijić S., Marić I., Bakić O. (2010). Spatial Organization of Tourism in Function of Mountain Destination Regional Development, SPATIUM International Review, December, No. 22, 19-28.

Milijić, S., Dabić, D., Krunić, N. (2006). Grad u planini ili planina u gradu, Spasić Nenad, Božidar Stojanović (ur.), Održivi grad i njegovo okruženje - 2, Posebna izdanja br. 49, Institut za arhitekturu i urbanizam Srbije, Beograd, 25-43.

Perera O., Hirsch S., Fries P., (2003). Renewable Energy Opportunities in the Turism Industry, UNPE

Popović T., Đurđević V., Živković M., Jović B., Jovanović M., (2009). Promene klime u Srbiji i očekivani uticaji, Peta regionalna konferencija EnE09 - Životna sredina ka Evropi, Ambasadori životne sredine i PKS, 6-11

Pucar M. (2002a). Metodološki pristup za korišćenje lokalnih izvora energije u planinskim područjima Srbije, Naučno stručni skup: Selo u novim razvojnim uslovima, UUS, Mataruška Banja, 333-346.

Pucar M. (2002b). Obnovljivi izvori energije kao potencijal i preduslov održivog razvoja planinskih područja Srbije, Konferencija o razvoju planinskih područja: PLANINA 2002. Savez inženjera i tehničara Srbije i Institut za arhitekturu i urbanizam Srbije, Kopaonik, 77-88.

Pucar M. (2003). Pregled stanja i metodološki postupci za racionalizaciju energije u planinskim područjima Srbije - put ka održivom razvoju, Poglavlje u Monografiji: Preispitivanje pojma održivog razvoja u arhitektonskom i urbanističkom projektovanju i urbanističkom i prostornom planiranju Srbije, edicija: ARHITEKTONIKA, Nađa Kurtović (ur.), Arhitektonski fakultet, Beograd, 110-128.

Pucar, M., (2004). Pristup planiranju i upravljanju energijom u planinskim područjima Srbije – put ka održivom razvoju, Monografija: Strateški okvir za održivi razvoj Srbije, Institut za arhitekturu i urbanizam Srbije, Beograd, 303-312.

Simpson M.C., Gössling S., Scott D., Hall C.M., Gladin E., (2008). Climate Change Adaptation and Mitigation in the Tourism Sector: *Frameworks, Tools and Practices, UNEP,* University of Oxford, UNWTO, WMO: Paris, France

Spasova, D., (2001). Klimatske promene kao posledica antropogenih emisija gasova sa efektom staklene bašte. Okrugli sto: Okvirna konvencija UN o promeni klime i Kjoto protokol, Banja Luka

Sustainable Energy, Progress Report, FAO, June 1997.

UNECE - The United Nations Economic Commission for Europe (2007)

Zakon o Prostornom planu Republike Srbije - PPRS, (2010). („Službeni glasnik RS“, br. 88/10)

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CLIMATE CHANGE AND URBAN POLLUTION

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ABSTRACT

Humans have a significant impact on climate change, through their actions, especially through emissions of greenhouse gases, particularly carbon dioxide (CO_2), which artificially warms the earth’s atmosphere. The average global temperature has increased by 0.74°C since 1900. Storms, droughts, floods and fires are caused by climate change. In addition, climate change has a serious impact on food production, water availability and ecosystems such as forests and wetlands. A severe worry is how rapid climate change will increase existing environmental stresses and contribute to food insecurity and loss of livelihood for millions of people. Some regions in the world will be more affected than others. The greatest global warming is expected to be at high northern latitudes. Learning and using of information are very important, especially in the case of the poor and vulnerable in developing countries, because it is a global responsibility to help these people to adapt. Experts offer a wide range of solutions and in this work will be presented IUCN solutions that help us to adapt to climate change. Moreover, natural resources can also help us adapt to the impact of climate change and it is an opportunity we can not afford to pass up.

Key words*:* changes, humans, global warming, education, solutions.

GLOBAL WARMING

Climate change is happening and humans have a significant impact on climate change, through their actions. The climate change impacts are beginning to be felt and will worsen in the decades ahead unless people take some actions. The serious problem is that Earth has already warmed by 0.7°C since around 1900 and it has influence on further warming over coming years simply due to past emissions. Current trends show that average global temperatures could rise by 2 - 3°C over the next fifty years (see also Table 1). The graph (see also Figure 1) shows predictions for temperature changes through to 2100 relative to pre-industrial levels. Nine illustrative emissions scenarios are shown with the different coloured lines, where the blue shading represents uncertainty between the seven different climate models used and coloured bars show the full range of climate uncertainty in 2100 for each emissions scenario based on the models with highest and lowest climate sensitivity. The basic elements of life for people, such as access to water, food, health and use of land and the environment are affected, too. Climate changes cause problems, particularly in some areas, like:

- Melting glaciers will increase flood risk during the wet season and strongly reduce dry-season water supplies to one-sixth of the world’s population, predominantly in the Indian sub-continent, parts of China, and the Andes in South America.
- Declining crop yields, especially in Africa, are likely to leave hundreds of millions without the ability to produce or purchase sufficient food - particularly if the carbon fertilization effect is weaker than previously thought, as some recent studies suggest. At mid to high latitudes, crop yields may increase for moderate temperature rises (2 – 3°C), but then decline with greater amounts of warming.
- Ocean acidification, a direct result of rising carbon dioxide levels, will have major effects on marine ecosystems, with possible adverse consequences on fish stocks.
- Rising sea levels will result in tens to hundreds of millions more people flooded each year with a warming of 3 or 4°C. There will be serious risks and increasing pressures for coastal

protection in South East Asia (Bangladesh and Vietnam), small islands in the Caribbean and the Pacific, and large coastal cities, such as Tokyo, Shanghai, Hong Kong, Mumbai, Calcutta, Karachi, Buenos Aires, St Petersburg, New York, Miami and London.

- Climate change will increase worldwide deaths from malnutrition and heat stress. Vector-borne diseases such as malaria and dengue fever could become more widespread if effective control measures are not in place. In higher latitudes, cold-related deaths will decrease.
- By the middle of the century, 200 million more people may become permanently displaced due to rising sea levels, heavier floods, and more intense droughts, according to one estimate.
- Ecosystems will be particularly vulnerable to climate change, with one study estimating that around 15 – 40% of species face extinction with 2°C of warming. Strong drying over the Amazon, as predicted by some climate models, would result in dieback of the forest with the highest biodiversity on the planet.[1]

IMPACTS ON CRUCIAL RESOURS

Water

People can already feel the impact of climate changes through changes in the distribution of water around the world. We all know that water is essential resource for life and, also, a requirement for good health. Water is a critical input for almost all production and one of the most important for sustainable growth and poverty reduction. In addition, about 70% of all freshwater supply is used for irrigating crops and providing food in the world. Factories are using 22% for manufacturing and energy (cooling power stations and producing hydro-electric power), whereas only 8% is used directly for drinking, sanitation, and recreation by households and businesses. The serious issue is that droughts and floods will become more severe in many areas. According to the analysis of scientists there will be more rain at high latitudes, less rain in the dry subtropics, and uncertain but probably substantial changes in tropical areas.

When the water cycle intensifies, billions of people will lose or gain water. The consequences for people, through floods or drought, will be determinate by seasonal and annual variability in water supply. The risk of flood will increase by melting glaciers and loss of mountain snow during the wet season and threaten dry-season water supplies to one-sixth of the world's population (over one billion people today). The consequences of this issue will feel people who live in the large parts of the Indian sub-continent, over quarter of a billion people in China, and tens of millions in the Andes.

Food

In some regions such as tropical, even small amounts of warming will lead to declines in income. In higher latitudes incomes may increase initially for moderate increases in temperature but then fall. Substantial declines in cereal production around the world are caused by higher temperatures, especially if the carbon fertilization effect is smaller than previously thought.

Agriculture as a very important part of economy (currently accounts for 24% of world output, employs 22% of the global population, and occupies 40% of the land area, 75% of the poorest people in the world live in rural areas and rely on agriculture for their livelihood) is affected by climate changes, too.

Health

Human health is in danger, because climate change will increase worldwide deaths from malnutrition and heat stress. Some diseases such as malaria and dengue fever could become more widespread if effective control measures are not in place. On the other side, in higher latitudes, cold-related deaths will decrease. Poor populations in urban areas are particularly exposed to disease, which refers to

[1] http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/d/Part_II_Introduction_group.pdf

suffering from poor air quality and heat stress, and they have limited access to clean water. Moreover, in some tropical areas temperatures have already reached the limit of human tolerance.

The World Health Organization (WHO) points on climate change and its effect on human health, showing that climate change since the 1970s is already responsible for over 150,000 deaths each year through increasing incidence of diarrhea, malaria and malnutrition, predominantly in Africa and other developing regions. Newly information from Africa is devastating. According to American estimates, more than 29,000 children under five years in the last three months died of starvation in southern Somalia. The UN estimates that another 640,000 Somali children malnourished acutely, indicating that the increase hunger among the young.

IMPACTS OF CLIMATE CHANGE

The primary cause of contemporary global warming are: greenhouse gas emissions from cars, power plants and other human activities. The greenhouse effect is a naturally occurring process that aids in heating the Earth's surface and atmosphere (see also Figure 2). It results from the fact that certain atmospheric gases, such as carbon dioxide, water vapor, and methane, are able to change the energy balance of the planet by absorbing longwave radiation emitted from the Earth's surface. Without the greenhouse effect life on this planet would probably not exist as the average temperature of the Earth would be a chilly -18°C, rather than the present 15°C.

The combined effect of impacts across several sectors could be very damaging and furthermore it could intensify the consequences of climate change. Slightly work has been done to quantify these interactions, however the potential consequences could be substantial. The consequences of climate change will depend on interaction between physical impacts and socioeconomic factors. Population movement and growth will often worsen the impacts by increasing society’s exposure to environmental stresses and reducing the amount of resource available per person. Otherwise, economic growth often reduces vulnerability to climate change and increases society’s ability to adapt to the impacts.

EXTREME WEATHER EVENTS

Climate changes have very significant impact on lives and live hoods. The consequences of climate changes are illustrated by a large number of costly weather disasters in 2010, which tied 2005 as the warmest year globally since 1880.

These years, 2005 and 2010, were noted for exceptionally damaging weather events, such as Hurricane Katrina in 2005 and the deadly Russian heat wave in 2010. Other significant events, which are happened in 2010, include Pakistan’s biggest flood, Canada’s warmest year and Southwest Australia’s driest year. The beginning of 2011 continued in similar way, with "biblical" flooding in Australia, devastating drought and wildfires in Texas, New Mexico and Arizona, and unprecedented flooding in North Dakota. New indicator of climate changes in 2011 is hurricane Irene in the USA. Bill Read, the Fugate and National Hurricane Center director, said Irene could cause problems even over open water. New England is particularly vulnerable to heavy rains because the soil is already saturated from summer storms, which could raise the threat of flash flooding.

The most important fact is that 2010 was one of the warmest years on record as well as one of the most disastrous, and it requires a considerable answer to question: Is global warming causing more extreme weather? This answer is short and simple: yes, at least for heat waves and heavy precipitation. The climate change’s impacts will become increasingly serious at higher temperatures, especially because of rising risk of triggering abrupt and large-scale changes, such as melting of the Greenland ice sheet or loss of the Amazon forest.

TECHNOLOGICAL SOLUTIONS

According to scientists it won't be easy to avoid the worst effects of climate change, because it will require action across all sectors of the economy, from electricity and transportation to agriculture.
For achieving cost-effective emission reductions and emerging technologies hold promise for delivering, even more emission reductions, in the future exist a portfolio of technologies. Governments, in the world, at all levels need to encourage short-term action to reduce emissions and to prepare plan for a long-term technology revolution. Meanwhile, the most important is that world change the way it produces and consumes energy. It is crucial to begin making the necessary investments in new technologies as a way to avert dangerous levels of global warming. Some emission reducing technologies, like wind power, hybrid gasoline-electric cars, solar energy, carbon capture and storage are advancing rapidly.

IUCN SOLUTIONS[2]

Conserving nature can help reduce greenhouse gas emissions (mitigation) and help us adapt to the impacts of climate change. Biodiversity can do for the planet what a healthy immune system can do for an individual: it can help us be more productive and adaptable to change but its loss can make us more vulnerable.

For several years, the world has been investing in technology and engineering to fight climate change. Technology is a vitally important part of efforts to tackle climate change. We already know how to manage, conserve and restore nature for the benefits it can provide.

IUCN's work puts nature at the center of climate change solutions. Healthy natural systems are critical for absorbing and storing carbon and helping us adapt to climate change. It is estimated that 17% of greenhouse gas emissions result from deforestation and forest degradation. Better managing forests, peat lands or mangroves can store substantial amounts of carbon. When developed in an equitable and sustainable manner, mechanisms such as Reducing Emissions from Deforestation and forest Degradation (REDD) can reduce emissions, conserve biodiversity and enhance human well-being.

People depend on natural resources for food, fuel and drinking water. The management, conservation, and restoration of ecosystems, known as ecosystem-based adaptation, can ensure that ecosystems continue to provide the services that enable people to adapt to climate change impacts.

EDUCATION

It is very important that people comprehend the importance of climate change, its impact on their life and what they can do to avoid climate change. However, the most important is to help children to understand climate change. The Pew Center collaborated with Nickelodeon to research children's and parent's attitudes and behaviors toward the environment. Nickelodeon implemented an interactive campaign called The Big Green Help and provides answers to six key questions about warming:

- Wait until you have a lot of clothes to wash before using the washing machine. Don't use the machine for one item just because it's your favorite shirt.
- Turn off the lights when you leave a room. Use fluorescent bulbs in your room.
- Turn off your computer or the TV when you're not using it. Unplug chargers when not in use.
- Close the blinds on a hot day if the sun is shining in. Dress lightly instead of turning up the air conditioning. Or use a fan.
- Dress warmly inside your house when it's cold, instead of turning up the heat.
- Bike or walk short distances instead of asking for a ride in a car.
- Take shorter showers. Heating water uses energy.

[2] http://www.iucn.org/what/tpas/climate/solutions/

– Plant a tree.

CONCLUSION

Poor countries and people, who live there, are the most affected by climate change, thanks to the impact of emissions coming from rich countries. Therefore, it is important to have in mind the ethical arguments and find a way to help these countries. It is necessary to find a way how to delegate the responsibilities to reduce the impact of climate change, but should take into account the costs and capabilities of developed countries. For instance, the European Council in March 2005 declared that it was ready to begin research with developed countries, whose aim is reducing the emissions for 15-30% by 2020. It is crucial to take actions to prevent that the level of greenhouse gases reach to a critical point. Actions (Figure 3) must include mitigation of climate impacts and implementation of innovations. There are great opportunities, which can be based on the current pilot programs to develop experiences that will help in the future. It is necessary for countries to establish mutual cooperation, a partnership between the public and private sectors, as well as work with individuals and the entire society. It is possible to avoid the worst effects of climate change if we take common steps, starting from today. We shouldn’t forget the fact that we have not received this Earth from their fathers, but we borrowed from our children.

TABLES AND FIGURES

Table 1: Highlights of possible climate impacts discussed in this chapter[3]

Temp rise (°C)	Water	Food	Health	Land	Environment	Abrupt and Large-Scale Impacts
1°C	Small glaciers in the Andes disappear completely, threatening water supplies for 50 million people	Modest increases in cereal yields in temperate regions	At least 300,000 people each year die from climate-related diseases (predominantly diarrhoea, malaria, and malnutrition) Reduction in winter mortality in higher latitudes (Northern Europe, USA)	Permafrost thawing damages buildings and roads in parts of Canada and Russia	At least 10% of land species facing extinction (according to one estimate) 80% bleaching of coral reefs, including Great Barrier Reef	Atlantic Thermohaline Circulation starts to weaken
2°C	Potentially 20 - 30% decrease in water availability in some vulnerable regions, e.g. Southern Africa and Mediterranean	Sharp declines in crop yield in tropical regions (5 - 10% in Africa)	40 – 60 million more people exposed to malaria in Africa	Up to 10 million more people affected by coastal flooding each year	15 – 40% of species facing extinction (according to one estimate) High risk of extinction of Arctic species, including polar bear and caribou	Potential for Greenland ice sheet to begin melting irreversibly, accelerating sea level rise and committing world to an eventual 7 m sea level rise
3°C	In Southern Europe, serious droughts occur once every 10 years 1 - 4 billion more people suffer water shortages, while 1 – 5 billion gain water, which may increase flood risk	150 - 550 additional millions at risk of hunger (if carbon fertilisation weak) Agricultural yields in higher latitudes likely to peak	1 – 3 million more people die from malnutrition (if carbon fertilisation weak)	1 – 170 million more people affected by coastal flooding each year	20 – 50% of species facing extinction (according to one estimate), including 25 – 60% mammals, 30 – 40% birds and 15 – 70% butterflies in South Africa Collapse of Amazon rainforest (according to some models)	Rising risk of abrupt changes to atmospheric circulations, e.g. the monsoon Rising risk of collapse of West Antarctic Ice Sheet Rising risk of collapse of Atlantic Thermohaline Circulation
4°C	Potentially 30 – 50% decrease in water availability in Southern Africa and Mediterranean	Agricultural yields decline by 15 – 35% in Africa, and entire regions out of production (e.g. parts of Australia)	Up to 80 million more people exposed to malaria in Africa	7 – 300 million more people affected by coastal flooding each year	Loss of around half Arctic tundra Around half of all the world’s nature reserves cannot fulfill objectives	
5°C	Possible disappearance of large glaciers in Himalayas, affecting one-quarter of China’s population and hundreds of millions in India	Continued increase in ocean acidity seriously disrupting marine ecosystems and possibly fish stocks		Sea level rise threatens small islands, low-lying coastal areas (Florida) and major world cities such as New York, London, and Tokyo		
More than 5°C	The latest science suggests that the Earth’s average temperature will rise by even more than 5 or 6°C if emissions continue to grow and positive feedbacks amplify the warming effect of greenhouse gases (e.g. release of carbon dioxide from soils or methane from permafrost). This level of global temperature rise would be equivalent to the amount of warming that occurred between the last age and today – and is likely to lead to major disruption and large-scale movement of population. Such “socially contingent” effects could be catastrophic, but are currently very hard to capture with current models as temperatures would be so far outside human experience.					

[3] http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/d/Part_II_Introduction_group.pdf

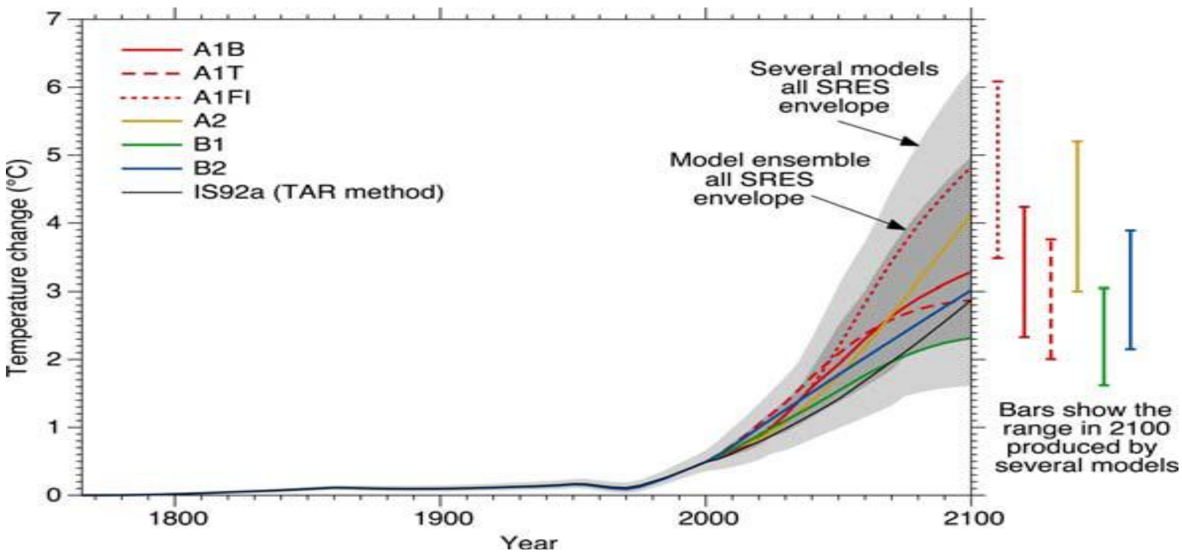

Figure 1. Temperature projections for the 21st century[4]

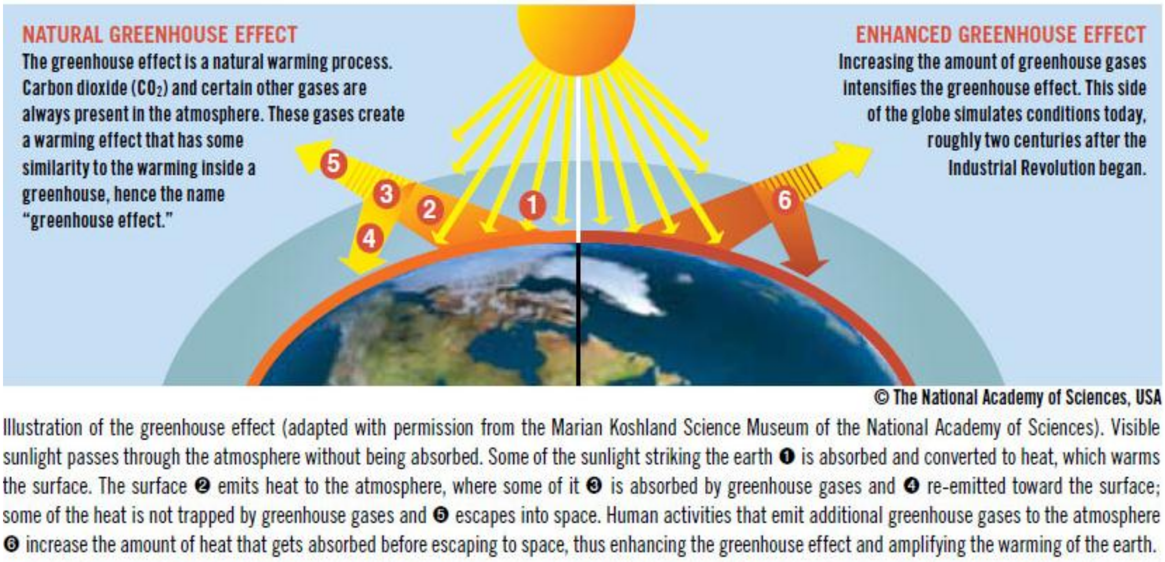

Figure 2. The Greenhouse effect[5]

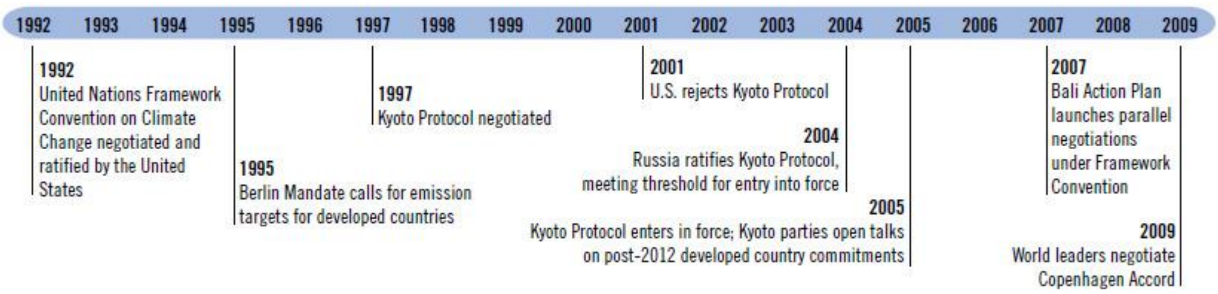

Figure 3. International action[6]

[4] http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/d/Part_II_Introduction_group.pdf
[5] http://www.pewclimate.org/docUploads/Climate101-FULL_121406_065519.pdf
[6] http://www.pewclimate.org/docUploads/Climate101-FULL_121406_065519.pdf

REFERENCES

Al Gore (2009). Our Choice: A Plan to Solve the Climate Crisis. USA: Rodale Books.
Jonathan M. Harris (2005). Environmental and natural resource economics: a contemporary approach. Boston, MA: Houghton Mifflin.
www.pewclimate.org
www.iucn.org
www.ipcc.ch
www.earthtrends.wri.org

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ECONOMIC SITUATION CAUSED BY CLIMATE CHANGE

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ABSTRACT

Climate change is a term that describes average changes in temperature or precipitation, however most of the social economic costs associated with climate change will result from transitions in the frequency and severity of extreme events. A large number of costly weather disasters in 2010 illustrates this fact, which marked 2005 as the warmest year globally since 1880. Life and economic systems are based on the building blocks, precisely on water, food, shelter and energy. The resilience of the global economy is closely connected to the state of the environment. Ecological economics and environmental economics are the two intricately related disciplines, which are specifically dedicated to the economic analysis of the relationship between humans and the environment. Business is a key driver of social and economic development because billions of people work in the private sector. In the current global recession now, more than ever, people should invest in nature to drive sustainable economic and social growth. The global economic crisis is still having far-reaching consequences and it has put pressure on world leaders to rethink about their economic policies.

Key words: costs-growth, green economy, New Source Performance Standards (NSPS), China, ecotourism.

ECONOMY WITHOUT ECOLOGY IS ECONOMY OF DEATH

Many complex policy problems are caused by the impacts of climate change, which are very broad ranging and interact with other market failures and economic dynamics. It's crucial to analyze ideas and techniques from most of the important areas of economics, including many recent advances.

We are witnesses that climate change has serious impacts within the lifetime of most of those alive today, and it will have more and more. In addition, future generation will be more strongly affected, than the present generation. It's very important to know that the impacts of climate change on economies and societies worldwide could be large relative to the global economy. Especially, it can't be assumed that the global economy, net of the costs of climate change, will grow at a certain rate in the future, despite of decision to choose together to reduce GHG (greenhouse gas) emissions. The impacts of climate change will be large relative to the global economy, without action to prevent climate change and nations will take a serious risk. This action requires countries to participate voluntary in a sustained, coordinated, international effort. Meanwhile, there are also significant gains to co-operating across borders, such as undertaking emission reductions in the most cost-effective way. Although adaptation to climate change will often deliver some local reduction in its impact, there are some countries which are most vulnerable to climate change and particularly short of the resources to invest in adaptation.

COSTS VS GROWTH

If damages increase, as expected, losses could potentially reach several percent of world GDP (Gross domestic price) in a highly non-linear manner. Extreme weather conditions, such as higher temperatures, will increase the risk of triggering abrupt and large-scale changes in the climate system. On the other side, monsoon failure or loss of glacial melt water, could have devastating effects in developing countries, specifically on food and water availability, and trigger large-scale population movement and regional conflict. All these effects may deteriorate existing political tensions and, also, could drive greater global instability.

The extreme weather events, like storms, droughts, heat waves and floods will increase the costs rapidly at higher temperatures, potentially counteracting some of the early benefits of climate change. Furthermore, the costs of extreme weather alone could reach 0.5 - 1% of world GDP by the middle of the century and will keep rising as the world warms. Statistics are devastating, in terms of costs of the extreme weather:[1]

- Damage from hurricanes and typhoons will increase substantially from even small increases in storm severity, because they scale as the cube of wind speed or more. A 5 – 10% increase in hurricane wind speed is predicted to approximately double annual damages, resulting in total losses of 0.13% of GDP each year on average in the USA alone.
- The costs of flooding in Europe are likely to increase, unless flood management is strengthened in line with the rising risk. In the UK, annual flood losses could increase from around 0.1% of GDP today to 0.2 – 0.4% of GDP once global temperature increases reach 3 to 4°C.
- Heat waves like 2003 in Europe, when 35,000 people died and agricultural losses reached $15 billion, will be commonplace by the middle of the century.

Higher temperatures lied to a growing risk of large-scale shocks in developed economies. These extreme weather events could have influence on trade and global financial markets through disruptions to communications and more volatile costs of insurance and capital. Social and economic consequences of very high temperatures could devastate the major areas of the world.

Climate change will affect economic output in the developed world through several different ways, which includes the availability of commodities essential for economic growth, such as water, food and energy. Nevertheless, it will be possible to moderate increased costs via adaptation, this in itself will involve additional expenditure.

Some studies showed that Canada and Russia would both see a 30% increase in tourists with just 1°C of warming. However, mountain regions like the Alps have a huge problem, because these regions rely on snow for winter recreation and they may experience significant declines in income. On the other side of the world, Australia’s $32 billion tourism industry will suffer from almost complete bleaching of the Great Barrier Reef.

IMPACTS OF EXTREME EVENTS[2]

Increases in extreme events will be particularly costly for developed economies, which invest a considerable amount in fixed capital each year (20% of GDP or $5.5 trillion invested in gross fixed capital today).

The costs of extreme weather events are already high and rising, with annual losses of around $60 billion since the 1990s (0.2% of World GDP), and record costs of $200 billion in 2005 (more than 0.5% of World GDP).

New analysis based on insurance industry data has shown that weather-related catastrophe losses have increased by 2% each year since the 1970s over and above changes in wealth, inflation and population growth/movement.

If this trend continued or intensified with rising global temperatures, losses from extreme weather could reach 0.5 - 1% of world GDP by the middle of the century. If temperatures continued to rise over the second half of the century, costs could reach several percent of GDP each year, particularly

[1] http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/d/Part_II_Introduction_group.pdf
[2] http://webarchive.nationalarchives.gov.uk/+/http://www.hm-treasury.gov.uk/d/Part_II_Introduction_group.pdf

because the damages increase disproportionately at higher temperatures (convexity in damage function).

COSTS OF COASTAL FLOODING IN DEVELOPED COUNTRY REGIONS

If rapid rates of warming continue to grow, particularly if one of the polar ice sheets begins to melt significantly (Greenland) or collapses (West Antarctic), this will cause a rise in sea level by 1-m. Particularly, in Europe, sea level rise will affect many densely populated areas, because an area of 140,000 km^2 is at the moment within 1-m sea level. According on today's population and GDP, an increase of sea level would affect over 20 million people and put an estimated $300 billion worth of GDP at risk. The most vulnerable European country if the sea level rise is the Netherlands, because of its depression, and with around 25% of the population potentially flooded each year for a 1-m sea level rise.

In the Figure 1 are shown projected costs of coastal flooding over the period 2080-2089 under two different sea level rise scenarios. In addition, these costs were calculated as net present value in US $ billion (1995 prices) and damage costs include value of dry land and wetland lost and costs of displaced people. The costs of protection include costs to protect against permanent inundation, however infrastructure damage from storm surges is not included.

CLIMATE CHANGE AND CONSTRAINTS ON INSURANCE CAPITAL

The insurance industry is very important and specific, because it requires sufficient capital to bridge the gap between losses in an average year, which are covered by premium income, and those in an "extreme" year. Nowadays, this industry holds around $ 120 billion to cover extreme losses from natural weather catastrophes, such as hurricanes, typhoons and winter storms.

A smaller amount than the extreme losses (in the graphic are shown as a 1 in 250 year event) will increase average annual losses (or expected losses), with the result that the amount of capital that insurers are required to hold to deal with extremes increases (Figure 2).

The predictions shows several climate models for a doubling of carbon dioxide or a 3°C rise in temperature and if this happens, where storm intensity increases by 6%, this could in crease insurers' capital requirements by over 90% for US hurricanes and 80% for Japanese typhoons – an additional $76 billion in today's prices.

SUMMARY COSTS OF EXTREME WEATHER EVENTS IN DEVELOPED COUNTRIES WITH MODERATE CLIMATE CHANGE

Climate change cause the costs for developed countries which could reach several percent of GDP as higher temperatures lead to a sharp increase in extreme weather events and large-scale changes. In many developed countries, higher temperatures (2 or 3°C) may increase economic output through greater agricultural productivity, reduced winter heating bills and fewer winter deaths. Nevertheless, in some developed regions which have existing water shortages, rising temperatures could lead to increasing evaporation and dry out land that is already dry (Southern Europe, California, South West Australia). In these situations, water shortages will increase the investment required in infrastructure, reduce agricultural output and increase infrastructure damage from subsidence.

Table 1 shows the summary of costs of extreme weather events in developed countries with moderate climate change. As higher temperatures lead to more intense extreme weather events and the risk of triggering abrupt and large-scale changes the costs are likely to rise sharply. Nowadays trends show that there is little robust quantitative information for the costs at even higher temperatures (4 or 5°C), which are plausible if emissions continue to grow and feedbacks amplify the original warming effect (such as release of carbon dioxide from warming soils or release of methane from thawing permafrost).

THE GREEN ECONOMY

According to the United Nations Environment Programme (UNEP), "Greening the economy refers to the process of reconfiguring businesses and infrastructure to deliver better returns on natural, human and economic capital investments, while at the same time reducing greenhouse gas emissions, extracting and using less natural resources, creating less waste and reducing social disparities."

Life and economic systems are built from the building blocks which include water, food, shelter and energy. State of the environment is closely linked to the resistance of the global economy. In addition, business also affects and needs biodiversity. The reason for that is the fact that billions of people work in the private sector and moreover, business is a key driver of social and economic development. It's becoming more obvious that some are beginning to see the value of biodiversity and the need to protect it, and finally the need to invest it. Business world is facing with the global recession and stimulative investments coming from governments, and now is important, more than ever, to invest in nature to drive sustainable economic and social growth.

Private enterprises are best exploit a strengthened biodiversity case. Private companies will have a leading role in the greening of the economy, notably by mobilizing the necessary resources for investing in sustainable projects. Nevertheless, it is not always simple to get private companies to change their usual business models, regardless there are likely to be significant opportunities for business who pro-actively engage in the transition to a green economy.

Scientists agree that the 'green' economy can be considered synonymous to a 'sustainable' economy. On the other hand, concept of the Green Economy carries a more distinctive meaning, one that focuses specifically on the fundamental changes that are required to ensure that economic systems are made more sustainable. Ambitious and forward looking views on how to overcome the deeply rooted causes of unsustainable economic development animate the ongoing discourse on the Green Economy. In addition, it has three main objectives of 1) reviving the world economy, saving and creating jobs, and protecting vulnerable groups; 2) promoting sustainable and inclusive growth and the eradication of extreme poverty by 2015; and 3) reduce carbon dependency and the degradation of ecosystems. The green economy discourse is more focused on the issue of jobs. Furthermore, a functional green economy will need to ensure that it is supporting the foundation of any sustainable economic system: employment.

IUCN presents some facts, which are related to the green economy[3]:

- Each year, we are losing ecosystem services worth an estimated EUR 50 billion from land-based ecosystems alone.
- While 35% of the Earth's surface is already dedicated to agriculture, irrigated crop production will need to increase by 80% by 2030 to match rising demand.
- In the Caribbean, the direct result of coral reef destruction has resulted in a 20% decline in tourism revenues (equal to approximately US$ 300 million per year).
- The overall costs and risks of climate change will be equivalent to losing up to 20% of global GDP each year, while the costs of action now can be limited to around 1% of global GDP each year.

According to IUCN critical steps in the necessary transition to a greener economy include[4]:

- Achieve a fuller integration of biodiversity and ecosystem values into economic policy, finance and markets **-** Strengthen the biodiversity business case through the generation of knowledge and awareness on the different forms and contributions of biodiversity and ecosystem values. Enhance the capacity of decision-makers to adequately account and manage for biodiversity and ecosystem values.

[3] http://iucn.org/what/tpas/greeneconomy/about/
[4] http://iucn.org/what/tpas/greeneconomy/about/

- Empower private sector companies to lead the way to the development of more sustainable business models and practices **-** Develop best-practice guidance and standards for advancing sustainability in key industry sectors, such as agriculture, extractives, and tourism.
- Make greater and smarter investments in nature-based markets and enterprises**-** Encourage the establishment and growth of innovative markets for public environmental goods and services, such as trading in carbon credits and banking of wetlands. Support the development of sustainable enterprises in areas such as renewable energy, organic agriculture and ecotourism.

NEW SOURCE PERFORMANCE STANDARD (NSPS)

The Environmental Protection Agency (EPA) is required by The Clean Air Act to regulate pollution from new, modified and reconstructed facilities through the New Source Performance Standards (NSPS) program, established in Sec. 111 of the Act. These standards are technology-based standards which apply to specific categories of stationary sources. During 2010 judicial settlement, EPA committed to promulgating NSPS for greenhouse gases for two existing source categories: power plants (to be finalized in May 2012) and refineries (to be finalized in November 2012).

This agency must establish performance standards for new and modified sources. An NSPS requires facilities to attain an emissions level that "reflects the degree of emissions limitation achievable through the application of the best system of emissions reduction which (taking into account the cost of achieving such reduction and any non air quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated."[5] The technological options available for emissions reduction must be reviewed by EPA and it should establish a new standard every eight years. Moreover, EPA is required to set standards for existing stationary sources. In using this section, EPA designates categories and establishes guidelines for setting minimum technology-based standards, and states are delegated the authority for establishment, implementation, and enforcement of these performance standards.[6] In addition, it is important to mention that EPA will issue a proposed NSPS for power plants by October 2011 and a proposed NSPS for refineries by December 2011.

ECOTOURISM

The International Ecotourism Society (TIES) gives a definition of ecotourism and they define ecotourism as "Responsible travel to natural areas that conserves the environment and improves the well-being of local people."

The fact is that tourism may have a number of direct and indirect impacts on biodiversity, like land use conversion, disturbance of species, unsustainable consumption, discharge of waste, pollution and other emissions. There are some estimates which suggest that tourism is responsible for approximately 5 percent of total greenhouse gas emissions, with a predicted rise to 10–20 percent by 2030.

TIES have developed an ambitious set of ecotourism principles, namely to[7]:
- Minimize impact.
- Build environmental and cultural awareness and respect.
- Provide positive experiences for both visitors and hosts.
- Provide direct financial benefits for conservation.
- Provide financial benefits and empowerment for local people.
- Foster sensitivity to host countries’ political, environmental, and social climate.
- Support international human rights and labor agreements.

[5] http://www.pewclimate.org/publications/new-source-performance-standards-nsps
[6] http://www.pewclimate.org/publications/new-source-performance-standards-nsps
[7] http://data.iucn.org/dbtw-wpd/edocs/2008-002.pdf

Figure 3 shows the growth in international tourist arrivals. Tourism is a huge industry. It is an important pillar of many economies that generates billions of dollars annually. Without revenues from tourism even the world's strongest and most prosperous countries could shake. Despite the economic downturn, which has stopped many people from traveling, the world's most popular destinations still receive enormous numbers of visitors, who leave enormous amounts of money in the pockets of their hosts.

Ecotourism is making direct, significant contributions to biodiversity conservation and numerous examples prove that. One of examples is through revenue which is generated to support protected areas, because these areas generate significant revenue from visitor fees collected at the point of entry or as user fees applied as, for example, part of an overall package cost.

Specific investment opportunities include[8]:

- Invest in ecotourism companies that can then take on the (business) management of tourism concessions in national parks. These investments could range from joint partnerships with existing ecotourism or hotel management companies to the creation of new companies. Any tourism facilities / operations would need to be certified according to credible standards.
- Investment in joint ventures (public–private partnerships), particularly between communities and the private sector (and government), based on participatory and equitable negotiations.
- A variation on this theme would be to invest in and / or create a ‘chain’ of ecotourism hotels and related operations – with well-designed facilities, professional management, centralized ‘back office’ operations, and a common promotional strategy – to create a brand that is synonymous with the highest ecotourism standards.
- Invest in existing eco-funds, and / or create new investment funds, that include ecotourism in their portfolios.
- In the generation of sustainable livelihoods via businesses that value biodiversity, there are opportunities to improve marketing (from product development to distribution); performance indicators to measure conservation results and poverty reduction; improved procedures for knowledge transfer between different projects, and investment in small / community-based operators whose services and products can be integrated in the mainstream tourism industry.

CHINA

China's green tech industry raked in 44 billion euros ($ 63.9 billion) last year, making the Asian giant the world's leading green IT producer in terms of revenue. According to a report by The Associated Press, the study also revealed that the China ranked second only to Denmark in terms of how much the green technology sector contributes to a country's gross domestic product (GDP). This market segment contributed 1.4 percent of China's GDP, compared with Denmark's 3.1 percent where the green tech industry generated revenues totaling 6.5 billion euros ($11.7 billion), which was commissioned by the World Wildlife Fund for Nature (WWF). China is a great investor in low-carbon technologies and is increasingly "making things happen".

China's vast market and economies of scale are bringing down the cost of solar and wind energy, as well as other environmentally friendly technologies such as electric car batteries. Their government is backing the trend. It wants to replicate the success of the special economic zones that transformed cities such as Shenzhen from a fishing village near Hong Kong into one of the biggest manufacturing export centers in the world. China has a technological lead in turning coal into gas. It has been using the technology widely to make petrochemicals and fertilizers as a substitute for pricier natural gas. Houston-based Future Fuels LLC has licensed gasification technology from China to use in a plant in Pennsylvania.

Climate change is not a domestic issue, but instead a matter of international strategy with a global impact. More importantly, the positive involvement of countries such as China, Brazil and India will

[8] http://data.iucn.org/dbtw-wpd/edocs/2008-002.pdf

serve as role models and a moral standard for other nations, helping to form a post-Kyoto framework. China`s transition to a green economy will be a model for other developing nations and will be China`s contribution to the world.

CONCLUSIONS

It is very important that the economics provide a strong foundation for developing policy frameworks to guide action, reducing the costs by providing flexibility over how, when and where emissions are reduced. These costs of acting on climate change will be manageable if the right policy frameworks are in place.

In addition, countries should know that the key building blocks for any collective action include:
• Developing a shared understanding of the long-term goals for climate policy
• Building effective institutions for co-operation
• Creating the conditions for collective action.

The institutions for monitoring, reporting and verification of emissions, which are established under the UNFCCC and Kyoto Protocol, have laid important foundations and should form a key element of continuing co-operation. However, these institutions are just a beginning: the challenge is to expand the scale of activities and put them on a secure footing for sustained and long-term action.

Therefore, a transformation of flows of carbon finance, which are linked to strong and effective national policy in developing countries, will be required to support the transition to a low-carbon global economy. Moreover, the other sources of finance are also important and required to work alongside the carbon markets, including the Global Environment Facility and the range of instruments available to the IFIs. They have a significant role in accelerating the process: the establishment of a Clean Energy Investment Framework by the World Bank and the regional development banks have significant potential to do this.

TABLES AND FIGURES

Table 1: Summary costs of extreme weather events in developed countries with moderate climate change

Region	Event Type	Temperature	Costs as % GDP	Notes
Global	All extreme weather events	2℃	0.5 - 1.0% (0.1%)	Based on extrapolating and increasing current 2% rise in costs each year over and above changes in wealth
USA	Hurricane	3℃	0.13% (0.06%)	Assumes a doubling of carbon dioxide leads to a 6% increase in hurricane windspeed
	Coastal Flood	1-m sea level rise	0.01 – 0.03%	Only costs of wetland loss and protection against permanent inundation
UK	Floods	3 – 4℃	0.2 – 0.4% (0.13%)	Infrastructure damage costs assuming no change in flood management to cope with rising risk
Europe	Coastal Flood	1-m sea level rise	0.01 - 0.02%	Only costs of wetland loss and protection against permanent inundation

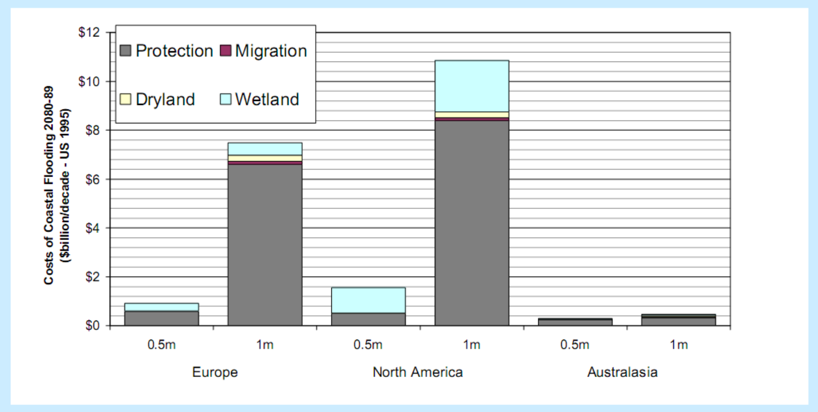

Figure 1. Projected costs of coastal flooding over the period 2080-2089 under two different sea level rise scenarios

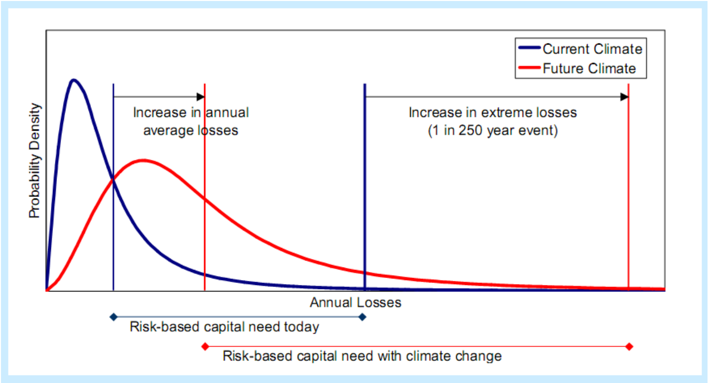

Figure 2. Climate change and constraints on insurance capital

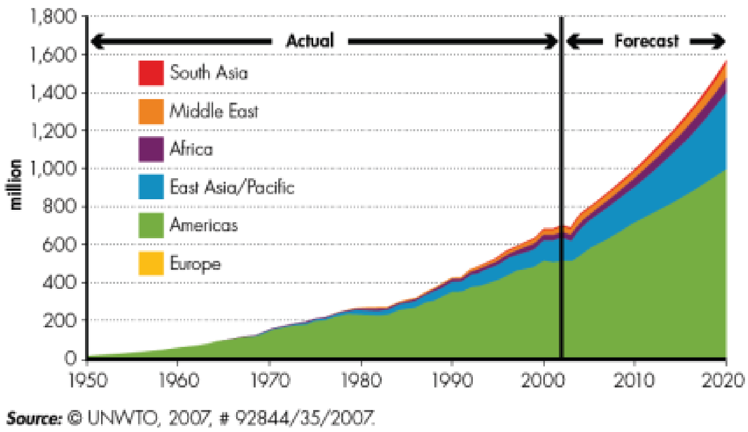

Figure 3. The growth of international tourist arrivals

REFERENCES

Al Gore (2009). Our Choice: A Plan to Solve the Climate Crisis. USA: Rodale Books.

Jonathan M. Harris (2005). Environmental and natural resource economics: a contemporary approach. Boston, MA: Houghton Mifflin.

Alan Beeby, Anne-Maria Brennan (2008). First ecology: ecological principles and environmental issues. Oxford, UK: Oxford University Press.

www.pewclimate.org

www.iucn.org

www.ipcc.ch

www.earthtrends.wri.org

SPATIAL PLANNING AND GREENING IN URBAN AREAS

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REDEFINING THE APPROACH TO STRUCTURING INFORMATION SUPPORT CLIMATE-CONSCIOUS BEHAVIOR IN URBAN AREAS

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ABSTRACT

Modern urban planning and design uses numerous information tools to support the formulation of sustainable strategies aiming to achieve a qualitative shift in climate-sensitive behavior of players in urban development. Nevertheless we are still witnessing offensive urban growth and growing negative, for the urban ecology, urban development trends. The conventional language of ecology and limits of growth is clearly not a motivating and compelling enough to reach all those whose "irresponsible" behavior reflects the frightening data on global climate change. The question is how and what "language", which "metric" to use to express and explain urban eco-dimensions to actors, not only in situations related to decision making, but also at the level of everyday behavior. The answers to this question may be found not only in conventional approaches to quantification and measuring, but also in terms more integrated approach including the qualitative methods of applied social psychology, which deals with the nature of individual and collective cognitive processes and their evolution. This paper aims, trough this targeted research, to come to the principles of information support structuring, important for climate-conscious behavior awareness raising process, which would create conditions for further improvement of methods and institutional and organizational settings of information support.

Key words: climate change, human behavior, integral framework, integral sustainability approach, quadrant analysis

PLANNING INFORMATION SUPPORT STRUCTURING – IDENTIFING THE PROBLEM

Problem scope

Climate change is now recognized as one of the most challenging and complex problems facing humanity and it calls for urgent action worldwide. Problem is real, the stakes are high, and there is no single solution (IPCC, 2007a). Actions taken over the next decade will have an enormous influence on the rate and magnitude of climate change that will take place over the next centuries, and both adaptation and mitigation are seen as necessary responses (Parry, et. al., 2008, Schellnhuber, 2008). The implications of climate change (poverty, disease, conflicts, environmental degradation, and so on) are serious and can be considered as the biggest environmental threat in human history and as the defining human development challenge for the 21st century (Stern, 2006, IPCC, 2007b, UNDP, 2008). Climate change is not simply an environmental problem, it is about human capacity of individuals and communities to respond to threats (Barnett, Matthew, & O'Brien, 2008), it is closely related to how humans perceive themselves in the world, how humans both create and respond to change, how we sustain our development in balance with nature (O'Brien, 2009).

> *"Tackling the immense and multidimensional challenge of climate change demands extraordinary ingenuity and cooperation. A climate-smart world is possible in our time - yet, affecting such a transformation requires us to act now, act together and act differently"(WB, 2010).*

If we take as a starting point globally accepted and institutionalized validity of the sustainability commitments in which we define our common beliefs about what is *good* today and for future generations, then the question is how is it possible that the local objectives that are formulated from them, remain at the level of declarative and general acceptance (Nikezić, 2010, Bajić Brković, 2010). Why is that, in real life, starting from these *higher* defined objectives and goals we finish with the local behaviors that are ultimately unsustainable locally or globally? In context of tremendous climate change paradigm of sustainability puts people and human action in the focus. When the question of governing and planning sustainability to adapt and mitigate climate constraints is aroused, than the subject of discussion is actually narrowed down to issues of decision making effectiveness that produces human behavior change in line with global issues. If we start from the fact that human behavior is changeable category and itself subject to development, as cultural sociology claims, then we should focus on the *ways and means* of achieving these *good* sustainable patterns of human behavior for the context of climate change.

So, the main question for us – urban designers, planners, or governance employees on a city level, for example in Serbia (less developed country, which adopted international policies on sustainability and climate change) is: what do we need in order to be able to govern human behavioral change to a more climate responsive one? Do we have to change the organizational and institutional systems? Or to plan differently, in order to be able to develop creative new measures? Or may be when we plan we have to change the scope of issues that we take into account? Do we have all information necessary? How to formulate measures that people will accept and perform? Do we need to improve communication?

SERACH FOR NEW CONCEPTS OF INFORMATION SUPPORT STRUCTURING

All questions, presented above are action motivated, with aim of planning capacity and capability improvement, from the point of view of belief that planning and governance are professions with the mission to lead change in agreed and desired direction. We are in search of new theoretical concepts and methodological approaches that will improve planning practice in our, Serbian, context. Therefore, in next chapter we will first focus on theoretical background of planning information support issues, using qualitative content analysis method and than, according to analytically identified needs, search for the new theoretical concepts that we estimate that will help us to redefine information support in a direction more appropriate for our context to deal with climate change constraints. New concept will be first presented in its basic content and than analyzed from the point of view of its appropriateness of use for facing the climate change issues.

Critical view of conventional approach to planning information support structuring

The information support for decision making in planning and governance tremendously developed in past three decades due to ICT and Internet revolution. From the point of view of planning profession it contributed mostly to efficiency, but also effectiveness: now we can plan with deeper understanding taking in account so many data, we perform complex multi-criteria analysis, we model, we simulate. Fantastic research results that can be found on the global scientific scene on information data bases and on top of that expert systems, support planning systems, decision support systems, systems to support public participation, etc. But still, it is not leading us to higher decision making effectiveness: the trends after our plan adoption are still negative, or with narrow or slow change impact. Why?

When we plan we are relying on tremendously developed quantitative approach methods and techniques, which were derived from traditional and rational theoretical approach to planning. Even now, in *post*-postmodern, information society we evaluate policies and plans qualities according the indicators reports and cross-referenced analysis, i.e. on quantitative interpretation of goals firstly formulated in qualitative way. It is undoubtedly very operative but, as praxis shown, obviously not enough in terms of planning effectiveness (Lalović K., 2010a). Social sciences "break trough" in planning theory (especially u Europe) was attempt to introduce issues of *quality* in planning, by focusing on: communication in consensus building or decision making, common understanding in collaboration or deliberative planning in community arena (Healey, 1997, Forester, 1998, et, al). In these circumstances first it was recognized that planner's language is unintelligible to most of the participants, so a palette of ICT tools to support multimedia and visual accessibility of information was developed.

But experience so far is: in spite of developed many ICT support tools and effective group facilitation methods and techniques we are still not able to capture all information or knowledge captured in “interior” of actors, due to power manipulation, declarative commitments, oppressive post planning behavior still occurs (Healey, 2006, Innes & Booher, 2002, Shonwandt, 2007, Yiftachel & Huxley, 2000, Lalović K., 2010a). Participatory, collaborative situations brought up the problem of “language” and “metrics” understandable by all (Adams, 2006, O’Brien, 2009, Hamilton, 2006, et.al.), and normative nature of sustainability is making these problems even more visible and substantial (Adams, 2001, Muhutdinova, 2006, Brown R. L., 2006). Experience shows that in these situations, information support (ICT or else) modeled by *planners* logic does not provide adequate information for all players, so the common understanding is not reachable.

We argue here that quantitative planning methods and techniques, empowered with ICT and multimedia visualization aides, and package of communication and facilitation methods and techniques is not enough to foster human behavioral change in circumstances of climate change urgency. Even if we now, for example in Serbia, could have on our disposal all this worldwide available planners knowledge and skills, we suppose that our success rate would be lower than in other contexts due to very different socio-economic genesis of our society and available resources (Lalović, K., Mrdjenović T., 2010b).

So, we think that, as a planners: - first we need to change our perspective, and than accordingly our behavior in order to be able to create a new strategic approach to increase planning effectiveness in out context, and - second, we need to be able to (at least) understand “interior” processes of individuals and groups that we deal with, in order to be aware of “real” potential behavioral consequences of planning process.

Changing planning perspective: Integral Sustainable Development approach

We searched for theoretical and practical knowledge resources that will help us to meet previously pointed out needs. Since the questions asked are in the scope of human behavioral change we explored behavioral sciences. Behavioral sciences investigate the “interior” processes of cognition and learning of individuals and groups, decision processes and communication strategies within and between humans in a social system. There are two broad categories: 1) neural—decision sciences, which involve those disciplines primarily dealing with the decision processes and individual functioning used in the survival, such as anthropology, psychology, cognitive science, organization theory, psychobiology, and social neuroscience, and 2) social—communication sciences, which include those fields which study the communication strategies used by organisms and its dynamics between organisms in an environment, such as anthropology, organizational behavior, organization studies, sociology and social networks.

There are many concepts that we found very applicable in planning practice but, here we will present one theoretical and empirical concept that tries to integrate all of them in larger perspective that we estimate that could provide us, planners, and the answer for the needs that we formulated. Integral Sustainable Development approach is based on Integral framework developed by philosopher and theorist of psychology Ken Wilber’s (1996, 2000), as response to global “calls” for an end to the age of fragmentation in field of sustainable development (SDv). This is a first attempt to create a concept for deploying knowledge from the full spectrum of disciplines in order to address local and global, social and environmental problems (Brown B.C., 2006, Esbjörn-Hargens & Zimmerman, 2009).

The essence of Integral Sustainable Development approach is that *with a perspective large enough, everyone is partially right*: all definitions address an important dimension of reality, each approach focuses on a necessary area of SDv, and all justifications are valid within their context (Wilber K., 2000). The main components of Wilber's the Integral framework are quadrants, levels, lines, states, and types. According the integral practitioners, the *quadrants* represent “lenses” which they use to better understand any occurrence, allowing them to reveal, in a integrated way, dynamics and forces of interiors and exteriors of individuals and collectives, i.e. to develop and examine an integrated map of psychology, behavior, culture, and systems (Brown B.C., 2006a).

Quadrants represent four distinct dimensions of reality: - UL, individual interiors like psychology and consciousness; - UR individual exteriors such as behavior and the physical body, - LL collective interiors like culture and worldview, and –LR collective exteriors such as systems and the physical environment. These dimensions have been “intensely investigated by literally hundreds of major paradigms, practices, methodologies, and modes of inquiry” (Wilber K., 2004). They represent the four principal domains of “*being-in-the-world*.” All four quadrants are inseparable components of every occurrence. They always arise simultaneously, as distinct dimensions of reality. Each one is an indispensable domain, interconnected with and affecting the others. Each plays a crucial role in the success or failure of any SDv initiative (Brown B.C., 2006a).

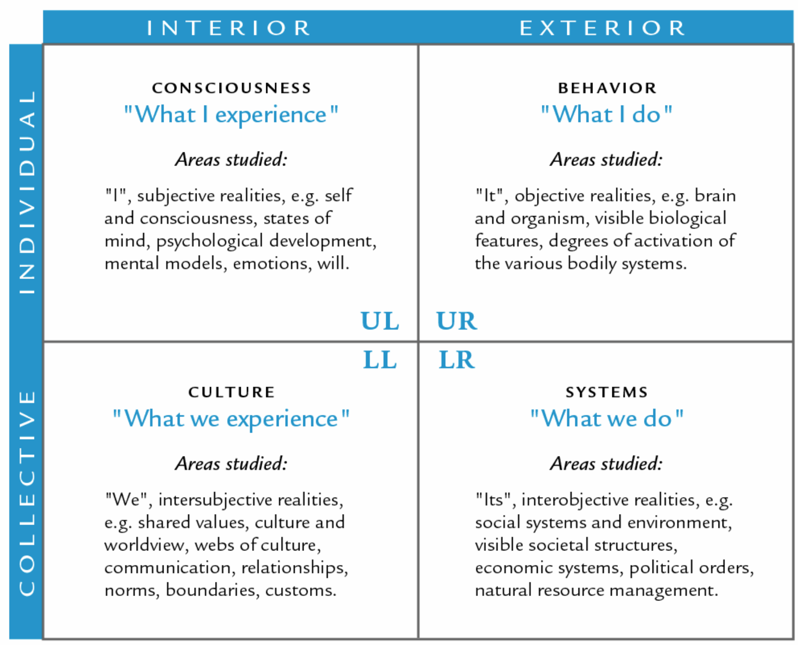

Figure 1. Integral framework: Quadrants (Brown B.C., 2006a)

According the this approach, if a particular methodology only takes into account one or two dimensions of reality it literally addresses only “half” of the picture, and therefore has a higher chance of failure. The complexity of today's development dilemmas calls for an approach that leverages all SDv tools available. Integral Theory is founded on an experiential understanding that disconnected or unbalanced solutions often do not generate sustained success. Therefore, one of the core principles of Integral Sustainable Development approach is that *the realities of all four quadrants should be taken into account when designing and implementing SDv initiatives* (Brown B.C., 2006a, Esbjörn-Hargens & Zimmerman, 2009). Integral framework was introduced in the context of sustainability practical issues within several UNDP and UNICEF programs (Beck D.E., 2002, UNDP, 1999, Brown B.C., 2007b, Hochachka G., 2005) and experiences showed that the quadrant analysis can be used in three key ways (Brown B.C., 2007a):

1) *To organize sustainability information*: often we are faced with an insurmountable influx of new information, new research, frameworks, tools, approaches and insights about sustainability appear every day. The question is how do we manage it, how do we recognize what is truly novel, how do we incorporate it into what we already know? The quadrants, and the larger AQAL integral framework that we didn’t present here, provides a way of doing so that has proven useful for practitioners, since they are scalable, they can organize everything from entire disciplines to the dynamics of a single act of recycling.

2) *to diagnose the challenges facing a sustainability initiative*: when attempting to identify the most powerful influences on a given situation, the quadrants can serve as a guide, reminding us to check in on all the major dimensions of reality. Usual question is did we remember to consider the cultural and psychological dynamics involved? Are there behavioral or body/brain issues at play? Figure 2. illustrates an example of how quadrants can be used to diagnose the major challenges of adapting to living within ecological limits.

INTERIOR: Individual (I)	EXTERIOR: Individual (IT)
Individual attitudes to stigmas and statuses associated with levels or resource use. Personal emotional challenges associated with decreases in personal space and privacy. Psychological adaptations and challenges related to natural resource flows and limitations. Knowledge and skills that relate to adaptations to lower resource use. Spiritual dimensions of living with decreased resource availability.	Changes to bodily comfort in environments with limited heating and cooling. Bodily changes related to a locally grown, seasonally produced food. Individual behavior related to limitations on food supply. Behavior suited to adaptations in environments of intensely shared resources.
INTERIOR: Collective (WE)	EXTERIOR: Collective (ITS)
Worldviews associated with the high resource using culture. Expected cultural norms of resource use. Values associated with voluntary limitations in resource use. Values associated with creating cultures of resource reduction through community living.	Communal systems that facilitate efficient and effective use of resources. Rules and guidelines for community systems. Tools, equipment and production systems for low input agricultural enterprises. Management systems for low resource availability environments.

Figure 2. Quadrants used to diagnose challenges of adaptation within ecological limits, Tim Winton, Integral Sustainability educational center in Australia (Brown B. C., 2007)

3) *To prescribe an integrated solution that accounts for all the major dynamics at play*: once the quadrants have been used to identify all of the major psychological, behavioral, cultural, and systemic influences upon any situation, they can then be used to prescribe an integrated response. Figure 3. illustrates an example of how quadrants can be used to create and organize integrated solution to foster sustainable consumption and waste reduction.

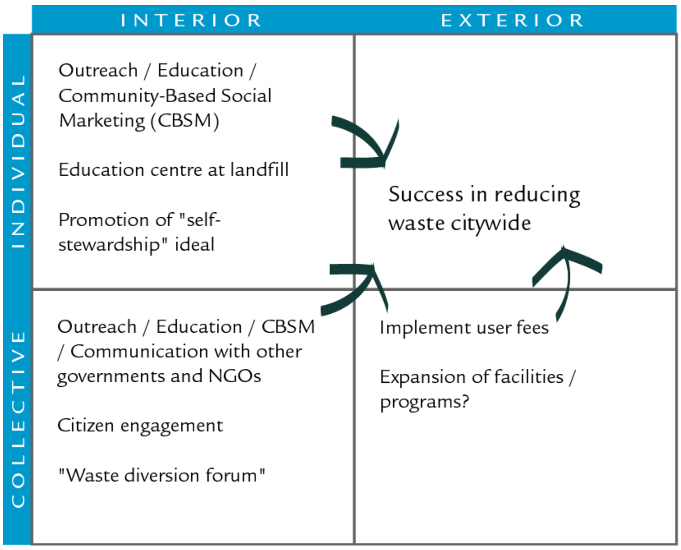

Figure 3. Quadrants used to create integrated solution regarding an initiative to foster sustainable consumption and waste reduction in Calgary, Ontario. (Brown B. C., 2007)

Considering the issue of organizing and structuring sustainability information Brown (2007) performed a research on relevant “most popular” literacy on SDv and he noticed that the authors predominantly focus the attention of readers on LR - the systems aspects of sustainability (Brown B.C., 2007). He underlines that our “worldview” is largely a product of our habits, and how we habitually see the world forges the *blinders* that ultimately conceal that which is rare to our attention. If we perceive the sustainability dominantly trough some of the “lenses”, our “lens” would bulge out of proportion, yet it would be natural to us. As we face our global challenges, we would see LR problems and prescribe LR solutions, and potentially, our interventions would fail, or at least not be as effective as they could, precisely because of ours prejudiced focus on the world (Brown B.C., 2007).

Wilber argues that “the LR quadrant, in other words the techno-economic mode of production, is the single strongest determinant of the average mode of consciousness in a culture. It’s not the only determinant, but it’s the single strongest.” (Wilber K., 2000) What he’s suggesting is that if you can influence the LR, you influence *the strongest lever on the average or low level of development in a context culture*. The more developed the LR structures are, such as sustainability policy mainstreamed into all corporate and governmental legal structures, the more they will serve to “pull” people “up” to that level of development. Thus, if you have to choose to focus only on one quadrant, the LR is the most powerful. However, we know that the LR quadrant is influenced by the other quadrants as well, because they co-arise, or “tetra-evolve”, thus it is useful and powerful to *utilize an integral approach* which leverages forces in all quadrants as they will all work to help develop the others (Wilber K., 2000).

Besides the quadrants analysis Integral framework is also consisted of “levels, lines, states, and types” the methods to analyze and acquire deeper understanding of human personal an cultural development which provides as tools for more efficient an effective research and integration of Left quadrants perspectives (Wilber K., 2000), which we will not present here due to rationality of focusing on answering the questions asked on the beginning of this paper.

Integral Sustainable Development approach and planning in Climate change

Integral Sustainable Development approach offers a framework that enables us to change perspective an to take into account the bigger picture in which climate change is occurring, and thus, we strongly believe, it can offer to planners and governance leaders much clearer way to insights on the types of responses and strategies that are necessary to confront the challenge. There are several reasons why integral framework (accounting also beside quadrants, analysis of levels, lines, states and types) may be both, useful and necessary for responding to climate change:

- *Integral Sustainable Development approach recognizes the interior and exterior dimensions of sustainability and climate change research, and emphasizes that the four quadrants “tetra-arise”, i.e. coexist simultaneously.*

As we previously described, sustainability and climate change ware mostly studied from an objective perspective - LR quadrant. Integral theory draws attention to the role of individual cognition and consciousness, and to the importance of collective values and beliefs as influence on behavior and systems. These subjective, interior dimensions represent an important part of the picture, and they need to be considered in discussions and debates about climate change. Even scientists or planners practitioners have a personal stake in the problem, both as contributors to the problem and to the solution, and sometimes they are more driven by interior motivations than by definition of their professional role (O’Brien, 2009).

It is also underlined in the concept that all four quadrants are closely related, and cannot be seen as isolated or independent from each other. The links between the LR- systemic processes associated with climate change are linked to human development – UL, LL: the impacts of climate change can influence human development, just as human development can influence the future climate system. It is very important to *recognize* that responses to climate change may also affect human development. One person or group’s adaptation to climate change may increase the vulnerability of others, or mitigation efforts can likewise influence development, either positively or negatively. The recent experience with bio-fuels and its impact on global food availability and access illustrates the complex nature of responses (Runge & Senauer, 2007).

Climate change interacts with many other global processes, thus it is difficult to project the exact outcomes of any policy or strategy (Leichenko & O'Brien, 2008). An integral approach captures the way that relationships emerge synchronously and causally in all four quadrants.

- *Integral framework focusing on left quadrants first recognizes differing levels - "stages" of human development and "altitudes" within them, second - that in different stages values and worldviews are different, and they are constantly changing as social group is moving from one stage to another, and third- that in accordance to different value system there are diversity of needs and motivations, and hence responses to sustainability and climate change.*

Integral framework explains that human beings are diverse and individuals and, that they can be characterized by many different lines of personal development in: cognitive, moral, interpersonal, emotional, psychosexual, kinesthetic, self, values, needs, and so on (Wilber K., 2000). Differences in the cognitive line of development have significant implications for personal responses to climate change. Indeed, climate change is a cognitively complex issue: it is a "big picture" problem, and to understand its full implications a world-centric perspective is required as well as an ability to handle both complexity and paradox: individuals, groups, and institutions need a well-developed capacity to be self-reflexive or "... to hear, and to seek out, information which might cause the self to alter its behavior, or share in a negative judgment of that behavior. This demands a high level of cognitive development, which may be demanding for many adults, leading to a situation as being "in over our heads" in relation to contemporary global problems." (O'Brien, 2009)

According the Integral framework human values are interrelated with the stage of development. This is very important for diverse groups understanding the impacts and consequences of climate change, and for making the problem "real and relevant" to them, because values influence prioritization of responses to climate change. Recognizing that climate change will mean different things to different individuals, communities, groups, or cultures is essential for providing "ownership" of the problem, which is prerequisite for responding to climate change.

Values are often assumed by planners to be random, culturally specific and static, but actually they can be traced inter or inner culturally with help of "stages" or levels of civilistaion human dveleopent descirbed in Itegal framowork, all togeter with dinamics of their chainge (Wilber K., 2000). Until recently, more research attention has focused on explaining differences in values than on understanding changes in values. However, it is also important to recognize that values change as humans develop, both as in individuals and through generations. There is a growing body of research that shows that values are structured in a coherent way and that they change over time as individuals and societies undergo processes of development (Schwartz, 1994, Inglehart, 1997).

- *Integral framework encourages integral research, theoretical and methodological pluralism*:

According to Integral framework in order to understand coupled social-ecological systems and the implications of climate change for humanity, is interdisciplinary research. But, it has been proven that it is very difficult, particularly when research is based on differing conceptual or mental models. Although it is easy for scientists from diverse disciplines to collaborate when they share the same conceptual framework, such as a LR systems perspective, it becomes much harder when researchers hold different models of reality. Yet it is becoming increasingly clear that fragmented research, as well as interdisciplinary research that is limited to one particular paradigm, based on one worldview, or limited to one way of knowing, is likely to be insufficient to meet the challenges of climate change (O'Brien, 2009). Without a common framework, it is difficult for scholars from different disciplines to see how diverse fields, approaches, and methodologies relate and fit altogether.

> *"It is important to note that climate change is almost always represented as bad news… However, climate change may also be good news: never before in human history has there*

> *been such strong evidence that we live in an interconnected world, where actions taken in one place have consequences in another. The notion of winners and losers, which has been a driving force for competition among individuals and between groups and states, becomes an illusion as the process of climate change accelerates. Inequality and injustices that have persisted throughout history must be confronted in order to address climate change, and there is now a window of opportunity to recognize that human well-being and human security are really about the connections and relationships among different perspectives."(O'Brien, 2009)*

This short overview of Integral Sustainable Development approach, gives us "higher "perspective from where it is obvious that there is no single solution to climate change. What is needed are *multitude* of measures that transform energy systems, social systems, economic systems, and institutions at an unprecedented rate and scale, but it is important to *target* these different responses to the existing diversity of beliefs, values, and worldviews within the context.

CONCLUSION

This presented review substantially grounded our belief that planning and governance perspective has to be fundamentally changed in order to redefine and understand its real professional role and performance scope within the "bigger" picture, scalable from global to specific local context. Only than we could be able to indentify more clearly and realistically the direction of our professional behavioral change in terms of creative patterns of theories, methodologies, procedures and organization appropriate to our context. Yet, it is very important to underline here that, as we could understand from Integral framework, it wont be enough just change systemic approach, but also to invent very creative strategies to foster "planners society" development on higher level of consciousness, including continuing personal professional capacity building. From this elevated point of view the predominant planning and governance believes and practice concepts and procedures, as it is case of Serbia, seem to narrow to achieve desirable change. More comprehensive and consistent strategy is needed: ongoing institutional and organizational reform has to be accompanied with complex professional capacity building, in order to refresh practice with new methods and techniques, and consequently new more effective measures.

From our starting point - point of view of planning practice, for example in Serbia, now we are able to identify clearly that our planning model is still mostly rationalized and addresses the sustainability issues from LR perspective. We just started to recognize the importance to address the socio-cultural issues (LL perspective) in planning by fostering participatory planning inspired by worldwide planning practices and theories developed in their own LR perspective and in accordance of their own other quadrants perspectives. However, but this direction of change would, almost certainly, not be successful since, the issues of UL and UR we don't even recognize as significant factor that should be treated by consistent policy, program or plan, except in cases most vulnerable groups which have lowest level of change power.

If we, urban designers, planners, or governance employees have the ambition to lead the change and achieve sustainability within climate change constrains we have to restructure firs our believes and perspective, to build up new "planners identity", and than from this identity to search for new creative combinations of interdisciplinary information, knowledge, methods, techniques, applicable and most effective in certain context, in order to make the "integral map" clear as possible. That means completely innovative approach to planner's education and evolutionary learning trough permanent theory-practice loops. For transitional country like Serbia this could be the opportunity to speed up process that already started but is inconstant and slow.

Our local urban planning strategies have to include programs, plans and targeted projects not only directed toward environment - natural and built, or economics, or social endangered or vulnerable groups, but to "seed" integral perspective in all citizens, or stakeholders of development. We believe that on an urban level this openness a completely new field of creative processes that each discipline in our interdisciplinary pattern can contribute if it has that particular perspective in mind. That means that we have to recreate the planning process, starting from redefined information support, which now above quantitative metrics, has to include qualitative research of decision group cognitive structure, and deeper to the levels of their believes and identities. This could be ground for our, professional, more effective contextual proposals for collaborative or participatory discussion.

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REFERENCES

Adams, W. (2001). Green Development: environment and sustainability in the Third World.

Adams, W. (2006). The Future of Sustainability: Re-thinking Environment and Development in the Twenty-first Century. IUCN.

Bajić Brković, M. (2010). Ka održivom razvoju gradova u Srbiji. In M. Bajić Brković (Ed.), Kreativne strategije za odživi razvoj gradova u Srbiji. Beograd: Arhitektonski faklutet Univerziteta u Beogradu.

Barnett, J., Matthew, R. A., & O’Brien, K. (2008). Global environmental change and human security. In e. a. H.G. Brauch (Ed.), Reconceptualizing security in the 21st century. Berlin: Springer.

Beck, & Cowan. (1996). Spiral Dynamics: Mastering values, leadership, and change.

Beck, D. E. (2002). The Africa institute: An integral initiative.

Benn, S. (2007). Sustainable Development. In International Encyclopedia of Organization Studies. SAGE Publications.

Brown, B. C. (2007a). The four worlds of sustainability: Drawing upon four universal perspectives to support sustainability initiatives. AQAL: Journal of Integral Theory and Practice .

Brown, B. C. (2007b). The use of an integral approach by UNDP’s HIV/AIDS Group as part of their global response to the HIV/AIDS epidemic. AQAL: Journal of Integral Theory and Practice .

Brown, B. C. (2005). Theory and Practice of Integral Sustainable Development, Part 1 – Quadrants and the Practitioner. AQAL: Journal of Integral Theory and Practice , 1 (2), 351-386.

Brown, B. C. (2006a). Theory and practice of integral sustainable development: Part 1 – Quadrants and the practitioner . AQAL: Journal of Integral Theory and Practice , 1 (2), 351-386.

Brown, R. L. (2006b). Plan B. 2.0: Rescuing a Planet under stress and a Civilization in trouble. New York: Earth Policy Institute.

Camagni, R., Capello, R., & Nijkamp, P. (2001). Managing Sustainable Urban Environments. In Handbook of Urban Studies. SAGE Publications.

Capello, R., Nijkamp, P., & Pepping, G. (1999). Sustainable Cities and Energy Policies. Springer-Verlag.

Carr, E. R. (2007). Sustainable Development. In Encyclopedia of Environment and Society. SAGE Publications.

Dudley, M. (2009). Sustainable Development. In Encyclopedia of Urban Studies. SAGE Publications.

Esbjörn-Hargens, S., & Zimmerman, M. E. (2009). Integral ecology: Uniting multiple perspectives on the natural world. NY: Random House/ Integral Books.

Esbjörn-Hargens, S., & Zimmerman, M. (2009). Integral ecology: Frequently asked questions. Boston & London: Integral Books.

Forester, J. (1998). Planning in the Face of Power. University of California Press.

Gamble, D., & Hoff, M. (2010). Sustainable Community Development. In The Handbook of Community Practice. London: SAGE Publications.

Hamilton, M. (2006). Integral Metamap Creates Common Language for Urban Change. Journal of Change Management , 19 (3).

Harris, M. J. (2002). Basic Principles of Sustainable Development. In The Encyclopedia of Life Support Systems. United Nations Educational, Scientific, and Cultural Organization (UNESCO).

Healey, P. (1997). Collaborative Planning: Shaping Places in Fragmented Societies. Palgrave Macmillan.

Healey, P. (2006). Relational Complexity and the imaginative power of strategic spatial planning. European Planning Studies , Vol 14(4), 525-246.

Hochachka, G. (2005). Integrating interiority in community development.

Hochachka, G. (2005). Integrating interiority in community development. World Futures: Journal of General Evolution , 61 (1-2), 110-126.

Inglehart, R. (1997). Modernization and postmodernization: Cultural, economic, and political change in 43 societies. Princeton University Press.

Innes, J., & Booher, D. (2002). Network Power in Collaborative Planning. Journal of Planning Education and Research , Vol. 21 (No. 3), 221-236.

IPCC. (2007a). Climate change 2007: Impacts, adaptation and vulnerability. Summary for policymakers. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change .

IPCC. (2007b). Climate Change 2007: The physical science basis. Summary for policymakers. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change .

Lazarević Bajec, N. (2009). Rational or collaborative model of urban planning in Serbia: Institutional limitations. Serbian Architectural Journal , 81-106.

Lalović, K. (2010a). Informacioni sistemi za podršku odlučivanju u održivom razvoju gradova, u Kreativne strategije za održivi razvoj gradova u Srbiji, ur.: M. Bajić Brković, 301- 341, ISBN 978-86-7924-035-4

Lalović, K., Mrdjenović T. (2010b). Development of municipal TIS as an instrument of planning approach transition toward integrated sustainable development– case of Serbia, 15th International Conference on Urban Planning and Regional Development in the Information Society, CORP 2010: Cities for everyone: Liveable, Healthy, Prosperous Promising Vision or Unrealistic Fantasy, ed.: Manfred Schrenk et.al., 207-221, ISBN 978-39502139-9-7

Lalović, K., Mrdjenović T., Radosavljević U. (2010c). Territorial information systems (TIS) as an instrument for developing social capital in local communities in Serbia, 15th International Conference on Urban Planning and Regional Development in the Information Society, CORP 2010: Cities for everyone: Liveable, Healthy, Prosperous Promising Vision or Unrealistic Fantasy, ed.: Manfred Schrenk et.al., 701- 710, ISBN 978-39502139-9-7

Lalović, K. (2008). "Development of integrated municipal Territorial Information systems TIS-Achieving integration", u : SIRP BOOK - The settlement and Integration of Refugees Programme in Serbia 2005-2008, Ur.: Ligia Ramirez, et. al., 157- 188, UN HABITAT, Beograd, 2008, ISBN 978-86-87415-06-5

Leichenko, R., & O'Brien, K. (2008). Environmental change and globalization: Double exposures. NY: Oxford University Press.

Mabogunje, A. (2002). 'Poverty and environmental degradation: challenges within the global economy. Environment 44 (1) , 10-18. .

McCormick, J. (1992). The Global Environmental Movement: reclaiming Paradise. London: Belhaven.

McManus, P. (2008). Sustainability. In Encyclopedia of Global Warming and Climate Change. SAGE Publications.

McManus, P. (2007). Sustainable Cities. In Encyclopedia of Environment and Society. SAGE Publications.

Meadows, D., Randers, J., & Behrens, W. (1972). The Limits to Growth. New York: Universe Books.

Muhutdinova, R. (2006). Sustainability. In Encyclopedia of World Poverty. SAGE Publications.

Newman, P., & Kenworthy, J. (1999). Sustainability and Cities: Overcoming Automobile Dependence. Island Press.

Nikezić, Z. (2010). Instrumenti upravljanja. In M. Bajić Brković (Ed.), Kreativne strategije za održivi razvoj gradova u Srbiji. Beograd: Arhitektonski fakultet Univeryiteta u Beogradu.

O'Brien, K. (2009). Responding to Climate Change - The Need for an Integral Approach. Integral Institute, Resource Paper No. 4 , 1–12.

Orr, D. (2006). Framing sustainability. Conservation Biology 20 , 265-6, p. 266.

Parry, M., Lowe, J., & Hanson, C. (2008). The consequences of delayed action on climate change. (Briefing for Poznan, Poland meeting on climate change) .

Parry, M., Palutikof, J., Hanson, C., & Lowe, J. (2008). Climate policy: squaring up to reality. Nature Reports Climate Change, 2 , 68-70.

Runge, C. F., & Senauer, B. (2007). How biofuels could starve the poor. Foreign Affairs , 86 (3).

Schellnhuber, H. J. (2008). Global warming: Stop worrying, start panicking? PNAS , 105(38), 14238-14240.

Schwartz, S. H. (1994). Are there universal aspects in the structure and contents of human values? Journal of Social Issues , 19-45.

Shonwandt, W. (2007). Planning in crisis?, Theoretical Orientations for Architecture and Planning. MPG Books Ltd, Bodmin, Cornwalt.

Silos, M. (1999). The politics of consciousness: Integral theory and Caribbean development.

Sorenson, A., Marcotullio, P., & Grant, J. (Eds.). (2004). Towards Sustainable Cities: East Asian, North American and European Perspectives on Managing Urban Regions. Ashgate.

Stern, N. (2006). The economics of climate change: The Stern review. Cambridge: Cambridge University Press.

UNDP. (2008). Fighting climate change: human solidarity in a divided world.

UNDP. (1999). Sustainable livelihoods guidance sheets. Department for International Development.

Vitousek, P. M., Mooney, H., Lubchenco, J., & Melillo, J. (1997). Human domination of Earth's ecosystems'. Science , 494–499.

WB. (2009). Global Monitoring Report A Development Emergency. Washington DC: The International Bank for Reconstruction and Development/ The World Bank.

WB. (2010). World Development Report 2010: Development and Climate Change. World Bank Group.

Wilber, K. (2000). A brief history of everything.
Wilber, K. (2000). A theory of everything: An integral vision for business, politics, science, and spirituality.
Wilber, K. (2004). The integral vision of healing.
William, L. (2007). Sustainable Living. In Encyclopedia of Activism and Social Justice. SAGE Publications.
Yiftachel, O., & Huxley, M. (2000). Vol. 24, 907-913.

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GROWING AND MAINTAINING OF GREEN AREAS – SYSTEMS OF VEGETATION - IN URBAN ENVIRONMENT

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ABSTRACT

A green area is a part of empty space in which the elements of landscape (plants, parts of relief, and water) and constructing elements (footpaths, bridges, plateaus, etc.) is organized according to a certain system. The idea of system points to the existence of certain rules coming from abiding the laws of nature, as well as following complex human needs. These needs very often in a harsh way neglect natural relations and needs of some elements of that system.What kind of influence do the green spaces exert on the urban environment?

Key words: a green area, green area systems.

ITRODUCTION

In the cities or inside the infrastructural systems, green spaces are surfaces on which greenery is groomed, often artificially planted and organized according to certain principles : a park, a square, a floral parterre, a lawn, an alley, a group of jardinieres… Beside the urban greenery, the suburban greenery located on the city finges with its miscellaneous purposes, functions and vegetation, also bears a great significance for cities: the park-forests, the protective green strips around the industrial facilities or drinking water springs, the individual greenery surrounding cemeteries,recreational spaces, excursion sities,ect.

Diferent types of trees play an unequal part in the process of gas exchange, wich varies from 100% to 700%, depending on the leaf size. Given that in this proportion the common fir tree (Abies sp.) has the efficiency of 100%, the numbers for other trees are:

Table1: Gas exchange of some plants expressed in percentages

Larch	(Larih decidua)	118%
Pine	(Pinus sp.)	164%
Broad-leaved linden	(Tilia grandifolia; platyphyllos)	254%
OakBerlin Poplar	(Quercus sp.)	450%
Berlin Poplar	(populous x berlinensis)	691%

Complex ecological analyses of plants impact on the environment and the surrounding's impact on plants prove that plant organisms in cities, just as in a landscape, wield an influence proportionate to their quantity: minor amounts of greenery, i.e. a small number of decorative plants in bound to achieve only a minor ecological effect. [3]

GROWING GREEN AREAS- THE MAIN AIM OF LANDSCAPE ARCHITECTURE

It can be freely said that the main aim of landscape architecture is to create qualitative, attractive, and functional green area. Bearing in mind the most important functions of green areas (ecological, recreational, health caring, esthetic etc.), it could be said that landscape architecture consists of 4 main fields: -Production of planting and seed material, -Projecting of parks and other green areas, -

Realization of a project (constructing), -Maintaining of green areas. When all the facts are considered, importance of choice of plants for each, even the smallest area, must be mentioned. It is especially important in specific, difficult and for living disadvantageous urbanized areas. Even the best imagined and raised green area, consisting of plants chosen most attentively, requires to conduct a whole system of interventions throughout a whole period of use. The first and the most important aim of this system is to neutralize the negative effects of the surrounding area. Then comes the aim related to esthetics. Taking into consideration all mentioned, it can be said that green area represents the real and final aim of landscape architecture. [1]

THE CONCEPT AND DEVELOPMENT OF GREEN AREA SYSTEMS

According to some Soviet authors, the system of green area represents all the green areas which are on a territory of residential zone and are connected, on the principle of being even and inappropriate to one another and to city park-forests M., Bugarski gives the following meaning to the concept of “system of greenery”: “Different categories within parks and gardens in cities and suburbs for everyday and weekend breaks, on the whole, form green areas of residential zone. In order to fulfill its purpose properly and form unique system of greenery, these areas should reach 2 basic requirements:

1. to be arranged on the territory of a settlement equally in the terms of quantity and quality,
2. to be connected to boulevards and areas with greenery, that is, to form a system.

Greenery system of a certain settlement represents complex green areas of all categories which are spatially connected to the city and suburb, and have a certain function and purpose.

Green areas organized as a system: should have an important role in dividing city macrostructure (zone structuring); should be connected into a unique system both in terms of space and organization, in accordance with the principle of equality and continuity; should create an optimal ecological, social and esthetically arranged environment; should match contemporary world norms in quantity and quality measures; should be created and nourished within complex greenery of a city; should be in accordance with the characteristics of natural surrounding. In contemporary urban concept, city system of greenery takes an important position since it brings together different functional zones into unique compositional whole. Through suburban greenery city system of greenery makes a connection between a settlement and surrounding nature. The creation of greenery system and putting its elements into dimension has the aim of creating a complex bioclimatic, functional and esthetic effect. Greenery system types: There are many qualifications of greenery systems, but the highest number of authors uses classification into these types:

1. Annular (belt system),
2. Radial (wedge like) system,
3. Mosaic (system of “green spots”),
4. Linear (stripe like),
5. Combined system of greenery**.**

With the annular system, concentric circles are being created. They go around city in one or more circles.

In radial system greenery spreads to the centre of the city in the shape of wide wedge, and it connects with green areas in suburbs (park forests and protecting zones). This model provides the best aeration of city, where clear air from suburbs gets to the city through various categories of green areas.

Mosaic system of greenery encloses green areas which are loosely situated around the whole territory of a settlement. This system is successfully used in smaller cities where polluting industry is not planed to be built.

Linear system of greenery is characteristic for settlements with geometric arrangements of streets. The problem of making green areas is completely solved with combined system, which represents making a connection between equally situated green areas of housing blocks and green corridors (boulevards and avenues). It is the most functional system because it provides improvement of climatic and hygienic conditions on the territory of a settlement and gives space for recreation to the people who live there. Continuous system, which is achieved with this model, provides higher architectural expression of green areas and the whole urban space as well. [2]

CLASSIFICATION OF GREEN AREAS IN CITY AND SURROUNDING AREA

All the green areas are divided into 3 groups:

- Green areas of public use,
- Green areas of limited use,
- Green areas of special purpose.

Green areas of public use fulfill the most important social functions with their availability to all citizens and the way of using. Parks, plantations, squares, boulevards, city and region centers, street greenery, and green areas of administrative and public places belong to this group. City parks are divided into 2 main types: multifunctional and specialized.

First type includes: central park of culture and rest; city, region and block parks. Second type includes: sport parks, children parks, memorial parks, fun parks, exhibition parks, etc.

City plantation – block park is a smaller park area which is situated in residential complex and is meant for resting and recreation of residents of surrounding blocks.

Square is an even smaller green area than a city plantation. It represents an important compositional complement to a net of parks and plantations. It also has sanitary and esthetic importance in built zone of the city. It is located around administrative and other public buildings, roads and city streets, on squares, in front of industrial and residential objects.

Boulevard is a road with larger green area. The main function is transitional motion and short rest. It has great sanitary and esthetic importance in a built zone. Greenery of streets and highways- this type of forming a green area is applied in pedestrian streets and alleys which are similar to boulevards, as well as in the streets with traffic. Greenery around administrative and other public buildings- those are smaller complexes of greenery which are usually used for short breaks and waiting.

Green areas with limited use - Specialized city parks, green areas around children and school institutions, faculties, scientific and researching institutes, hospital institutions, sport complexes, residential complexes, industrial companies, etc. belong to this category.

Green areas of special purpose: sanitary protective zones, protective belt, belts for protection against wind, zones for protection against fire, nurseries, flower complexes, green areas, cemeteries - all the categories mentioned are connected into one and make the system of greenery of the city. [2]

CONCLUSION

Air pollution serves to the deficiency of greenery in urban environment. Urban environments which are industrial environments at the same time are very often in bad condition when it comes to greenery. It happens that sometimes during construction of some industry or factory a protective belt, that was planned, does not come to the realization, but it gradually turns into construction site: for expansion of factory capacity or deposing of waist materials. All this points to the importance of growing and cultivation of green areas in cities so to lower the level of damaging effects of urbanization and civilization development which destroys everything ahead for the sake of profit, and we forget that “we did not inherit this planet from our ancestors, but we borrowed it from our descendants.”

REFERENCES

Anastasijević, N., “Podizanje i negovanje zelenih površina” 87-93, Šumarski fakultet, Beograd, 2002.

Vujković, Lj., “ Pejzažna arhitektura – planiranje i projektovanje “, 88-93, Šumarski fakultet, Beograd, 2003.

Đukanović, M., “Ekološki izazovi”, Elit, Beograd, 1991.

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TOWARDS A STRATEGY OF REGENERATION OF URBAN LANDSCAPE: BROWNFIELDS AS A STRATEGIC RESOURCE

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ABSTRACT

This research addresses the issue of transformation of urban landscape, especially its green structure, in the context of urbanisation understood as a complex socio-spatial process possessing both global and local characteristics, which produces a new form of urban space. This new urban landscape extends beyond the traditional relations between the city centre and periphery as two distinct categories; hence the research explores the transformation of Banja Luka's rural suburbia and historic city center. The problems identified concern a quantitative reduction in the green structure being transformed into construction land, a reduction in the diversity of its spatial patterns and the creation of new images of urban landscape not originating in the local identity and urban tradition. As a possible approach to this issue it is proposed to devise an interdisciplinary urban landscape regeneration strategy, which would feature an integrated approach to green structure preservation, planning and design. The research has identified neglected areas, called brownfields in the city planning jargon, as a special category of urban space to be used as an instrument for the preservation and improvement of urban landscape, especially its green structure. In a strategic sense, brownfields should be observed as spare space in which to place a part of the facilities and uses occupying the green structure of urban landscape. Seen as an integral part of urban history and memory, brownfield sites have been identified in this context not only as an unused spatial and environmental resource, but also as representative of the city's social and cultural strata.

Key words: urban landscape, urbanisation, green structure, brownfield, urban regeneration

INTRODUCTORY NOTES

The inhabitants of Banja Luka quite often describe their city as "green", according to how they see and experience it on a daily basis. The epithet "green" may be found in a number of travelogues originating in the late 19th century and in 20th-century monographs focusing specifically on the city (Simonović, 2010). Its urban green space produces a powerful visual effect opposite its man-made structures, even in the city core, which leads to the assumption that these areas have continually been perceived as a "green city". The facts that these areas are used daily as gathering points and places of social interaction, that they have an educational role when it comes to flora and fauna, that in terms of design they have distinctly local features, qualify them as a cultural and social phenomenon. These sites boast their own private history within the history of the city.

The trends in Banja Luka's urbanisation over the last decade have been posing an immediate threat to its green structure.[1] Green areas have become prospective construction sites: inside the city core as a consequence of the densification of the built environment, as well as outside it due to urban sprawl, i.e. the spreading of new urban tissue. These trends, perceptible in everyday life, may be seen as part of the global issue of endangerment of the environment caused by the pressures of the necessity of

1 *Green structure* or *greenstructure* as a concept meaning a synthetic notion comprising all green areas as urban structure or whole emerged in the planning of European cities in the last several decades of the 20th century. For more information, see Werquin, A. C. et al. (Eds.) (2005), *Greenstructure and Urban Planning – Final Report 2005*, COST Action. European Commission.

economic growth and scientific and technological development, although they also have some local characteristics. This study identifies the issues of the quantitative reduction in the green structure as a result of its being transformed into construction land, a drop in the diversity of its spatial patterns and the creation of new images of urban landscape ungrounded in the local identity and urban tradition.[2]

This paper is based on the premise that a city's green structure is an integral part of its urban space, and as such, it must be regarded, planned and designed at the same level as all the other city structures (Werquin et al., 2005). Although this initial premise may seem explicit and self-evident, it is often disregarded by urban planners and designers, in the context of intricate relations and many disparate interests involved in the process of production of space. Urban green structure both connects and separates the man-made environment and vacant land, various segments of urban space, private and public space, as well as different urban functions or uses. The green structure is concurrently a part of "nature" and a part of urban culture. For the purposes of this research, the concept of urban landscape has been selected as a theoretical concept employed by disciplines dealing primarily with city space, which will also allow a synthetic analysis of urban structures. Urban landscape is understood as the human habitat, as the urban form imbued with and encapsulated by the green environment, charged with the dynamism of human activity and enriched with symbolic values, meanings and messages.

This paper focuses on brownfield locations as a way to study qualitative and quantitative changes effected in the green structure, viewed as an integral part of urban landscape, in the context of the process of urbanisation. Urban planning and design professionals identify them as previously developed and built locations, which are under-exploited or have fallen into disuse, and which have the capacity for urban regeneration and development (Stratton, 2000). They represent strategically important spatial reserves which may take over a part of the uses imposed upon and biting into the green environment. In that sense, brownfields are seen as an instrument of preservation and enhancement of urban landscape, i.e. of its green structure. At the same time, these locations are regarded as an indispensible part of urban history and memory and are accordingly identified not only as unused spatial and environmental resources, but also as socially and culturally stratified urban space.

URBAN LANDSCAPE MORPHOLOGY

The concept of *landscape* evades unambiguous definition in the domain of theoretical research on space. Studies of landscape conducted in the closing decades of the 20th century show various combinations of theories as to what landscape is and how it should be approached for the purposes of research and definition. The complex content of this concept – at the same time spatial, cultural, social, political, economic, artistic, aesthetic and environmental – verges on everyday life and science. Interdisciplinarity is the fundamental presupposition of any contemporary research into landscape. This paper treats the concept of landscape from the aspect of urban morphology.[3] What does that mean?

The relationship between nature and culture is traditionally considered a relationship defined by landscape. Nature is part of the mentioned couple which exists as the background or intact nature upon which culture then acts, changes it and is changed in the process. In the scientific context, the nature/culture dichotomy in the content of landscape is called *cultural landscape* and the term was first used by geographer Carl Sauer (Carl Ortwin Sauer) in 1925 (Wylie, 2007). Sauer defines

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2 This research identifies its subject and problems in relation to the author's earlier research on the city of Banja Luka's green structure, its history and origins, and its status in urban planning documents and the process of urban planning from the mid-20th century onwards, as well as to research on the development of the identity of Banja Luka's urban landscape (Novaković, 2008; Novaković 2008a; Simonović, 2010).

3 The ensuing text about the concept of landscape within the field of urban morphology is based on the theoretical research of author N. Novaković presented under the title Landscape as Urbanism: Interdisciplinary Landscape Studies in the Second Half of the 20th Century, at *The Third International Symposium for students of doctoral studies in the fields of Civil Engineering, Architecture and Environmental Protection* held in Novi Sad, Serbia, in 2011.

landscape as objective, tangible and measurable. It refers to a physical material reality, made up of facts, which is why Sauer designates field work as the basic, i.e. the only correct method of experiencing and studying landscape. According to Sauer, landscape is outside the city, but as a modification of nature, it is composed of distinct physical and cultural forms. It stems from this that we can identify specific landscapes depending on the nation, region or local communities which are the result of long-term human impact on a certain environment.

Sauer considered the term culture to be any human effect on nature. He observed culture as active in the nature/culture relationship and in this context cultural landscape was a milestone in geography of the time and a response to the schools of thought of environmental determinism. “…The term ‘landscape’ is proposed to designate the unit concept of geography, to characterise the peculiarly geographic association of facts… Landscape is the English equivalent of the term German geographers are using largely, and strictly has the same meaning: a land shape, in which the process of shaping is by no means thought of as simply physical. It may be defined, therefore, as an area made up of a distinct association of forms, both physical and cultural,” (Wylie, 2007, 21). Landscape analysis can lead to the understanding of culture, so that the task of geography, i.e. *morphology*, is to describe the shape, form and structure of a certain landscape and thus discover and explain the characteristics, traces, distribution and impact of cultures that inhabited it and shaped it. The definitions of the notions *culture* and *nature*, around which the criticism of Sauer’s landscape was produced in the remainder of the 20th century, are important in this scientific context.

The concept of landscape was introduced into the fields of architecture and urbanism thanks to the other line of development of the discipline – *urban morphology* studies – which dealt with exploring the form and structure of human settlements in the process of their emergence and transformation. Urban morphology became an organised discipline in the late 19th century thanks to German-language-speaking geographers (Đokić, 2004). Geographer Otto Schlüter observed the city as an integral part of landscape, the concept earlier reserved for natural and rural environment. As a result of this geographer’s work emerged the term *Stadtlandschaft*, i.e. *cityscape*, which would later on become one of the central subjects of study of cultural and human geography in the first half of the 20th century. It was as early as 1920 that Siegfried Pasarrge used the term cityscape to designate a specific, separate unit of cultural landscape specially shaped by human activity (Unstead, 1931).

Landscape continued to be defined through the relationship between nature and culture, except that this definition also included the city, a place where human impact changed nature to the greatest extent. Sauer’s morphology, i.e. the geographical analysis of the shape, form and structure of a certain landscape, was consequently applied to urban landscape. However, key theoretical works of architecture and urbanism where urban space was seen as landscape occurred in the second half of the 20th century.[4] The concept of landscape was applied in two ways, as a method of analysing the existing city structures – within urban morphology, and as a method of designing new ones. In both cases, the city was observed in its spatial entirety and through the interaction of its parts and it as a whole. Nikola Dobrović writes about the cityscape as about a method of designing a city by which one can achieve “the highest level of spatiality”, i.e. it represents “assembling the building blocks, their plastic, hollow plastic between them, the architecture of the terrain, vegetation and the horizon into a conceived organic composition,” [Dobrović, 1954, 52-53]. This concise description of cityscape suggests visual comprehensiveness as the crucial feature of this concept. To be more exact, a simultaneous experience of various scales of space and its content.

Understood in this manner, urban landscape turns into an instrument of environmental research, planning, design and preservation. It is seen as a tool of essential and integral city conceptualisation. A

4 In the context of urbanism in the second half of the 20th century, there has been a move away from regarding urban landscape as a solely physical entity, from researching its form, shape and structure and designing it as an aesthetic, representative object, towards perceiving it as imaginary and subjective landscape. Urban landscape is designed in view of what is known about the human experience of urban space, i.e. the perception and ways of conducting activities in city space. See the works of G. Cullen, K. Lynch.

concept which implies a synthetic perspective and dealing with spatial-morphological structures and their use, a subjective experience of the living space, in which the green structure takes a prominent place. High-capacity urban landscape with a lot of potential is understood, through the complementariness of the natural and the man-made, as space of reception and emanation of significations, messages and the sense of belonging to a locale. That landscape is “shaped and built upon relations between structures themselves, as well as upon relations between structures and the ground, flora and fauna, texture and structure of materials; upon building concepts and traditions, the old and the new. People and their activities conceive urban landscape and provide it with character, and their movement, as a series of interconnected images of space integrated in one’s conscience, generates that cohesive force which makes belonging to a specific city the essential prerequisite of existence of any human space (Radović, 1972, 86).” To understand better the issue and impact of transformation of Banja Luka’s urban landscape, some of the most important elements of its urban identity are singled out, based on the more recent urban-morphological research on the city (Simonović, 2010). These elements of identity are recognised as lasting values and major urban resources: the visual presence of the natural in the city setting and the harmonious impregnation and unity of the man-made and green structure in its urban landscape.

NEW URBAN TISSUE

Christian Norberg-Schulz wrote about the processes of city construction as about “the endangerment of landscape continuity”, by which he meant the process in which natural landscape is forced interminably to metamorphose into other forms – urban forms (Norberg-Šulc, 2006, 114). As the built environment bites into the natural landscape, which often coincides with the territory of a city or town linking with other adjacent towns or villages, urban landscape transforms into new spatial forms. Back in 1970, Henry Lefebvre wrote the following in his introduction to *The Urban Revolution*: “I’ll begin with the following hypothesis: Society has been completely urbanised. This hypothesis implies a definition: An urban society is a society that results from a process of complete urbanisation. This urbanisation is virtual today, but will become real in the future” (Lefebvre, 2003, 1). Since 1970, Lefebvre’s hypothesis has proved increasingly true.

Lefebvre conceptualises urbanisation as *urban tissue* (*tissu urbain*), a tissue-phenomenon which expands into and reshapes rural areas, and at the same time transforms historic city cores (Lefebvre, 2003). This new urban landscape is formed as boundaries between towns or cities and their surroundings are made relative, with the city dominating over the rural and natural. In this relationship the city can hardly be seen as a spatial and functional whole, while at the same time its perimeter represents an area characterised by highly dynamic forms, sizes and characteristics. Lefebvre describes this concurrent “implosion-explosion” as “the tremendous concentration (of people, activities, wealth, goods, objects, instruments, means, and thought) of urban reality and the immense explosion, the projection of numerous, disjunct fragments (peripheries, suburbs, vacation homes, satellite towns)” (Lefebvre, 2003, 14).

We focus our interest on these different, multifarious, unique forms and structures of urban landscape, susceptible to change in space through time, brought in harmony with the social and natural context. The related scientific and professional jargon recognises several terms used to denote this new kind of urban space: conurbation, urbanised rural territory, pseudo-urban space, urban-rural continuum, etc. (Milić, 2002, 65). It is characterised by the dynamics and spontaneity of the process of generation and expansion, by the absence of planned control and planning activity. It is generated in the course of overlapping of two traditionally distinct types of the built environment, each with its own specific density, land use, space use, access to utilities, and way of living. The outcome of this process is a special urban form – “neither a village nor a town”, insufficiently researched by the local theoretical urbanism (Milić, 2002, 66). Evidently, there are no theoretical and analytical mechanisms for the study of transformation of urban landscape, i.e. for the study of new urban space and the process of urbanisation in the contemporary context.

CONCEPTUALISING BANJALUKA'S NEW URBAN TISSUE

The growth of the urban area is evident if we compare the Banja Luka 1975 Urban Plan with the 1993 Draft Urban Plan and the 2009 Draft Plan. Namely, the city area according to the 1975 Plan equals 12,392 ha; in the 2009 Draft Urban Plan it amounts to 18,347 ha, meaning a 48% increase over a period of 35 years. This territorial growth of the city area may be linked with the population rise, a growing need for residential space and workplaces. As the city area grew, the population and architectural density rose from 21 apartments/ha, as it was in 1975, to 34 apartments/ha in 2009. (Banja Luka 2008-2020 Draft Urban Plan, 2009). Moreover, changes to the economic system and manner of production have led to a new spatial organisation of businesses, which considerably altered the urban landscape, endangering the green structure in the process.

This has brought about a new ratio between the green and built environment, both in the visual and physical sense, with the built environment growing at the expense of the green structure. According to the 2009 Draft Urban Plan, the green area coverage – understood as the ratio between the inner urban area covered by green public spaces and the number of inhabitants – equals 10 m^2/inhabitant, which is lower than the European standards recommending 12-15 m^2/inhabitant (Draft, 2009). In the context of urban sprawl and demographic growth, the quantitative increase in green public spaces in the planning period 1975 through 2009 never occurred. For that reason, the city has not enough green public areas, which is additionally aggravated by the fact there is no vacant space to build them. The parks are slowly vanishing due to inadequate maintenance, but in particular as they are being transformed into construction land, as shown by construction in places such as Poljokan's Park, Kupusište and elsewhere. (Draft, 2009).

Changes to the quality and quantity of green areas in Banja Luka's suburbs and rural surroundings take place as a tendency to make farmland and woodland more functional by transforming it into construction land, and by building for residential and storage purposes, as well as for service and production businesses. This trend is highly conspicuous along the Banja Luka-Gradiška trunk route, as well as along local roads leading to suburbs and villages. A new conurbational form has been created, with a permanent link to the inner city core into which it is being integrated, which has in turn altered the form and structure of the urban landscape. Along with structural and morphological transformations, it has undergone certain socio-cultural, organisational and functional changes, with various effects on the characteristics of the local urban identity.

In parallel with this, the growth of the tertiary sector of economy has led to service businesses concentrating in the central city zone, producing an increase in the building density and a corresponding reduction in the green structure. Support given to the development of small and medium enterprises reflects in the spatial fragmentation of manufacturing businesses; as they require less space, they are easily incorporated in the existent urban tissue. As a consequence, they have dispersed across the urban area and expanded along major roads to form a conurbation. The transformation of the former military barracks "Little Camp" (Mali logor) into the new commercial city center serves as a striking illustration of the tendency to change green areas into construction land. By comparing the plans for the area of the former barracks, located in Banja Luka's inner city core, one discovers that prior to the said transformation the building density coefficient was 0.08, whereas today it is 1.54. Viewed from the perspective of the green environment, the vegetation and environmental potential of the barracks area represented a valuable asset. Today, the area is home to high rises and is fully paved ("Centar-Aleja" Banja Luka Regulatory Plan Amendments, 2004).

On top of it, industrial complexes, previously planned for these uses, went unrecognized as areas suitable for businesses and investment. Attention is drawn to these trends in the Banja Luka 2009 Draft Urban Plan, which says that roughly a half of all economic activity takes place outside designated industrial zones. According to the Draft Plan, the total urban area used actively for economic activity is 541.71 ha, of which 55% is located in industrial zones, and the remaining 45% lies scattered around the urban tissue (Draft, 2009). On the other hand, the Draft Plan indicates that a mere 21% of the area (297 ha) of previously designated industrial zones is currently used (Banja Luka

1975 Urban Plan). Such trends of spatial relocation of economic activity have a significant bearing on the transformation of urban landscape. While on the one hand vacant arable land is occupied, farmland is transformed into construction land, and the building density in the city core rises, on the other the existent spatial resources of industrial zones are used inadequately or are falling into disuse and will be allowed to dilapidate.

URBAN PLANNING OF BANJALUKA'S GREEN STRUCTURE

The activities of urban planners in the city of Banja Luka can hardly keep pace with the process of urbanisation, with a direct bearing on the status of the green environment in urban plans and the process of planning. Based on the results of a questionnaire filled out by the professionals working in the city of Banja Luka5, the green structure is treated rather marginally in urban planning and design activities. More specifically, open-ended responses in the questionnaire confirm the perceived prevalent trend of the contemporary urban context, which is the construction of buildings in vacant urban areas under the pressures of economy.

Urban planners argue that the concept of viewing green areas as inherent to urban landscape may be found in a great number of urban plans for the city of Banja Luka. Indeed, the analysis of the 1975 Urban Plan reveals the presence of this concept. The green structure was also defined in the City of Banja Luka 1952 Draft Master Plan, prepared by architect Anatol Kirjakov. However, if the green structure concept is identified by an urban planning document as one of its strategic goals, it is certain to disintegrate and slowly lose prominence in lower-order documents and plans. When the goals of an urban plan or project reach the operational level or with the transition from general social values to more specific ones, the priorities as outlined in documents are shuffled and regrouped. The societal value of green urban areas is exploited in plans and projects to promote the overall outcome, only to be completely neglected after the adoption of the document.

As indicated by the questionnaire respondents, one of the key factors contributing to the diminishment of the green structure viewed in terms of operational goals in the process of urban planning and design are conflicting private and public interests. Also, an issue plaguing the process of planning urban landscape is the formalist urban planning approach inherited from the former or earlier social, political and economic system. The "top-down" approach, following a hierarchy, initiated by the state and based on expertise, is equally present today in the planning discourse in the city of Banja Luka, despite a diametrically opposed social and political situation. Urban planners and designers have no mechanism at their disposal to facilitate them to comprehend and deal with the complex relations and different interests of the many stakeholders. This issue of complex relations and a great number of interests in the local and global context is analysed only partly and superficially, and planning decisions are made within concurrent though often conflicting and disparate frameworks. The green environment, in terms of both its physical and non-physical aspects, is only partly appreciated and taken into consideration, neglected in the intricate relationship between society, the state and the market.

A different approach to planning is needed, according to which the planning and building of towns take place according to general rules and in compliance with urban plans. Currently, we are in a situation where plans direct the construction of towns, laws are ineffective and instead only regulate the preparation and implementation of urban plans, and there are no relevant construction codebooks. Introducing codebooks and urban planning and design norms which would combine the results of research and long-term experience of preparation and implementation of urban planning documents would serve a mediatory and constructive role. Codebooks would facilitate spatial design, ensure a certain level of spatial quality, particularly in terms of the green environment, and they would also establish frameworks for laying down requirements for investors and constructors and enabling them

5 An anonymous questionnaire was circulated in November 2006 to be filled out by urban planning and design professionals working in Banja Luka. The questionnaire was completed by twenty-five respondents from the private sector, the Institute for Urbanism of Republika Srpska and the Faculty of Architecture and Civil Engineering of Banja Luka University.

to claim and enjoy their rights. It is highly important that the rules be adaptable to the specific needs and possibilities of individual communities and their spatial capacities.

BROWNFIELD CHALLENGES

According to the research network CABERNET6, brownfields are places or areas that have been affected by former uses of the site or surrounding land; are derelict or underused; may have real or perceived contamination problems; are mainly in fully or partly developed urban areas; and require intervention to bring them back to beneficial use. In general terms, this definition concerns brownfields areas, although it must be pointed out that defining them must take account of local characteristics. The factors causing this problem, the forms it takes, the models and dynamics of the transformation of brownfields, are all dependent upon the local social, economic, political, cultural and historical situation. The phenomenon of brownfields has not been sufficiently researched in Republic of Srpska. The issue and potential of brownfields remains unrecognised; there is no official definition of brownfields; nor is there a clear vision at the national or local level as to how they can be regenerated. Urban planning professionals identify them as previously developed and constructed sites, which are evidently not used efficiently, and which have capacity for urban regeneration and development.

The observation of Banja Luka's urban landscape allows the identification of brownfields as a special category of urban space. They account for substantial areas of spare urban space; as such, they are an important tool for guiding urban development and preserving and improving urban landscape. Banja Luka's brownfields have not been researched sufficiently, and it is estimated that industrial complexes and military bases, which cover 12.55% of the city's urban area (Draft, 2009), are the most important representatives of this category of urban space. In combination with other kinds of brownfields (utilities, residential, commercial, health and other structures and complexes), they as such represent the city's unrecognised resource, strategically important reserves which may be counted upon to take over a part of those uses usurping or endangering the green structure of the city's landscape.

In the context of the subject under consideration in this paper, it is important to say that industrial brownfields do not only represent significant reserves of built structures (suprastructure and infrastructure) and construction land suitable for the transfer of certain uses, but also of green areas. According to the Banja Luka 1975 Urban Plan, 712 ha was the area planned for the buffer zones and recreation zones in only two industrial complexes, amounting to 55% of the total area of industrial zones. Bearing in mind the fact that 248 ha of the area allocated for construction in the industrial complexes remain unused to this day (19% of the total area of industrial complexes), it may be concluded that these areas are even larger (Draft, 2009).

It must not be forgotten that brownfields partake in urban memory and are eloquent physical testimony to our past, which, if destroyed, will lead to the local community wasting a part of its history and of the city itself. In that respect, revitalising brownfields means a necessary step towards preventing their further devastation and dilapidation, and essentially its sense and purpose is to preserve the integrity of these material witnesses of an epoch sinking into oblivion. In these terms, regeneration may be defined as various possibilities and options allowing an "old" space to serve new, contemporary purposes, while preserving the past in the future (Stratton, 2000).

In the context of the above-said, it may be concluded that brownfields are apparently a problem, but also a missed opportunity (Nathanail et al., 2007, 60). Obviously, the issue and potential of brownfields remain unrecognised, compounded with the problem of the lack of a clear vision and

6 The definition of brownfields was given by the research network CABERNET (Concerted Action on Brownfield and Economic Regeneration), whose mission is to promote the regeneration of Europe's brownfields. The task of the network, with members from 21 European countries, is to provide a theoretical basis for the problem of brownfields, grounded in the latest most up-to-date knowledge and discoveries, and practical tools for their regeneration. For more information see www.cabernet.org.uk

strategy at various levels of administration, from the national to the local. The double effect of this problem is reflected, on the one hand, in a partial, impetuous and ill-suited activation of brownfields, leading to the endangerment and devastation of the local cultural, natural and building heritage; on the other, the lack of will to tackle the problem or deal with it in due time has been causing damage and loss to all categories of space and in all realms of social life – economic, cultural, environmental.

The social, cultural and economic potential implicit and inherent in brownfields indicates they are important in more ways than one and underlines the necessity of their regeneration. The first step towards achieving this goal must be the preparation of a strategy of regeneration of brownfields, integrated into a network of partial and specific space use strategies for the regeneration of Banja Luka's endangered urban landscape. As an alternative for a society "growing" incessantly and exploiting its natural resources in an uncontrolled way, regenerating brownfields represents one of the more economical solutions which will allow the activation and new profiling of structures already in existence. The regeneration of brownfields will promote and support sustainable territorial development due to more efficient exploitation of urban spatial resources, for the purpose of curbing the expansion of new urban tissue to vacant land.

CONCLUDING REMARKS

First and foremost, this paper poses questions and points to a variety of issues; nonetheless, it also promotes certain ideas and makes claims intended to offer answers, solutions and actions.

- The concept of *landscape* is identified as an instrument which integrates and synthesises a number of important aspects of research into space and of design of space. The green structure is viewed as traditionally its constituent part. Urban landscape represents a tool for environmental research, planning, design and preservation. It is an instrument of integral and essential town conceptualisation, in which a synthetic understanding and analysis of spatial-morphological structures and their use features prominently (with the green environment occupying a central place), along with the subjective experience of the living space.

- New urban tissue endangers and disintegrates the traditional form of urban landscape. There exist no theoretical and analytical mechanisms to study the formation of new urban landscape, its general, globally recognisable features, as well as its specific, locally expressive characteristics. Banja Luka's new urban landscape has not been researched sufficiently.[7] It has not been conceptualised, nor have methods been adopted for it to be examined in depth. This new urban landscape requires a new approach and new methods of analysis.

- *Brownfields* are identified as a special spatial resource and instrument of preservation and improvement of the green structure of urban landscape. If development shifts from the trend of detrimental use of greenfields and other green areas for economic and commercial purposes to reactivating and regenerating abandoned industrial complexes and military bases, the green structure of urban landscape will gain in status, receiving a new treatment in urban planning and design. Such a shift would be beneficial in a number of ways: urban landscape would be preserved (on the condition intensive theoretical and empirical research is conducted continuously); economically and socially passive neighbourhoods would be regenerated; there would be well-considered and guided development, with the introduction of measures of land use control and construction regulations; and most importantly, the most prominent features of Banja Luka's urban identity would be invigorated: Banja Luka as *a landscape city, an industrial city*, *green city* etc.

7 Urban landscape as an element of Banja Luka's urban identity is studied in the research by author D. Simonović (Simonović, 2010, 190-193). Also, a special focus is put on the problem of integration/disintegration of Banja Luka's new urban form, and in particular on the green – landscape – structure (Simonović, 2010, 258-259).

- The previously neglected morphological types of green environment found in brownfields and “discovered” by this paper hold a special place in the above-outlined relationship between brownfields and urban landscape. These forgotten spatial patterns of the green structure are valuable primarily in terms of their environmental potential, given the size and prominence of green areas in brownfields; however, they are also of social, cultural and historical value.

- The approach currently used in urban planning does not pertain to the problems the city is experiencing in the time of transition. It still revolves around practices whereby plans are used to direct the planning and construction of towns; there are no codebooks to regulate urban planning or construction that would be flexible enough and offer guidelines that could be changed and adapted according to new needs and possibilities. A codebook containing general norms of regulation of urban landscape in towns and villages would help balance urban plans with constantly changing contextual conditions, needs and interests.

The key recommendation of this paper is that a developmental, interdisciplinary and integral approach should be used in dealing with the complex phenomenon of urbanisation and transformation of urban landscape. An integral approach means that in terms of methodology and in relation to inherent problems, the regeneration of urban landscape should be analysed and acted upon from a number of perspectives, for the purpose of activation of identified spatial potentials (physical, social, economic, environmental, cultural etc.):

- Integral identification of resources and potentials of the broader city area taking account of a number of aspects, which would focus on the green structure of the central city zone, the city’s outskirts, and in particular on brownfields, greenfields and river banks;
- The generation of a wide range of models of integral preservation, improvement and regeneration of the existent green structure, as well as the planning, design and interpolation of new elements and its systemic linkage to the existent green structure;
- The creation of an integral network of partial spatial strategies[8] leading to a project of regeneration of urban landscape. It is essential that these partial strategies be conceived on an interdisciplinary basis and connected into a single network on the city level.
- The development of a regeneration strategy for brownfields sensitive to the local situation, as a constituent part of the strategy of regeneration of urban landscape in its entirety.

Owing to Banja Luka’s special character as an industrial city and a *military* city, attributable to the social and historical circumstances in the second half of the 19th century, and its long-standing reputation as a landscape, garden or green city (Simonović, 2010, 10-11), the proposed strategy of integral regeneration of urban landscape is firmly grounded in the local identity and urban tradition. It opens up possibilities for well-suited and far-reaching action through a set of specific activities.

REFERENCES

Dobrović, N. (1954). Što je gradski pejzaž? Njegova uloga i prednost u suvremenom urbanizmu. *Čovjek i prostor*, 20, 1-3.

Đokić, V. (2004). *Urbana morfologija. Grad i gradski trg*. Beograd: Arhitektonski fakultet Univerziteta u Beogradu.

Lefebvre, H. (2003). *The Urban Revolution*. Translated by Robert Bononno. Minneapolis, London: University of Minnesota Press.

Lefebvre, H. (1991). *The Production of Space*. Translated by Donald Nicholson-Smith. Blackwell Publishing.

Milić, V. (2001). Stara i Nova atinska povelja - efekti i projekcije identiteta gradova u Republici Srpskoj. In *Zbornik ljetnje škole urbanizma Šipovo 2001*. Banja Luka: Urbanistički zavod Republike Srpske, 29-37.

Milić, V. (2002). Pseudourbani prostor između sela i grada: trendovi u Republici Srpskoj. In *Zbornik ljetnje škole urbanizma Šipovo 2002*. Banja Luka: Urbanistički zavod Republike Srpske, 65-73.

8 The New Charter of Athens defines spatial strategy as well-considered, visionary thinking about space at a number of levels, from local through regional, national, continental to planetary, including land, people and their activities. (New Charter of Athens 2003, 2010, 37)

Nathanail, P. et al. (Eds.) (2007). Key findings from CABERNET – Europe's sustainable brownfield regeneration network. In *Proceedings of the 2nd International Conference on Managing Urban land*. Stuttgart: Theaterhaus, 59-64.

Novaković, N. (2008). Zelena struktura grada Banjaluke: razvoj diskursa u urbanističkim planovima. In Simonović D., Novaković N. (ur.), *Banjaluka: Urbana i graditeljska obnova grada u duhu održivog razvoja - uvodna razmatranja*; *Monografija naučno-istrživačkog projekta Arhitektonsko-građevinskog fakulteta Univerziteta u Banjaluci*. Banjaluka: Arhitektonsko-građevinski fakultet Univerziteta u Banjaluci, 116-132.

Novaković, N. (2008 a). Društvene vrijednosti i interesne grupe u definisanju zelene strukture grada Banjaluke. *Arhitektura i urbanizam*, 22/23, 87-95.

Unstead, J. F. (1931). The Regional Geography of Siegfried Passarge. Reviewed work(s): Die Grundlagen der Landschaftskunde, Vergleichende Landschaftskunde, Landschaft und Kulturentwicklung in Unseren Klimabreiten, Stadtlandschaften der Erde, Die Landschaftsgürtel der Erde. *The Geographical Journal* 2 (78), 164-166. http://www.jstor.org/stable/1784449

Radović, R. (1972). *Fizička struktura grada. IAUS*, Beograd.

Simonović, D. (2010). *Pejzažni gradovi: poređenje razvoja urbanog identiteta Banjaluke i Graca*. Banjaluka: Arhitektonsko-građevinski fakultet Univerziteta u Banjaluci.

Stojkov, B. (1996). Obnova gradova u Srbiji u novim uslovima razvoja. In Stojkov, B. (ur.), *Obnova gradova u Srbiji - temeljne odrednice*. Beograd: IAUS, 9-54.

Stratton, M. (2000). *Industrial Building, Conservation and Regeneration*. London: E & FN Spon.

Werquin, A. C. et al. (Eds.) (2005), *Greenstructure and Urban Planning - Final Report 2005*, COST Action, Europen Commision. http://map21ltd.com.

Wylie, J. (2007). *Landscape. Key Ideas in Geography*. London and New York: Routledge.

Vesnić-Neđeral, Ž. (1993). *Urbana rekreacija: funkcionalno i prostorno organizovanje rekreativnih prostora u gradu.* Arhitektonski fakultet Univerziteta u Beogradu, Beograd

(2010). Nova atinska povelja 2003. Vizija gradova u 21. veku Evropskog saveta urbanista. Beograd: Udruženje urbanista Srbije.

(2004). Izmjena Regulacionog plana područja „Centar-Aleja“ u Banja Luci. Banja Luka: Urbanistički zavod Republike Srpske.

(2007). Izmjena Regulacionog plana „Centar- Aleja“ - Banja Luka. Banja Luka: Urbanistički zavod Republike Srpske.

(1975). Urbanistički plan Banja Luka. Banja Luka: Urbanistički zavod Banja Luka.

(2009). Nacrt – Urbanistički plan Banja Luke 2008-2020. Banja Luka: Urbanistički zavod Republike Srpske.

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USE OF LANDSCAPE ARCHITECTURE IN ENVIRONMENTAL REGULATION OF SMALL CLAY PIT MINE

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ABSTRACT

In Vojvodina, the most degraded areas in the rural areas of surface mining of clay, sand and gravel. Small irregular depression or no water or filled with groundwater. We presented the preliminary design of the open pit design with no water. The preliminary decision is regulated by the camping area with a lake swimming and fish farm of Budisava.

Key words: open pit, clay, lake, fishing **.**

INTRODUCTION

In cases of smaller open pit recultivation (with or without water), principally there can be discussed the same critera for their managing as in cases of largere pits:

- Recultivate to the level of previous state – that understands fulfilling of depression of open pit mining with mullock, communal waste, material from newly opened prospects, construction pits etc. and then covering it with humus layer in order to bring the surface to its previous purpose (agriculture, viniculture, orcharding);
- Recultivate of depression of the open pit mining in order to establishing ecologically valuable habitats, especially in cases of locations in natural parks of different level of protection or in case of some autochthonous habitat regeneration;
- Recultivate with aim to arranging area for sport and recreation, aqua parks, specially when the open pit mining is nearby settlement;
- Renouncing to spontaneous natural development after exploitation termination. This solution is taken in consideration if the open pit mining edges (slopes) are so shaped that there is possibility of spontaneous or revitalization with the slightest interventions of a landscape architect. Most often there is necessary the area of the open pit mining to be enclosed, in order to avoid damage that could be caused by people, wild and domestic animals. This solution doesn’t exclude activities according to legal obligations for recultivate.

In order to determine the purpose of depression utilization and procedure how to achieve that, first there are explored basic guidelines, limitations and fundamental natural characteristics of the open pit mining depression. This location purpose depends on natural conditions, size of the surface, existing infrastructure and potential users needs. In the following phase, there are explored elements of recreation program and then follows the solution for recultivation and planning.

Among existing solutions, there is represented the solution of recultivate with aim to arrange recreation area along with ecologically valuable habitats protection. Namely, initial decisions in making the Project for recultivate and planning of the open pit mining refer to: lake constructing, its utilization in recreation purposes and keeping this location as ornithological valuable habitats.

The basic criteria for projecting of small open pit managing are shown in the table 1.

Very important criteria and essential as well is a water quality (see table 2). In order to conserving water quality and preventing plant growing in water enriched with organic matter, there is not reccommended to apply any intense form of fish breading. The future fish in the lake should be in accordance with the

Table1: Criteria for different types of recreation

Recreation type	Convenience criteria
Swimming	- water body, at least 3 – 5 (ha) - free surfaces bigger than the lake surface - acceptable bacteriological water quality - no permanent phosphates presence - more than a half of water surface water depth more than 3 (m) - acceptable water temperature - constant water level - well formed banks and underwater relief - good relation “meadow – forest – field* - convenient traffic connections - no damages from nearby locations usage (noise, gases etc.) - no danger for neighbor purpose of the location (noise)
Fishing	- minimal water body surface 2 (ha) - more than a half of water surface water depth more than 2 (m) - without extreme concentrations of salts and pH values - shoal presence
Rowing	- minimal water body surface 20 (ha) - good approach to banks

production potential of the lake itself along with protection measures. In case of creating small water surfaces fo fishing purposes, there are minimal protection measures required: permited usage of appropriate tools, security guards and prevention of prohibited devices usage or fish theft. There is neccessary to determine the extent of baits usage in order to prevent eutrofication. Surfaces for camps are required to contain infrastructure: water bringing and drainage from the lake, sewage system etc.

PRELIMINARY DESIGN OF RECREATIVE – PRODUCTION FISHING POND IN BUDISAVA

Closed to the settlement, at the north, along the meliorative channel D 608, nearby the road Novi Sad – Titel, there are gathered fields of Budisava municipality – 15 ha surface direction north – south. From the north and south thez are surrounded with meadows, from the east with the channel D 608 and at the west there is a road (see also Figures 1,2,3,4).

According to the preliminary design, the most of the terrain is presented with fish ponds and cantonment, and south from this production there is a hotel, a summer garden, sport terrains, an open swimming pool, a children playground, showers and cabins. Dimensions of the production pond are shown in the table 3 (see also Figure 5).

Proper allocation of all surfaces and direction cinncenting, ther is provided a better circulation of pedestrians within the complex. A project of an approaching tarnsport routes and a pariking place defines more precisely all the elements, The general disposition of objects there is given at the clutter

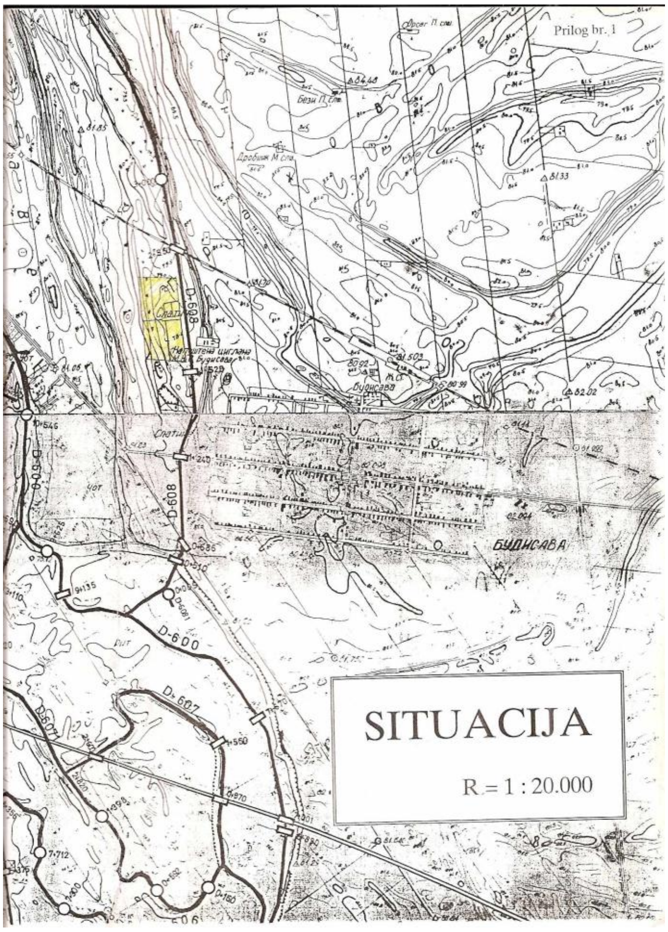

Figure 1. Geographic location of the future pond

Table 2: Required water quality for ponds

Elements	Reccomended (mg/l)	MAC (mg/l)
Water colour in grades	30	50
Transparence	Transparent	Easily blured
O_2	4-8	2.5
CO_2	10	20
H_2S	0	0.1
pH	7	6.5
Total hardness	5-8	3-5
N albuminoid	0.5-1.5	2
Oxidation O_2	15-20	40
Ammonia salts	0.5-1	1.5
Nitrites	Do 0.2	1.5
Nitrates	1-2	0
P_2O_2	0.2-0.5	0.5
Fe	1-2	4
Cl	5-10	25
SO_4	10	20-30
Salinity	1 000	1 500

Figure 2. The current situation without water

Figure 3. The current state of water

Figure 4. Current Status of the storm pond

According to the preliminary design, the most of the terrain is presented with fish ponds and cantonment, and south from this production there is a hotel, a summer garden, sport terrains, an open swimming pool, a children playground, showers and cabins. Dimensions of the production pond are shown in the table 3.

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Table 3: Dimensions of he production fish pond in Budisava

Pools	**Bottom surface (m^2)**	**Water mirror surface (m^2)**	**Pool lenght (m)**	**Pool width (m)**
I pool	27 321,5	30 352,1	270	86-123
II pool	43 979,0	48 411,0	290	100-240
Cantonment	2 910,0	4 714,7	97	30
Total	74 210,5	83 477,8		

Pools are sunk in terrain after its niveling to 20-50 cm and are devided from other surfaces with embankments. Cote of the crown of embankment is +80,5 m.a.s and the water mirror is at +80,0 m.a.s. Width of the crown of embankment is 4 m so there is provided one direction traffic between pools. The slope of embankment towards water mirror is 1:3, and towards the dry side is 1:1,5. Water depth in the first pools is about 2,0 m, in the second 0,8-2,0 m, and in winter pond it is 2,1-2,2 m depth. Three wells of 20 m i ndepth regulate water supplying. Pools charging last about 25 days, and of the cantonment 19 days. Water drainage from the pond is arranged through reinforced concrete system to the channel D 608 .

The pool 1: Length about 270 m, width in the narrower part 86 m, width at the wider part about 123 m. The cote of the embankment crown is at 80,50 m.a.s., a water level is st the cote 80,00 m.a.s.. Water depth of this pool is about 2 m.

The pool 2: Length about 290 m, width in the narrower part 100 m, width at the wider part about 240 m. The cote of the embankment crown is at 80,50 m.a.s. and a water level is at 80,00 m.a.s. Water depth of this pool is from 0,80 to 2m.

Cantonment: Average length 97 m, width 30 m. The cote of the embankment crown is at 80,50 m.a.s. and water level is at 80,00 m.a.s. Water depth in the cantonment goes from 2,10 to 2,20 m.

Water drainaged from the pools go to the channel D 608 with pipeline Ø400mm.Water drainage from the cantonment goes through pipes Ø300mm, gradually 117 l/s (that is under the drainage potential of the channel D 608). The place of water drainage to the channel D 608 should be coated with concrete 5 m left and right, depth 10 cm.

Ramps: Each pool and the cantonment has one downward ramp, width 4 m, length 15 m, embankment slope is 1:1,5

Periphedal canal is positioned by the embankment at three sides of the produciton-recreative-fishing center. It has a purpose for collecting and drainage of water from pools. Width of the channel is 0,5 m and the depth is 0,5 m

Water supply is organized from the 20 m depth well thanks to diesel agregates of 15 l/s capacity.

Figure 5. Conceptual design of a future production sport-fish ponds

Figure 6. Conceptual design of children's playgrounds

The other part of the complex has less surface, south from the production part and has a purpose for summer recreation. It contains fish restourant with rooms, tennis terrain parallel to the longer side of the swimming pool. Between objects there aregreen areas with flowers, bushes and trees (see also Figures 5 and 6). Around the swimming pool there are showers, cabins, children playground and sport terrains for basketball and valleyball.

The material used for the children's playground, trails on the shore and the coast of ponds, then furniture and restaurant terraces are made of natural materials-wood planks, moldings, beams and wattle.

The south east part of this complex is planned to be afforested with high leaved of native species, as well as those area along the fence towards fields.

Figure 7.Tthe coast paths and ponds for fishing

CONCLUSION

The ambience covered by the plan is located on the edge of the village in the north-west and consists of pastures. From the aspect of agricultural production, this area is of special importance with regard to the quality of land and pasture. At this location there is a relatively mild flooding of the canal surface atmospheric and underground waters. The quality of ground water for filling ponds meets the standards for fish production. Given the above, this space can be used to build production-sport fisheries, as prescribed by the proposed technical solution and the technology of production of fish is not realistic to expect a negative impact on agricultural land in the region.

REFERENCES

Brookes J. (2002). „Garden ‚esterclass“, Great Britain 2002, A penguin company.
Tibor S., Tibor S. (1999). „Növényismeret“, Budapest 1999, Nemzeti Tankönykiadó.
Donaldson S. (2002) – „Containers“, London 2002, Hermes House.
Vujkovic Lj. (2003) "Tehnika pejzaznog projektovanja", Beograd 2003.

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THE SYSTEM OF GREEN SPACES IN SPATIAL AND URBAN PLANNING IN SERBIA WITH SPECIAL REFERENCE TO THE GENERAL REGULATION PLAN OF THE CITY OF KNJAŽEVAC

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ABSTRACT

The system of green spaces - green infrastructure, represents an important element of urban areas climate infrastructure. Recognizing the fact that the Republic of Serbia is in the process of preparation for a special legal framework that should regulate the subject matter, the paper provides an overview of the existing regulations relating to the planning of the system of green spaces. Using the selected case studies an insight into the current practice of planning of the system of green spaces in urban areas is presented where, specially, the General Regulation Plan of the city of Knjaževac is distinguished. The Plan represents the concept for interconnection of of the fringe zones vegetation with the green surfaces in the city using tree lined paths and river coastal vegetation. In this way better circulation and the flow of air will be allowed and therefore ventilation of the city. This concept supports the primary goal - the protection and promotion of the green spaces system as an integral element of climate infrastructure of the city of Knjaževac.

One of the main conclusions of this paper emphasizes the necessity to work on establishment of the adequate information (data) base – the cadastre of green spaces - as the basis for adequate planning and management of the system of green spaces. It also emphasizes the increasing importance for development of a database within Geographical Information System (GIS) environment, the ability to use Internet technology, Google's satellite imagery during the phases of understanding current situation but also later in presenting the obtained results on any Web page.

Key words: system of green spaces, Geographical Information System – GIS, vegetation, climate infrastructure.

INTRODUCTION

Vegetation – the system of green spaces – green infrastructure represents today a very important potential for urban areas, not just because of its ecological functions such as, inter alias, direct confiscation of CO2, reduction of the use of energy (trees are providing shadow and also green roofs and walls) and reduction of the run off participation, but also in social terms, in a sense of positive impacts to the human health. The green infrastructure within working environment provides production and maintenance of jobs and encourages development of tourism (the greener city will attract more visitors). Taking into consideration that the system of green spaces implies the complex of spatial connected urban and suburban green spaces, making an entity within spatial composition form with specific function and purpose, there is an obligation for its satisfactory planning, implementation, as well as the management.

Contemporary frames of spatial and urban planning today provide support to the protection and improvement of vegetation at all levels, especially when the role of vegetation and the system of green areas as climate infrastructure is considered. The green infrastructure has a limited and important role to mitigate what particulary highlights its adaptation role in a sense to moderate temperature extremes, reducing the volume and slowing the rate of rainwater, flood management, soil erosion, proving, so called “wild” corridors and providing space for recreation (Mathey&Robler, 2010).

An updated database – the information base is necessary for effective and efficient planning and managment. In that sense, the Geographic Information System (GIS) of the system of green spaces has its place in the phase of systematization and in the implementation/application phase of the subject plan. The actual planning process of the system of green spaces includes the inventory of green spaces and their connections, the indentification of the opportunities for their protection and restoration, developing a coordinated strategy in order to develop “channels” and the redevelopment to the most adequate locations (Benedict & McMakon, 2002). As one of the main problems regarding the proper planning and management of this system in Serbia is the non existence of data, actually the cadastre of the green spaces, a significant progress in establishing a database to work in GIS has been made in this respect within last years at different levels: republic level, regional and the level of the city (Crnčević, Bakić, 2010).

The main objective of the paper is to, by analyzing the existing legal framework, give an insight into the actual situation, and by an overview of the selected case studies, where it is specially singled out the example of the city of Knjaževac, present the situation of the current practice of the green spaces system planning in Serbia and allocate the priorities.

OVERVIEW OF THE MAIN LEGAL FRAMEWORK COVERING THE PLANNING OF THE SYSTEM OF GREEN SPACES IN SERBIA

Republic of Serbia is continuously aligning the legal framework within European and international agendas and therefore the obligations and recommendations related to the vegetation – protection of nature and respectively to the system of green spaces in urban areas. Ratification of the European Landscape Convention is one of the latest positive steps towards improving the landscape planning in Serbia.

It should be noted that a separate law covering green infrastructure does not exist in Serbia. The law that provides the basic framework for spatial and urban planning in Serbia is the Law on Planning and Construction (Official Gazette of RS no. 72/09, 81/09 – correction, 64/10 – US and 24/11). This Law does not have specific provisions for the system of green spaces within Rules of Planning and Constructions. However, in the section covering urban planning „general directions, the transport corridors for energy, water, communal and other infrastructure“ (Article 24) are included and correspondingly „urban and other requirements for regulation and construction of surfaces and objects for public use and traffic network and other infrastructure...“ (Article 30, paragraph 2) where the „other“ infastructure might include green infrastructure apropos the system of green spaces.

The Law on Environmental Protection (Official Gazette RS no.135/04), under Article 20, imposes an obligation for respecting public green spaces under following provisions: “The public green spaces in urban areas and areas covered by spatial and urban plans are raised and maintained by the way that allows the preservation and enhancement of natural and created values. If they are destroyed after construction, they must be compensated under the terms and conditions determined by local government. General conditions for protection, the way of raising, maintenance and reconstruction of green spaces and keeping the record are regulated by special laws”.

Spatial Plan of the Republic of Serbia (SPRS) (Off. Gazette no.88/10) indicates that the basic problem of protection and planning of landscape in Serbia, among others, is the „disappearance of the specific character of urban and rural landscape by expanding peri-urban areas, conversion of agrucultural land, by construction and by using spaces without respecting regional and local specificities..“ further “..the reduction of green and open spaces in urban areas and loss of the connection with regional system of open spaces..“. Accordingly, the SPRS is committed to the improvement/preservation of the image and structure of urban landscapes, among other things by „conservation, enhancement and sustainable use of open, green spaces and elements of nature in the cities and as well by creating the network of green and public spaces that connect natural and cultural values of the settlements, peri – urban areas and rural landscape“.

A good example is the project „Green infrastructure of Belgrade“ (JUP Urbanistički zavod Beograda 2003, 2004). This project improved the quality of information related to the green infrastructure and offered a framework for planning, implemenation and management of the system of green spaces to local govrements. The project is in the phase of creating Geographic Information System of Belgrade Green Spaces (GIS BGS). For the municipalities Novi Beograd and Zemun approximately 218,84 ha, were done (Sekretarijat za zaštitu životne sredine i JKP Zelenilo Beograd, 2009):

- data collection (spatial and attribute related),
- assessment of methodology then theoretically defined data collected through practice (field work) and assessment of collected data,
- testing the system in real business processes and development System,
- technical and organizational practice of the Project key processes with involvement of direct users of the System.

Also, the adopted Strategy for afforestation of the Belgrade area (Official Gazette of the city of Belgrade, no.20-7) where one of the objectives, among others, is the protection of the green spaces system represents an important frame for further management and improvement of overall vegetation of the Belgrade area.

All this mentioned above represent important documents for implementation during the process of planning and definig strategic solutions and, an important frame for the management of green areas and the base for continual and further improvement of the green spaces system. However, there is lack of law which will cover green infrasructure – the system of green spaces. Therefore, the Law on raising, planning and maintance of green spaces which is now in the procedure will be an important, it could be said even crucial regulation for further protection and enhancement of green spaces and vegetation in urban areas.

PLANNING OF THE GREEN SPACES SYSTEM AND GIS – OVERVIEW OF THE SELECTED CASE STUDIES

The example of spa settlemets

Characteristic for spas settlements in Serbia is the fact that, in addition to mineral resources, the existing vegetation represents also very important resource. Therefore, it should be stressed that the existing vegetation within the system of green spaces represents an important element of climate infrastructure within the spa settlements.

An explicit representation of green areas, over 60%, together with the surrounding of forested hills and forest land, that naturally follows up to the forest of the mountain Goč, while on the other side, goes down to the Zapadna Morava valley in gentle slopes, characterizes the landscape of Vrnjačka Banja. The main potential of the area besides mineral water is the wealth of vegetation – the system of green spaces. The system of green spaces in Vrnjačka Banja is presented within the public surfaces (parks, squares, greenery within blocks, tree line paths), the greenery for special purposes and limited uses (around schools and medical institutions, sports and recreational spaces), conservation greenery (around industrial and other objects, coastal greenery), park forest and conservation forestry and natural property (monuments of nature). An accurate information database is also one of the potentials. Referring to the limitations for the planning area subject, the illegal construction that leads to the fragmentation and the appearance of illegal dumps can be singled out.

The Master plan for Vrnjaka Banja 2005-2021 (Official gazette of the comunity Kraljevo n.12/05) stands to protect all elements of the natural structure and promotes improvement, not only in the esthetic way but also in the restoration of sanitary-hygienic conditions. Therefore it can be assumed, that the plan stands for continual protection of the green spaces system and specially for the protection of forests and the spa park in the center of Vranjacka banja (Crnčević, Bakić, 2008).

Pribojska Banja also besides mineral resources has significant potential within preserved vegetation where within the public green spaces, based on the Plan for detailed regulation (IAUS, 2008), the green spaces system includes spa park, the green areas for special purposes (areas around the buildings for public services – Health Center, Multimedia Center, baths, annexes), forests and forest land and protected surrounding environment – cultural and historical monument the Monastery of Saint Nicholas from 13th century (the immediate surroundings of the monastery is under protection). One of the main limitations of this plan area was lack of data regarding the green spaces. The plan area is not developed so the stress of the plan was in raising new green spaces together with the protection of the existing biological fund and keeping the landscape authentic (Crnčević, Bakić, 2008).

Taking into consideration that development of the planning documentation is a complex, time consuming and expensive process, it is clear how important is to establish an efficient and flexible system for monitoring, implementation, updating and evaluation of planning solutions so that creating planning documentation is simpler and faster while the phase for searching and retrieval of data about the subject area is reduced to the negligible period of time (Kilibarda et al., 2010).

GIS of green spaces (GS) in that context means the creation of a model that includes the specification of system requirements, hardware, software, data collection methods, the organizational chart and the maintenance of the site, (Crnčević, Bakić, 2009). The establishment of a base and the use of the set standards is done for Master plan of Vrnjacka Banja and The plan of detailed regulation for Pribojska spa by the Institute for Architecture and Urban and Spatial Planning of the Republic of Serbia. The above green spaces systems caused tracking of the surface, point and line objects in the field and establishment of a database that monitors the status that can be expressed in quantities (measurable) and be descriptive (quality, condition). The GIS mapping of green spaces, at one side, represents graphical representation of the size and distribution but also the data base which, in the form of a table, contains the exact surface, number of the land parcels, the parameters of the state, further use etc.

The development of database in GIS environment for mapping of the green areas included following phases:

- the phase of collection – various current maps and studies and other papers relevant for mapping.
- the phase of conversion of standard CAD graphic applications in advanced GIS geospatial data base ESRI ArcGIS 9.3 of the software package.
- the phase of formatting preliminary maps after adoption of the key for mapping.

It should be stated that presentation contains cartographic representation of the system of green spaces within selected plans in GIS environment. The entire base can be seen on the web site http://groups.google.com[banjski turizam]@googlegroups.com and on IAUS intranet .

Recognizing the fact that the vegetation is an integral part of the urban areas infrastructure, the establishment of a database of the green spaces system within GIS environmnet is important as part of a comprehesive database of the area, which would find its application in plannig and implementaion of plans (Crnčević, Bakić, 2010).

The potentials of GIS of GS are:

- ability to integrate various data into new information,
- to improve and facilitate easier manipulating of a large number of spatial data,
- to visualize the data by interactive maps,
- management of the spatial data and their integration into unified information system of the space,

- to combine geographical data (the locations of natural and man made structure on Earth's surface, their spatial elements) with various types of information,
- the information available could be searched quickly and perceived, monitored, upadated, reviewed and applied.

On the other side the limitations are: system is highly complex in technical terms and organization, there is need for the support at the local government level, by the public enterprises and at the higher level / ministries, republic, etc.

In the process of landscape planning and planning of the green spaces system it is important that the large number of heterogeneous data is systematized and can be easily accessible from one place. Such work implies the existence of a unique database (the existence of spatial and attributes components), and various cartographic displays, analysis and combinations of different data (Crnčević, Bakić, 2010). Working in any GIS enironmnet offers the opportunity to analyze the data by setting different queries. This feature is particulary important advatage because the desired results can be obtained in different output formats: as text, tables, graphs or maps. The analyses further can be performed for a particular segment, such as green spaces within the area of a cadastre municipality, urban unity or administrative municipality. For example, the data for one tree in a spa park, display of park spaces within the urban zone or the view of a diseased tree within the level of a forest estate. The obtained results can be presented in several ways, in the table with possibility for creating charts (line, Bar, Pie) and thematic maps (map of green infrastructure and of the green spaces system) (Crnčević, Bakić, 2010).

The example of the Knjaževac city – The General Regulation Plan of the city of Knjaževac

The location of the city of Knjaževac conditioned the development of settlements and likewise the system of green spaces. Located between the hills Tupiznica, Tresibaba and Stara Planina, the city lies on the banks of rivers, Trgoviškog and Svrljiškog Timoka that just below the city zone confluence and make Beli Timok. In addition, there are rivers Grežanska and Kaličinska in the city and Čivlik stream. The majoprity of the river flows is regulated / the original regulation is made without manor bed and in the very central area. The regulation of banks was done parrallel with the regulation so that today the intergal part of the green spaces system is the coastal green space. The overall surfaces of the green spaces system is 25.53 hectares or 1,45% of a total teritory.

Knjazevac has few regulated public parks surfaces – only two that are located in the city center on the left bank of the river Svrljiški Timok. The original shape and surface has been modified after reconstruction, but the primary function is not endangered which is passive recreation and repose of the citizens. Characteristic in Knjaževac is the fact that most of the streets with high profiles have tree line paths. One of the positive results of the last years development is the development of green spaces around/in front of the objects for public service.

Although the city of Knjazevac lacks green spaces, the green spaces within the collective housing are undeveloped, with no vegetation and adequate parking space. Individual green areas are represented within the house surroundings and mainly in the peripheral parts of the city. These surfaces are also presented in unplanned settlements "Lastavičko polje" and "Kasarna".

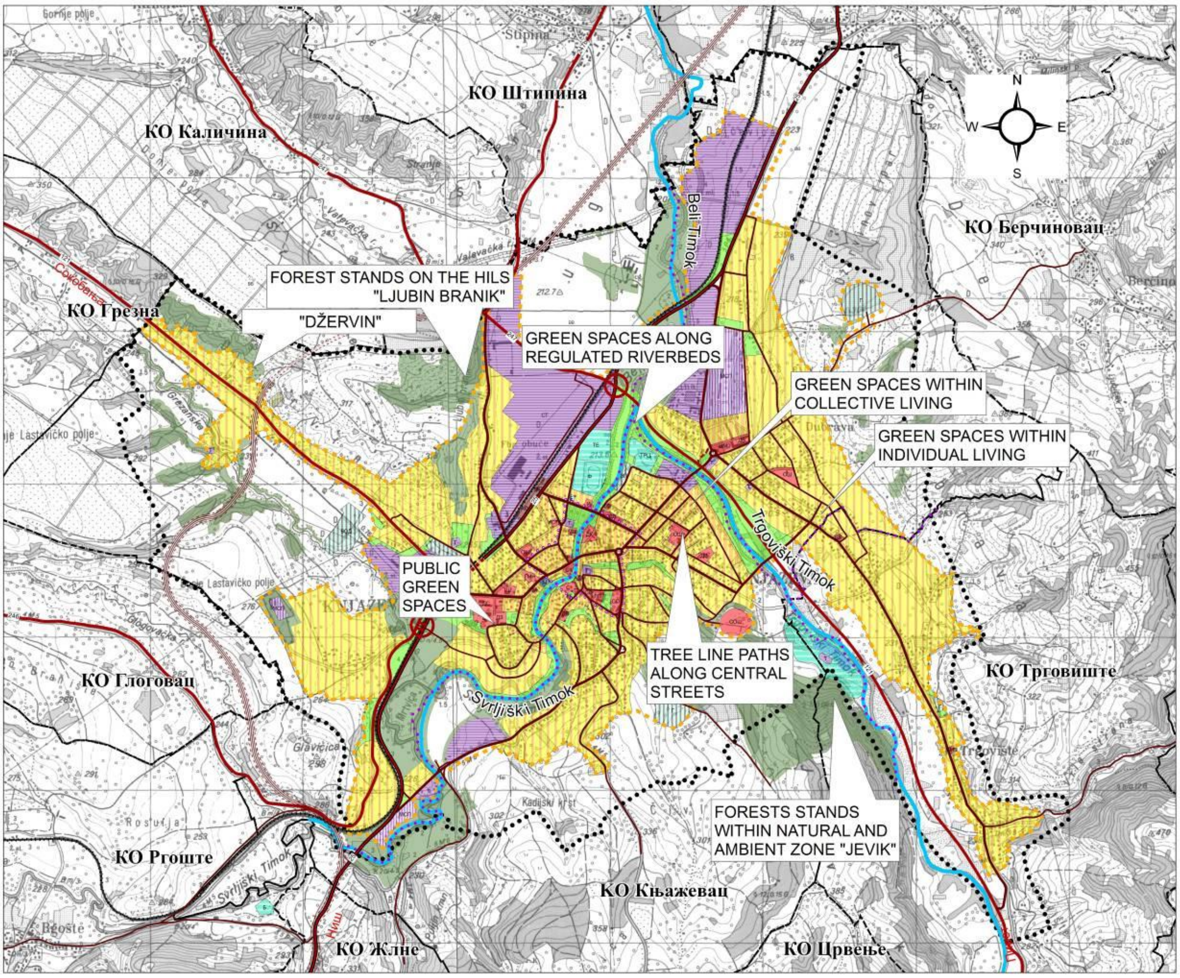

Figure 1. The system of green spaces for the Knjaževac town
Source: General regulation Plan for Knjaževac, plan concept, 2011

The green space within Health Center with total surface of 1750m^2, which is in function for leisure and passive recreation can be distinguished. In addition, the schoolyards and kindergartens have adequate green spaces. There is a regulated churchyard within the Church with total area of 300m^2.
For intensive and recreational sports activities there are quality and spacious areas that do not have regulated green spaces, where surfaces are mostly covered with grass: the complex where is the city stadium “Timočanin”, the shooting range and tennis courts.

Three industrial zones are established, two downstream and one upstream of the city and one smaller complex for technical service. What is characteristic is that the industrial zones are located usually and mainly within the flat terrain where the soil is of a high quality class. Green space within the complex “Branka Dinic” (390m^2) is neglected. Basically, it can be assumed that industrial objects do have regulated green space around main - administrative buildings. The area covering cemetery is 2865m^2.

For the peripheral areas of the city the presence of the forest stands, mainly on the steep surfaces is characteristic. As the result of the previous management – the over-exploitation and the lack of rejuvenation, the current condition of the forest is not satisfactory, in terms of the overgrown by trees and wood mass and by participation of species and internal structure. The species represented in these woods are oak and beech and other in a lower percentage. Species such as poplar, alder, willow are also represented, but less and mostly along water flows and at low and very moist soils.

As natural and ambient zone the hill “Jevik” can be distinguished situated southeast from the city with an area of about 20.00 hectares. The terrain is mostly rocky and overgrown with thickets of oak. On the surface of 3- 4 hectares, on the high terraces of this terrain the culture of black pine – Pinus nigra is raised. The tendency for the development of this area is to become Park Forest for passive recreation and relaxation. The role of this hill is important to the city - it is source for aeromeloration of the polluted urban air as well as the hills "Ljubin branik" and "Džervin".

Therefore, based on the mentioned above, it can be stressed that the main potentials are: established and maintained public green spaces in the central zone of the city, a significant presence of the individual green spaces and forest and forest land at the peripheral zones of the city. On the other side, the main limitations arise due to the lack of space for developing of new green spaces in central zones and lack of adequate information base in view of a cadastre of green spaces.

Taking into consideration that the green spaces system is an important element of climate infrastructure its importance in relation to sunlight, atmospheric purification of air, dust, smoke and soot can be emphasized, and the protective role within ionizing radiation, as well as positive impact on the human. The presence of forests has a significant positive impact not only to climatic conditions of Knjazevac but also to other conditions which are in function of the environmental protection, such as regulation of water content in rivers, the impact of the erosion process resulting from rain, wind and water flows etc. The Plan represents the concept for interconnecting the vegetation of the fringe zones with the green surfaces in the city by using tree line paths and river coastal vegetation. In this way better circulation and the flow of air will be allowed and therefore ventilation of the city. Therefore, the main objective of the Plan is protection and improvement of green spaces as a significant natural resource component of the city of Knjaževac and integral part of climate infrastructure.

The priorities within the system of green spaces are, among others,

- city's rough surfaces which are not intended for the construction and agriculture regulated as public green spaces.
- greening of the city center: vertical greenery, the formation of the roof terraces and usage of the flower pots,
- development of the information base for green infrastructure / the cadastre of the green spaces.

The plan has been prepared in analogue and digital form for the needs of the software package and the appropriate software of GIS. The plan was presented in a standard GIS software package in Windows environment (in the licensed software package ArcGIS 9x). The preparation of drawings meant the translation of analogue basic substrate in digital form, digitalization of thematic content and transfer of already digitized data. Text part is given in a form which is part of a standard. Within the way of structuring and organizing data focus was on functionality and the most suitable presentation of the results, according to the needs and desired results. Using standard commercial software tools offers the possibility for more quality work of spatial analysis of the plan area, review and evaluation of possible alternative solutions and presentation of the planning solutions. GIS software package is compatible with other programs and AutoCAD and others.

CONCLUSIONS

Planning and management of the green spaces in Serbia still lacks full legal support. The adoption of the Law on raising, planning and maintenance of green spaces is therefore an important step towards further protection and enhancement of green spaces and vegetation in urban areas. It should be noted that the adoption will imply adjustment of regulations, covering planning, environmental and nature protection.

However, the situation within current practice shows that Serbia do have a developed and diverse system of green spaces where spa settlements should be recognized. Also, the presented case studies show the existence of rich vegetation within planned areas and to some extent the adequate information base, where the case of Vranjčka Banja can be singled out. The development of the green spaces system within Knjaževac is an example of recognition the role of the green spaces system as an important element of the climate infrastructure, which is in accordance with contemporary agendas on climate change.

One of the main limitations within planning of the green areas system, besides the lack of legislative , is non existence of adequate and accurate information base regarding the green spaces. Therefore, this implies the necessity for work on the establishment of the accurate and adequate information base – the cadastre of green surfaces - as the basis for appropriate planning and management of the green spaces system. Developing the database within GIS environment, the ability to use Internet technology, Google's satellite imagery during the phases of understanding the current situation and later in presenting the obtained results on any Web page is consequently today of the increasing importance. In this way, among other things, it will enable more efficient and better controlled work of the local governments, better information for citizens, transparent decision making process within planning of the green spaces system and the possibility of integration into specific systems such as TOS –Tourist organization of Serbia.

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REFERENCES

Benedict & McMakon (2002). *Green infrastructure*: *Linking Landscapesdand Communities*. The Conservation Fund and Sprawl Watch Clearinghouse, www.conservationfund.org

Crnčević, T., OBakić O. (2009). Primena GIS alata u procesu planiranja sistema zelenih površina banjskih naselja: primer Vrnjačke Banje. *Međunarodni naučni skup „Regionalni razvoj, prostorno planiranje i strateško upravljanje”*, Tematski zbornik radova, drugi deo, Beograd: IAUS, 473-482.

Crnčević T., Bakić O. (2010). Zelene površine banjskih naselja Srbije – prilog uspostavljanju i razvoju informacione osnove u GIS okruženju, *Održivi razvoj banjskih i turističkih naselja u Srbiji,* Posebna izdanja 64, 59-74

Crncević T., Bakić O. (2008). The system of green surfaces in spas with special reference to the case studies: Vrnjačka, Kanjiža and Pribojska spa, *Spatium 17/18*, IAUS, 92-97.

JUP Urbanistički zavod Beograda (2003). *Zelena regulativa Beograda- informacija o projektu*

JUP Urbanistički zavod Beograda (2004). *Zelena regulativa Beograda- druga faza projekta*

Kilibarda M., Samardžić M., Bakić O., Stevanović Stojanović J., Krunić N., Bajat B., (2010). Primena Ajax i Google Maps Api tehnologija u Web kartografiji - Primer Generalnog urbanističkog plana Vrnjačke Banje, *Održivi razvoj banjskih i turističkih naselja u Srbiji*, Posebna izdanja 64, 267-302.

Law on Planning and Construction, Official Gazette of RS no. 72/09, 81/09 – correction, 64/10 – US and 24/11.

Law on Environmental Protection, Official Gazette RS no.135/04.

Master plan for Vrnjaka Banja 2005-2021, Official gazette of the comunity Kraljevo n.12/05.

Mathey, J, Robler, S., (2010). Adaptationto Climate Change by Urban Green Systems in Relation to Urban Wasteland renaturation, www.ioer

Sekretarijat za zaštitu životne sredine i JKP Zelenilo Beograd (2009). *GIS Zelenih površina Beograda – prva faza realizacije*, prezentacija projekta.

Spatial Plan of the Republic of Serbia, Official Gazette no.88/10.

Strategy for afforestation of the Belgrade area, Official Gazette of the city of Belgrade, no.20-7.

The plan of detailed regulation for Pribojska spa, Institute of architecture and urban and spatial planning of Serbia - IAUS, Belgrade, august 2008.

The general regulation plan for Knjaževac, plan concept, IAUS, 2011.

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ECO BUILDING CONSTRUCTION INFLUENCE ON QUALITY OF URBAN AREAS

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ABSTRACT

Eco building construction or sustainable construction aims to embody the principals of sustainable development i.e. environmental protection, economic development, and social development, in the siting, design, building, maintenance and occupation of buildings. Eco buildings are designed and constructed to high environmental standards and thereby; minimise energy requirements, reduce water consumption, use materials which are of low environmental impact e.g. low embodied energy and resource efficient, reduce wastage, conserve/enhance the natural environment and safeguard human health and wellbeing.

Key words: eco building, environment, sustainable construction.

INTRODUCTION

Since the Industrial Revolution, the world has witnessed incalculable technological achievements, population growth, and corresponding increases in resource use. As we enter a new century, we are recognizing the "side effects" of our activities: pollution, landfills at capacity, toxic waste, global warming, resource and ozone depletion, and deforestation. These efforts are straining the limits of the Earth's "carrying capacity"—its ability to provide the resources required to sustain life while retaining the capacity to regenerate and remain viable.

As the world's population continues to expand, implementation of resource-efficient measures in all areas of human activity is imperative. The built environment is one clear example of the impact of human activity on resources. Buildings have a significant impact on the environment, accounting for one-sixth of the world's freshwater withdrawals, one-quarter of its wood harvest, and two-fifths of its material and energy flows. Structures also impact areas beyond their immediate location, affecting the watersheds, air quality, and transportation patterns of communities.

The industry's growing sustainability ethic is based on the principles of resource efficiency, health, and productivity. Realization of these principles involves an integrated, multidisciplinary approach—one in which a building project and its components are viewed on a full life-cycle basis.

This "cradle-to-cradle" approach, known as "green" or "sustainable" building, considers a building's total economic and environmental impact and performance, from material extraction and product manufacture to product transportation building design and construction, operations and maintenance, and building reuse or disposal. Ultimately, adoption of sustainable building practices will lead to a shift in the building industry, with sustainability thoroughly embedded in its practice, products, standards, codes, and regulations.

THE PRINCIPLES WHICH SHOULD BE FOLLOWED

The principles of good construction with cost, economic, cultural, health savings considering:

- Increasing the quality and comfort of the environment,
- Improving mental and psysical condition of the people,
- Efective use of primary, used, revitalized or recycled materials,
- More efficient utilization of solar light and heat, and resources such as water and air.

The result of applied guide principles of building with savings, for which is characteristic that is primarily oriented towards the creation of new opportunities, not to solve specific problems, is building:

- That is connected to and operates in synchronism with the local eco-system, which itself belongs,
- That poses no obstacle on other buildings, or any other element of the eco-system,
- Which have been adopted and applied technologies that unbecoming of existing local conditions,
- Which is a mirror of cultural and environmental awareness of people,
- Whose overall negative impacts on the environment is minimal.

Figure 1. Example of eco building [5]

The choise of the building site

The choice of site for construction can significantly contribute to saving and cost of building the entire enterprise, if If you make a good consideration. From the point of building savings, ordering party of construction project by the contracting authority can offer the choice of the point of a suitable site for construction, designers are reflected in. That would be a site:

- Which has a good orientation with respect to the world (“the northern aspect”), and all for the best utilization of solar light and heat,
- If there is a high-quality vegetation, which creates conditions for better temperature control, which is due to better air quality, which provides shelter and provides greater opportunities in terms of environmental regulation,
- Which is near the general-purpose objects such as shops, schools, sports facilities, public bus station, tram or rail transportation, reducing dependence on transportation with your own cars,
- Located at the place well connected with the neighboring streets, providing easy access to the building.

- In any case, you should consider the following good ideas guiding:
- 10-minute routes - in order to reduce dependence on your own transport, ideally, the distance between the potential building sites, or future place of residence of people, and any other place in which these people for whatever reason it may be on foot or public transportation pass for no more than 10 minutes. In this case, the aforementioned route would have to be found nearby shops, schools, parks, sports facilities, public transport stops, and also facilities for recycling,
- Well connected streets - with the previously mentioned facilities contributes to a positive security situation in such an environment, with significantly facilitated the movement of pedestrians and vehicles,
- The streets are pleasant and safe for humans - the ratio between the number of vehicles and pedestrians is balanced, and there are green trees, there are public spaces, there are parks and houses are facing the street.

Local authorities should help planners and building contractors of residential buildings in term to launch an initiative to form a council, whose suggestions can have a major impact on the choices made by planners or decision made by construction contractors, and through such:
- The development of planning process, which takes into account the master plan,
- Implementation of policies related to the construction savings,
- Support and incentives in the form of prizes if, in the application of innovative building methods that contribute to the concept of building savings.
- When it comes to concessions that contractors can consider and make the developers and future tenants, aspects may be, for example:
- Preservation of existing vegetation on the site and leave the topsoil, to reduce the effect of erosion on the site, possibly to keep that part of the vegetation that is suitable for human consumption,
- Minimizing runoff of rainwater, achieved by a smaller hard surfaces,
- Appropriate design of individual sections of the building for better utilization of solar light and heat,
- Smooth and easy access to public transport system,
- Safe and is complemented access for pedestrians.

Project phase

At this stage of building design, enterprise creates ample room to apply the savings. The efficiency of the design process, from the standpoint of this principle, it increases the number of features of the environment for future construction sites that are on this occasion taken into consideration. However, it is essential that the project design prior to commencing new construction, should analyze all possibilities of restoration of existing buildings.

Before stage of building construction, positive impacts should begin from the earliest stages when it is possible, and that is:
- Specifying the objectives of eco-construction in the contract documents, which are trying to achieve,
- Design that is adapted to the natural limits of the selected sites, which would significantly reduce the volume of earthworks and the amount of generated waste soil,
- Planning, carrying out earthworks in the summer, to avoid erosion.

In addition, it should be considered:
- Increase the security factor in the street where the building is located, that is the reason why the windows should be oriented to the street,
- Building and parking garage space in the building, to avoid situations in which the street is crowded, paving of access paths and planted vegetation around garage should reduce their negative impact on the environment,

- Special marking the entrance to earmarked residents who wants to go by foot.

If you want to achieve positive impact and effect in the phase of construction, the application of practices of quality procedures for waste management, is considered through:

- Standardization of the size /dimension of materials and products used during construction that would affect the reduction of waste residues,
- Providing accurate data within the projects in order to remove any doubts or deviations,
- Implement measures to ensure the deposit of materials contained in construction waste can be used again or as they are, or are subject to the revitalization and recycling.

Impacts on the possibility of revitalization of the material are reflected in a separate applied conscious strategy whose main goal is to increase the chances of rehabilitation and recycling of the materials from which the building is made, when the projected period of its use for the intended purpose (life span of bulding) ends. This is largely achieved through:

- Design buildings in such a way as to ensure its easy demolition or dismantiling,
- Designing a way as to ensure easy separation of materials suitable for direct reuse or recycling and revitalization,
- By making precise construction drawings that will contain all the information regarding the operation and construction, and will be used by all current and future owners of the building.

Digression

Probably the most significant approach which is used to reduce the negative impact of buildings from the ecological point of view on the environment is an approach of intelligent and rational usage of energy. This approach takes into account climate change, scarcity of natural resources, health care factor, comfort, and the average cost of living. In this case, attention should be directed towards two main areas:

- When the building is seen as a unit (degree of insulation, orientation, use of massive construction materials),
- Devices, equipment and installations in the interior (high energy efficiency, use of energy from renewable natural energy sources).

Previous two aspects of energy are taken into account in design phase.

Environmental impacts of life span of the building or the materials which should be used in construction, represents necessary tool to recognize and then choose the eco-materials, including assessments of material characteristics, including:

- The appropriateness of building materials-products from the point of recycling,
- Use of recycled materials-products,
- Durability,
- Non-toxity,
- Originate from renewable sources,
- Obtain a local sources.

Purchase of recycled building materials from local suppliers is a good option.

CONSTRUCTION PROCESS

On a global scale, in the buildings are located about 40% of the total weight of materials that are in circulation in the world economic space. Most of this amount ends at various landfills. Construction waste is in fact a significant resource that is often found in the wrong place, and its quantity can be reduced by the introduction and implementation of fully developed site management procedures.
Management decisions that affect the reduction of construction waste generated on-site:

- Availability of accurate project information and plans in order to eliminate potential ambiguities and discrepancies which can occur,
- Consultation with the local level by local authorities, on materials that are recyclable,
- Informing all employees and other persons engaged in the construction site with efforts directed towards reducing the amount of construction waste generated, and what is expected of them in terms of achieving this aim,
- Clearly mark of separation and disposal of waste materials that can be reused or recycled, or those whose recycling is impossible,
- Adequate protection of material while it is stored,
- Develop a plan for waste management.

Application of the hierarchical selection of waste materials:
- Reduction: always to order the quantity of material that is truly needed,
- Reuse: to use those products-materials that can be used several times its original purpose and form, provided that it is safe,
- Recycling: apply when reusing the same purpose is not possible,
- Repair: to extend its useful life.

Revitalization – Reuse of materials

The first question that always arises is, should this building must be demolished, or it can be made its adaptation or restoration to meet the new requirements. Here the advantage is often given the financial side, but should also consider other factors.

With demolition of the building loss is:
The landscape and wildlife with which the building was in symbiosis,
Part of the heritage and community identity.

If it makes out that the demolition of the building is the only option, the plan should be prepared to extract the greatest possible amount of material from construction waste, generated by the demolition process, and to treat those who are or may be directly used on other sites, or recycled.

RESPONSE ON CLIMATE CHANGE

Expected major climate change at the global level, the design and construction of new buildings must have adequate in itself answers to this global effect, in terms of retaining the existing level of usability and comfort. Although the situation varies from region to region, main indicators of climate change in general are:
- Increasing in average air temperature annual,
- Increased rainfall, higher frequency of rainfall, increased rains,
- Increased risk of flooding in coastal areas and the coastline,
- More frequent storms, stronger winds, more windy days a year.

This would mean that for the building increases the risk of:
- Overheating - an intensive occurrence of mold, heat stress and demands for air conditioning,
- Damage due to rainfall - the inflow of rain water in the hole and pressure on the drainage system,
- Flooding - damage to plaster and insulation,
- Damage due to wind - apply roofing material and damaging windows.

In addition to increasing risk of natural disasters and accidents (floods, cyclones, etc.), urban environment can be affected by subsidence and landslides, as well as changes in the upper limit of the groundwater.

The best methods of building preparation for the upcoming climate change:

- Measures to prevent overheating - should be installed in the building of passive solar cooling, the houses set quality thermal insulation,
- Measures to reduce damage due to rainfall - to use water-resistant building materials, to make roofs that will have a steeper pages and cover them with resin, and applied techniques such as manipulation of rainwater drainage, diversion, or drying,
- Measures to reduce the risk of flooding - should not be built in areas where floods are common, minimum height floor to rise as much as possible, made of concrete slab floors, use other appropriate methods of flood protection,
- Measures to reduce risk of damage due to wind effect - plan for the next higher level of wind intensity on a scale for a given region, apply construction solutions for fixing roofing.

In addition, building materials should be chosen with care, so future building has a greater degree of tolerance to weather effects and thus remains in good standing at any time during its life span.

Projectants and contractors should ensure that future building:

- Has a high degree of passive solar energy utilization,
- Has an efficient cooling system if the construction is done in warmer regions,
- Be easy to adapt, alter or disassemble and the materials from which is made, can be reused or recycled,
- Be constructed from waterproof materials.

CONCLUSIONS

Ecologically sustainable development is a major concern, and embodies both environmental protection and management. The concept of sustainable development is broad. Generally, sustainable development concerns attitudes and judgment to help insure long-term ecological, social and economic growth in society. Applied to project development, it involves the efficient allocation of resources, minimum energy consumption, low embodied energy intensity in building materials, reuse and recycling, and other mechanisms to achieve effective and efficient short- and long-term use of natural resources. Current environment assessment methods do not adequately and readily consider environmental effects in a single tool and therefore do not assist in the overall assessment of sustainable development.

Construction is one of the largest end users of environmental resources and one of the largest polluters of man-made and natural environments. The improvement in the performance of buildings with regard to the environment will indeed encourage greater environmental responsibility and place greater value on the welfare of future generations. There is no doubt that environmental building assessment methods contribute significantly in achieving the goal of sustainable development within construction. On one hand, it provides a methodological framework to measure and monitor environmental performance of buildings, whilst on the other it alerts the building profession to the importance of sustainable development in the building process.

However, existing environmental building assessment methods have their limitations as examined in this paper reducing their effectiveness and usefulness. There is a requirement for greater communication, interaction and recognition between members of the design team and various sectors in the industry to promote the popularity of building assessment methods. The inflexibility, complexity and lack of consideration of a weighting system are still major obstacles to the acceptance of environmental building assessment methods. In the sustainability index stakeholders will have the opportunity to participate in identifying the criteria and sub-criteria that concern them most in the evaluate framework. Additionally, stakeholders will also be participated to derive weights to reflect the level of importance of criteria and sub-criteria during the feasibility stage of a project.

Building developments involve complex decisions and the increased significance of environmental issues has further complicated the situation. Society is not just concerned with economic growth and development, but also the long-term effects on living standards for both present and future generations. Certainly sustainable development is an important issue in project decisions. Using a conventional single-dimension evaluation technique to aid decision-making is no longer adequate. A much more sophisticated model needs to be used to handle multi-dimensional arrays of data. The development of a sustainability index is a way to address multiple criteria in relation to project decision-making. Use of a sustainability index will greatly simplify the measurement of sustainable development, and thereby make a positive contribution to the identification of optimum design solutions and facility operation.

REFERENCES

CRES (Center of Renewable Energy Sources), (2002). Press release: *The energy of future, New Program of CRES*.

China Climate Change Country Study (1999), Research team of China Climate Change Country Study. Tsinghua University Press.

Karanovic N. (2008), *Construction and Demolition Waste Management*, Master Study.

Grace K.C. Ding (2006), *Sustainable construction – the role of environmental assessment tools*, University of technilogy Sidney, Elsevier 2006.

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APPLICATION OF THE UNIVERSAL DESIGN PRINCIPLES IN THE LANDSCAPE ARCHITECTURE

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ABSTRACT

Everything that is designed and made by people for themselves should be available and customized for every person, respecting human variability. This will ensure the possibility of better, more active and pleasant participation in present environment, as well as its functional usage, regardless of physical, communicational, intellectual, sexual and age differences of total users. The subject of this paper is to explore the importance of application of universal design in landscape architecture. In the first phase of the work, the principles of Universal design were systematized and synthesized in the context of possible application, precisely a certain fields were determinate in which this information may be used for landscape architectural design. In the second phase an analysis was done of landscape architectural object which is regulated by the principles of universal design, as examples of good practice. On the one hand, the results showed the importance of accessible space design and on the other hand, the position and importance of landscape architecture in achieving objectives - environment available for all users.

Key words: universal design, accessibility, people with disabilities, landscape architecture.

INTRODUCTION

Universal design is based on the principle og designing for people of all abilities (Miyake et al. 1996). The use of many products, for instance, chairs, teacups, or structures as buildings, is more obvious than the use of outdoor spaces (Miyake, 2002). Can universal design be followed in designing outdoor spaces? This paper will present example of garden designed using principles of universal design.

Universal design adresses to large number of professions which deal with human directly or indirectly. Principles of universal design can be applied, more or less, in the fields of architecture, urbanism, industrial design, informatics and in the field of landscape architecture. Development of inclusion and social aproach to disability, obligate many professions to change previous direction of their professional work. Following changes and new trends, landscape architecture as well had to change itself in the direction of universality. These changes are most expressed in developed countries. However, in countries with less developed landscape architectural practice, principles of universal design and accesibility are not yet applied in the field of landscape architecture. In southeastern Europe, in the last few years efforts have been made to change such a situation. However, there are just a few cases of open spaces that are adapted and transformed to be accesible for all users. This concept needs more time to become actual in our country and in the region. Sistemic changes in the profession need to be done to achieve this goal.

THEORY

Universal design started to develop in the United States in the seventies of the twentieth century. It is a kind of design of products and environments which can be used by all people in the widest possible sense without the need for special design and adaptation. The term "Universal design" was coined by the architect Ronald L. Mace to describe the concept of designing all products and the built environment to be aesthetic and usable to the greatest extent possible by everyone, regardless of their age, ability, or status in life [5].

Design for All has roots both in Scandinavian functionalism in the 1950s and in ergonomic design from the 1960s. Similar to universal design, it is a design for human diversity, social inclusion and equality (EIDD Stockholm Declaration, 2004). It aims to enable equal possibilities to all people to participate in all aspects of the society. To achieve that, built environment, objects, services, culture and information-in brief, all that humans designed and built for humans-must be accesible, suitable for use by anyone in the society and react to human diversity which is developing. Design for all represents a creation of the environment, a products and services in order to everyone, including the future generations, sex, abilities or cultural background, could enjoy in participating in and creating society, with equal chances to participate in economy, culture, sports, recreation, as well as possibility to attend, use and understand any part of the environment, with as much independence as possible.

The idea of universal design is that every space, building, product, service and information, should be designed to be accesible, usable, understandable and comfortable for all people. This concept can be an instrument for establishing standards which enable all people, including those with disability, to enter into the built environment and have acces to services and information. Also, it could be the way how decision makers and local governament, responsible for built environment, learn to create societies which are acceptable and accesible to the most part of the population, withouth further investment in adaptation.

METHODS

In this work, numerous methods were applied depending on the task and phase of the research.

In the first phase, information about the subject are collected from the domestic and international literature. This was done by studying of available sources (literature, internet, international organisations, questionnaires etc.). At this stage the method of content analysis was used. By synthesis and comparison of different written sources basic terms for this work were defined, and methods and elements significant for the analysis and systematization of principles of accessibility of open spaces adjusted to persons with disability were determined. Previous results were synthesized in the context of possible operationalisation of findings, and fields were determinated where these findings can be used for the purpose of landscape architectural designing of open spaces. At the next phase analysis of objects of landscape architecture which were arranged by principles of universal design was done. In the last phase conclusions were made by synthesis of results.

FINDINGS

The Principles of Universal Design

In order to get an appropriate product and / or services through the universal design and tailored to all, it is necessary to respect certain principles. Universal design is based on seven principles. The Center for Universal Design at North Carolina State University expounds the following principles [6]:

Principle one: Equitable Use - The design is useful and marketable to people with diverse abilities. Guidelines:

1a. Provide the same means of use for all users: identical whenever possible; equivalent when not.
1b. Avoid segregating or stigmatizing any users.
1c. Provisions for privacy, security, and safety should be equally available to all users.
1d. Make the design appealing to all users.

Principle two: Flexibility in Use - The design accommodates a wide range of individual preferences and abilities. Guidelines:

2a. Provide choice in methods of use.
2b. Accommodate right- or left-handed access and use.
2c. Facilitate the user's accuracy and precision.
2d. Provide adaptability to the user's pace.

Principle three: Simple and Intuitive Use - Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level. Guidelines:

3a. Eliminate unnecessary complexity.
3b. Be consistent with user expectations and intuition.
3c. Accommodate a wide range of literacy and language skills.
3d. Arrange information consistent with its importance.
3e. Provide effective prompting and feedback during and after task completion.

Principle four: Perceptible Information - The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities. Guidelines:

4a. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.
4b. Provide adequate contrast between essential information and its surroundings.
4c. Maximize "legibility" of essential information.
4d. Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).
4e. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

Principle five: Tolerance for Error - The design minimizes hazards and the adverse consequences of accidental or unintended actions. Guidelines:

5a. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.
5b. Provide warnings of hazards and errors.
5c. Provide fail safe features.
5d. Discourage unconscious action in tasks that require vigilance.

Principle six: Low Physical Effort - The design can be used efficiently and comfortably and with a minimum of fatigue. Guidelines:

6a. Allow user to maintain a neutral body position.
6b. Use reasonable operating forces.
6c. Minimize repetitive actions.
6d. Minimize sustained physical effort.

Principle seven: Size and Space for Approach and Use - Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility. Guidelines:

7a. Provide a clear line of sight to important elements for any seated or standing user.
7b. Make reach to all components comfortable for any seated or standing user.
7c. Accommodate variations in hand and grip size.
7d. Provide adequate space for the use of assistive devices or personal assistance.

The Sensory Garden at Oizumi Ryokuchi Park in Osaka, Japan

Designers and landscape architects all around the world have responded to the challenge in creating an accessible environment. Achieve accessibility within the concept of universal design, is increasingly seen in cities around the world - new solutions in squares, parks, recreational areas, as well as reconstruction of existing landscape architectural buildings. One of the problems in the 21st century is the problem of open area, limited resources, which are in minority and which every part, especially in urban areas, must be maximally utilized. Therefore, efforts to ensure barrier-free environment in the area that is already built, represent major challenge.

The Sensory Garden at Oizumi Ryokuchi Park in Osaka (Figure 1), Japan, designed by Yoshisuke Miyake, is a good example of universal design principles integrated into an outdoor environment. The space had been originally designed in 1974 as a "Garden for the Blind", suggesting a segregated place for people with visual impairments [7]. Tucked away in a distant corner of the park, the garden received few visitors and stagnated over the years. The Miyakes’ response was that the new garden should be a place for everyone to enjoy in a more central location – not a separate piece of design for disabled people.

Figure 1. Map of Oizumi Ryokuchi Park in Osaka, Japan

The Sensory Garden (Figure 2) was designed with two principles in mind: to design for all five senses and to follow universal design principles (Miyake, 2002). This garden invites exploration through the senses of sight, sound, smell, and touch. It is divided into five different zones according to the five senses: Kitchen Garden, Color garden, Fragrance Garden, Touch Garden and Sound Garden. Different areas of the garden are clearly marked with visual cues, so people intuitively know how to navigate its pathways [8]. A variety of tactile displays and audio information, as well as opportunities to touch and smell flowers and to feel the water and sculptures, enrich everyone's experience in the garden. Handrails sport Braille descriptions of the environment, seats on benches are wide, comfortable and are spaced to accept wheelchairs in-between. Plants had been chosen for their textural qualities and aromas, as much as their strong visual contrast and interest, and they create a rich tapestry of shapes, movements and sounds.

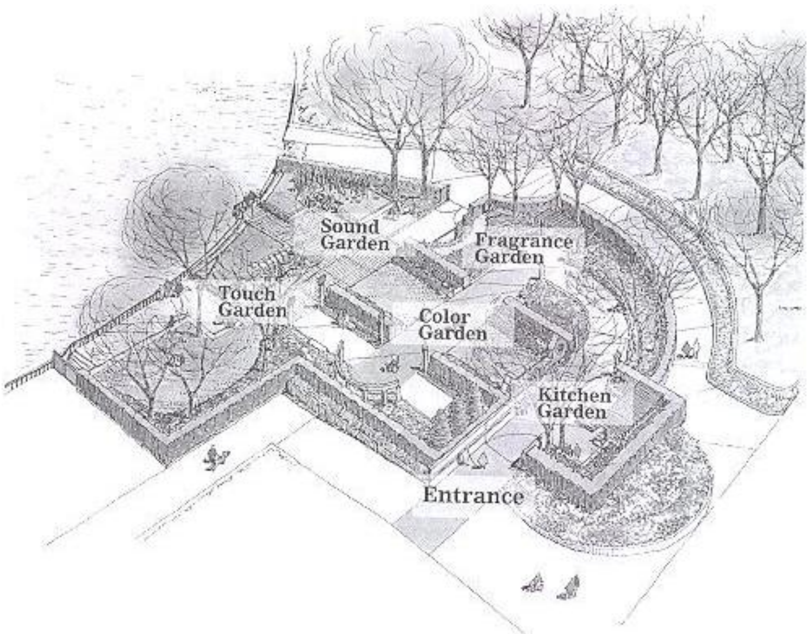

Figure 2. The Sensory Garden

Analysis of the Sensory Garden through principles of Universal Design [9].

Equitable Use. All visitors use the same level entrance and route of travel, and are afforded the opportunity to have a sensory experience. The water element (Figure 3: B, C), the aquatic life, the tactile elements (Figure 3: G, H), and the sculpture (Figure 3: I) all make a rich experience possible for people with vision disabilities, and enhance the experience for other visitors. The elevated plant beds (Figure 3: F) and elevated pond place the experience within a range that can be experienced equally by standing and seated visitors and not require seated users or users with limited flexibility to bend and lean over.

Flexibility in Use. Visitors may explore and examine features at their own pace. Sufficient numbers of sitting alcoves are available so users may linger as long as desired. The design of the alcoves allows visitors to interact with water from either the bench provided or a wheelchair or stand (Figure 3: B).

Simple and Intuitive Use. The garden is small and lay out with a single wide path, marked with pillars (Figure 3: D, E), and a strongly defined entrance, all useful for orientation. The metal guide rail embedded into the path (Figure 3: D) also marks the path for both sighted and visually disabled visitors. Users also are informed of their location in the garden by different surface materials along the walk and paths.

Perceptible Information. Relief tiles, Braille text at the entrance (Figure 3: G, H, J) and at each display, audio systems and text in both English and Japanese provide a variety of methods from which a visitor may choose to receive information. Way finding cues are plentiful and readily apparent, i.e., the pillars, changes in the texture and color-contrasting walking surfaces, the metal guide rail embedded in the path, and contrasting edges on the raised flowerbeds.

Low Physical Effort. The path through the garden is short and generally flat, requiring little effort to traverse the route. Raised plant beds and ponds are easy to experience, allowing visitors to maintain a neutral body position and requiring little stooping or bending to approach and enjoy.

Size and Space for Approach and Use. The benches (Figure 3: A), walkways, plant beds, and water elements have all been sized and positioned to accommodate multiple users simultaneously. Visitors, both standing and seated, as well as people of short stature may reach all components comfortably.

A B C D E F G H I J

Figure 3. A. The bench, with side and center armrests, provides a gripping surface for a visitor who may need additional support when sitting and rising; B. Visitors with little or no sight who must rely on sound and touch for information and those visitors who are primarily kinesthetic in their processing style share in a common experience with all visitors; C. The pond level, elevated above the walking surface, makes it easy for all visitors to enjoy the multiple, sensory experiences of contact with water and aquatic plants without having to kneel, bend, stretch, or stoop; D. Multiple wayfinding cues are incorporated to guide users and aid in orientation; E. Prominent ornamental pillars indicate the entrance to this section of the garden; F. Raised plant beds, allow direct access, minimizing the amount of stooping and bending required of a standing visitor and allows a seated visitor to get close; G. Relief tiles on the entrance wall and Braille labels on the backside of a conventional-appearing handrail provide identifying information on the plants found in the garden; H. The garden layout, readable by all visitors, is presented both tactilely and visually in the same informational board; featured is standard print, Braille, a tactile map and push-button audio system; I. The height of the pedestal places the model within an optimal range to be easily examined by seated people, children and adults of short stature, as well as tall visitors; J. The entrance gate with its visual and tactile elements.

DISCUSSION

Creating an accesible open space must be a result of team work of experts in different fields of work – urbanists, spatial planners, architects and landscape architects. In developed countries which have not only high living standard but also high democratic principles (where equality of people with disability is not only proclaimed but essential and realized in practice), landscape architect is essential part of the team of experts which creates a spaces adjusted to persons with different abilities (Gačić, 2009).

In our country, unfortunately, it is not the case. There are few examples where the role of landscape architect is mentioned as part of an expert team which is responsible for solving different problems concerning the free movement of persons with disabilities. Reasons for this are numerous. They are partly connected to the economic issues (Serbia is in the country in transition), and partly with a systemic and political issues, because there is no good and clearly defined legislation about this problem(Gačić, 2009). The question remains if landscape architects in Serbia are to be blamed for their inadequate representation in this field of work? (Is there enough interest for this specific activity, are criteria for building such spaces sufficiently well defined?)

Role of landscape architect as in charge of designing and building open spaces like parks, squares, recreational and sports areas is very important and necessary. It is important to emphasize that with correct planning, designing and building of open spaces, it is possible to achieve one of the human basic needs and also one of the human basic rights – the right to move freely, without obstacles and barriers. Knowledge of landscape architect together with knowledge of experts from the other relevant professions may be very helpful in finding the best solutions for overcoming the problems of people with disability, which affect their movement and mobility, and therefore better quality of life. Close cooperation of all mentioned professions ie. team work is necessary to create a complete picture about possibilities of different elements of open spaces in overcoming numerous problems which affect persons with disability everyday in their environment.

CONCLUSIONS

Since all open spaces consist of living elements (plants) and inaminate (building-architectural) elements, role of landscape architecture is important in shaping accesible environment, because it combines knowledge about both elements of the space. Landscape architects have, more than any other profession which participate in environment building, knowledge about plants as essential element of all open spaces. We should not talk much about general importance of plants, because it has been enough said on this topic but about importance of plants in organising and designing spaces for persons with disability It is necessary to explore the potential of plants in achieving easier and unobstructed movement of persons with disabilities. Population with visual disorders is especially interesting, where the role of plants with their characteristics could be enormous potential in creating better conditions for spatial orientation and independent movement. It can be concluded that landscape-architectural arrangement of open spaces should be based on planning the environment that is usable to all people, to the greatest extent possible, withouth the need for adaptation or specialized planning. The intent of universal and accesible landscape-architectural planning and design is to simplify the life of each individual by making the outside environment usable to more people. The task (and role) of landscape architect is in the breeding of open space, creating a more beautiful, more plesant and functional environment, but for all people.

IMPLICATIONS

The concept of universal design involves multi-disciplinarity – common work of experts in the field of planning, architecture, landscape architecture, design, with the participation of the representatives of different population groups. All this increases the level of expertise and ensures that needs of all people are taken into account in the early stages of planning, and in order to that it is increased a possibility of ensuring equal opportunities for the usage of products and services.

For the southeast Europe, the region in transition, universal design could be specifically very important considering the actual reconstructions of cities and communities and many development programs that take place within process of joining the European union. So, there is an opportunity to introduce the principle of Universal design in the development plan in order to prevent a new spaces to be constructed inacccessible. It is clear that it is little known about accesibility standards and that there is no awareness and understanding of Universal design concept. Key factors, responsible for the built environment generaly have low level of sensitivity for issues of disability and they are often unaware of the concept and principles of universal design.

REFERENCES

Gačić A. (2009). *The design of open space accessible to disabled on the example of school for the visually impaired children Veljko Ramadanovic in Zemun – master thesis,* Faculty of Forestry, University of Belgrade.

Miyake F.A. (2002). *Linking People with Nature by Universal Design*, Interaction by Design – Bringing People and Plants Together for Health and Well-Being, International Symposium, 53-61.

Miyake, F. A., Kameyama H., and Miayke Y. (1996). *Creating people-friendly parks: From barrier-free to universal design.* Tokyo, Kajima Institute Publishing.

EIDD Stockholm Declaration (2004).

http://en.wikipedia.org/wiki/Universal_design

http://www.ncsu.edu/www/ncsu/design/sod5/cud/about_ud/udprinciplestext.htm

http://www.sensorytrust.org.uk/news/newsletters/newsletter_9/japan_visit.html

http://blog.safetytubs.com/182/universal-design-2/

http://www.ncsu.edu/project/design-projects/sites/cud/content/Landscape/Sensory_Garden/principles.html

DEVELOPMENT OF URBAN ECOLOGY THROUGH EDUCATIVE AND INFORMATION ACTIVITIES

I International Conference
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PRACTICAL TRAINING BETWEEN NECESSITY AND FACTS. PRACTICOR PROJECT PRESENTATION

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ABSTRACT

The paper present The PRACTICOR project co-financed by the European Social Fund through the Human Resources Development Operational Programme 2007-2013 aims establishment of transnational networks regarding the educational guidance, counselling career and practice, coupled with labour market in knowledge society. This project proposes an innovative model of practice is going to students from technical universities to increase their performance and quality training. Reviving the notion of practice applied directly related to economic units will complement the information that the student become a graduate, completes his studies. Curricula of Politehnica University of Timişoara require practice training for all students as engineers.

Key words: teamwork, professional learning and development.

INTRODUCTION

A future engineer who is granted a major role by members of the group in which it manifests professionally and who by interpersonal relationships fulfils a clear role in human resource structure will be provided with a series of attributes as shown below[1]:

- cognitive experience;
- communication skills;
- judgement power and understanding the transmitted message;
- resolute capacity, creativity in thinking and action;
- availability to knowledge;
- availability for cooperation and interpersonal communication within the group;
- self-confidence and to another;
- attitude to overcome the obstacles to attaining the proposed profit;
- flexible style of approach to the task and interaction with its partners to achieve the common goal of the group;
- honesty, responsibility and empathy in interpersonal relationships;
- need for cognition, affection and social valuation
- for relationships, development, acceptance and integration in the work group;
- satisfaction with participation and individual and group success
- skills and interpersonal skills.

This actually represents the sequence of factors whose interaction network and networking abilities outline of a sphere of social competence of a responsible individual.

THE OBJECTIVES FOR PRACTICAL LEARNING METHODE

European Youth Pact focuses on facilitating access of youth on the labour market, combating youth unemployment and increases the quality of education.
The PRACTICOR project co-financed by the European Social Fund through the Human Resources Development Operational Programme 2007-2013 aims establishment of transnational networks regarding the educational guidance, counselling career and practice, coupled with labour market in knowledge society.

By this project we hope to increase the base for the selection of candidates in higher education, professional advice from international students, in conjunction with economic development needs.

The project team aims to promote and financially support the work of practice because it is an important link to enhance chances active professional life of graduates.

This project provides training for tutors and from economic and industrial environment (practice partner companies), which form the link between education and economic units.

We started this project the need for social skills training in the engineering profession. Development of social skills and recovery in the workplace is a necessity due to multiple effects abilities clearly targeted toward productivity and success.

Of these empathy allows understanding and cooperation within an organizational structure, both vertically and horizontally.

For example, non-empathically managers produce discontent among employees who may become the cause for dissatisfaction, absenteeism and staff rotation. Assertiveness also provides personal opinions and provides the ability to protect the rights that a person holds, which will lead to gaining authority and respect in front of other employees or supervisors.

Gratuity and conflict resolution skills improve steep lines that may arise at some point in their professional relations.

Along with taking advantage of these abilities, competence in communication is presented as a basic need to achieve professional success.

To prepare students as future engineers aims to train these skills through practical activities carried out in the middle of productive environmental of the economic reality.

The overall objective of the Practicor project was to organize practice to ensure their students a greater chance on graduation, in the labour market and strengthen their training level, in line with socio-economic reality.

In addition, through this project it is also aimed the guidance and advice in career to those who wish to choose a vocational route to embrace a successful career in priority areas of engineering and to improve through practice, correlating and aligning learning and labour market.

To provide initial training anchoring with the labour market demands preparation of engineering as a whole must take the following steps:
Step 1. "Saying" – didactic presentation for information and knowledge skills that are to be trained - activity that is done in classes and seminars;
Step 2. "Show" - creating opportunities and necessary platform demonstrating behaviour and possible responses - Work carried out under laboratory hours;
Step 3. "Doing" – putting students in a position to perform, to practice the skills - stage made within hours of practical training;

Step 4. "Transfer" – providing logistics and resources to implement the new abilities gained in solving specific production tasks - step resulted in practice in a job at the employer;
Step 5. "Feedback" - ensure awareness and reflective dimension of learning - is an ongoing process rather than a step and takes place through self-evaluation and evaluation of student activity and behavior from peers and the coach / guardian of the level achieved for gained skill;
Step 6. "peer learning" - the participants support each other in developing skills - by solving a common task - again a continuous process integrated in all other stages. To strengthen my skills is a co-drive with a "master" phase in which for example may have involved another student who graduated step four.

Another way to enhance skills through training is done under the supervision of "master."

To maintain the skill level is achieved by building "personal training".

Long-term objectives of the project

- Career guidance and counseling for students and pupils, carried out by specialized personnel;
- Making sustainable partnerships with employers for student practice and building a relationship with the business community;
- Full financing expenses relating to the practice of students - accommodation, per diem, transport, support materials, protective equipment;
- Promoting and rewarding results.
- Training and skills development for future student employment;
- Promotion and dissemination of results and examples of good practice;
- Shaping the premises for the continuity of the idea of the project, after completion.

ANALYSES, DISCUSSIONS, APPROACHES AND INTERPRETATIONS

Bologna strategy is beginning to implement the national and European system of higher education and should be supported. Basically reducing the learning period in the first cycle degree (four years) than the old system of diplomats engineers (5 years) should be compensated through careful use of the time of preparation, particularly related to specific practical and necessary areas of society, especially productive and importance related to the company's energy security and environmental protection.

The Practicor project gives the opportunity to develop skills training and supported the acquisition of skills to help graduates.

The Practicor project helps students to find a job and begin a successful career after graduation.

The Practicor project is an initiative of the Polytechnic University of Timisoara, as coordinator and project partners: University from Piteşti, The Institute for Studies and Energetic Design ISPE Bucureşti and FRAUNHOFER – Gesellschaft zur Förderung der angewandten Forschung, Germany.

On completion of the project in 2013 students must be better prepared not only theoretically but also practically, and their prospects for employment upon graduation to increase significantly.

Our goal is that business people and companies to want to hire our graduates.

Companies agree to have a say in our students' practical training, and project facilities are part of the team with us. So companies conducting practice under the guidance of tutors trained specifically in the project, assisting students trained during practice for the acquisition of specific job skills. These skills will facilitate the integration to the working place of graduates trained in the Practicor project.

Other support activities relate to counselling and career guidance through visits to companies, presentations, panel discussions with representatives of the business world, workshops, simulations (job interviews, job fairs).

Practice partner companies have selected a group of employees to participate in a tutor-training practice to put in dialogue with the teachers of universities and practitioners together to prepare students. This course completes with a certification of the competence recognized by the Ministry of Labour and Ministry of Education;

CONCLUSIONS

The Practicor project is relevant because the younger generation has the main subjects of future engineers who will ensure the sustainable development in the context of the ecologic balance change, the need to intensify innovative actions environmental protection and saving energy resources, organization and implementation of sustainable transportation technologies.

The project duration is from October 2010 until October 2013. Trans-national network related to educational guidance, career counselling and practice, coupled with labour market, in the knowledge society formed under the project will work and after completion of the project.

Team of the project is a partnership and homogeneous unit based and complementary, formed community of interests and goals, which aims to provide greater access to opportunities in priority areas that support sustainable development of European society, in areas related to traditional and renewable energy resources, transportation and advanced technology to protect the environment and ensure evolution and harmony in the society’s transnational space in the process of sustainable development.

Cohesion of interests, experience and awareness that there is room for improvement are the glue of the partnership.

For Politehnica University from Timisoara the purpose of the project is to ensure performance and financial conditions for the organization of the students’ practice in the Department of Mechanical Machinery, Technology and Transportation for a chance to ensure increased and enhanced training, in agreement with the necessity of the labour market.

Related objectives is to develop sustainable partnerships with employers for students in first to four years of study and building a relationship with the business community, developing a guidance system and counselling for career integrated into the practice of students.

Besides establishing a network of tutors to coordinate and guide the students practice in line with the practical needs of society and skills development helps prepare students for future employment.

REFERENCES

Gilson Morales, Clarissa Unica Morales, Model for engineering education to development of competences and abilities, *International Conference on Engineering Education – ICEE 2007-05-01*, available: www.ineer.org/Events/ICEE2007/papers/74.pdf

Moti Frank, Knowledge, abilities, cognitive characteristics and behavioural competences of engineers with high capacity for engineering systems thinking (CEST), *Systems Engineering, Volume 9 , Issue 2 (May 2006) pp. 91 – 103,* Publisher John Wiley and Sons Ltd. Chichester, UK ISSN:1098-1241

Eileen P. Arnold, Global Systems Engineering Competencies: A Business Advantage, *INCOSE 2008 Symposium*, available: www.incose.org/.../May_IS2008_Arnold_Global%20SE%20Competency.pdf

***http://practicor.ro/

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STATISTICAL PARAMETERS ON THE CONTENT OF ARSENIC OF ANTHROPOGENIC ORIGIN IN THE SKOPJE REGION SOIL

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ABSTRACT

Arsenic, as the most common soil contaminant, was the subject of our research, presented in this publication. Namely, at the previous construction of the geochemical atlas of the presence of heavy toxic metals in the Skopje region soil, the area of about 300 km^2 has been explored. The analysis has been performed applying a semi quantitative method of ESA (Emission Spectral Analysis). The minimal detection limit for arsenic of this method is 100 ppm, so the obtained results did not show any value exceeding the previously pointed. Having in mind the probability of anthropogenic pollution of some segments of Skopje valley with arsenic, we enlarged our investigation as second phase of investigation applying the method of ICP-MS (Inductively Coupled Plasma - Mass Spectrometry). According to this method the minimal detection limit for arsenic is 1 ppm, and four micro-localities of increased arsenic content were considered. In third phase has been a process of detailed grid analysis of arsenic contents in the top soil samples of specific micro-localties. With a statistical processing of data the following values of statistical parametres have been evaluated: number of samples (500), minimal detected content (< 0,3 ppm), maximal detected content (244,7 ppm), arithmetic mean (≅19 ppm), geometric mean (≅ 16 ppm), median (≅ 16 ppm), mean (≅ 16 ppm), standard deviation (1,8 ppm); threshold (≅ 20 ppm), threshold's double value (40 ppm); threshold's four times value (80 ppm); anomalous mean (> 80 ppm). The comparative frequency polygon, as well as the comparative diapason diagram were constructed.

Key words: Arsenic, top soil sample, statistical parameters.

INTRODUCTION

Most contaminated regions in the world generally are considered territories with greater population density i.e. largest cities which represent huge complexes of heterogeneous structures (Bowen, 1979). The contamination of wider city areas is a result of the intensive traffic, presence of industry, agrochemical influences inside and around city regions, radioactivity of natural and anthropogenous origin, as well as other anomalies (Kim, 2000; Alloway, 1990). All these factors are reflected upon the ecological condition and the contamination in the city and the wider region (Šajn, 1994).

According to the recent investigations, in the Skopsko Pole territory, was determined the contaminations with heavy toxic metals in the soil. With the aim of getting the idea of the terrain's real condition (Bogoevski and Jancev, 2007; Jancev et al., 2007), there has been realized a project for preparing a geochemical atlas of heavy toxic metals for the territory of Skopsko Pole, with investigated area of more than 300 km^2. In this research there has been put a particular accent on Arsenic (As), as one of the most common soil contaminants (Shacklette et al., 1974), as well as for the existence of relative assumptions of its increased concentration in some micro-localities (Jancev et al., 2010).

EXPERIMENTAL AND DISCUSSION

In Phase 1 there have been analyzed samples of the top soil layer of cca 10 - 40 cm in depth. According to previously defined systematic grid (1 km x 1 km), 300 samples have been taken. Every sample has a mass of around 1 kg, and it is a represent of 5 separate samples.

Firstly, samples have been dried at room temperature in the period of 3 weeks. The coarse-grained rock-samples as well as organic relics (roots, leaves etc.), were separated from samples. The dried samples have been classically treated in the preparation process, i.e. have been sieved (under 63 μm), and milled. From a total sample was selected cca 0,2 - 0,3 kg representative sample for the further processing by the squaring treatment method.

Due to the fact that maximum permissible concentration of each metal separately depend of the acidity of the soil, pH value of the soil has been measured in total of 30 representative samples, within the value interval between 6 - 6,5.

Analysis of samples has been made by using the semi quantitative method ESA (Emission Spectral Analysis). There have not been found values of As content, it hasn't been detected presumably due to the fact that examined soils of Skopsko Pole are characterized by values under the lower detection limit (< 100 ppm) for the analyzed microelement.

Due to reasonable doubt of anthropogenous contamination with As in separate micro-localities, there has been conducted a research of 30 representative samples of analysed soils, with the application of ICP-MS method (Inductively Coupled Plasma - Mass Spectrometry) with a lower detection limit for As of 1 ppm. The results are presented in Table 1 and the markings on soil samples taken for analysis are original and taken from the Phase 1 of the research.

It is evident from the results that As content in the analysed samples is within the limit interval so that to be a serious pollutant in the soils of Skopsko Pole and for that reason, Phase 2 of the research is conducted with the application of the ICP-MS method.

Table 1: As - contents in 30 representative samples of analysed soils

Sample	As [g/t]	Sample	As [g/t]
XIII/18	24	XXIV/7	16
XXI/16	31	XXIV/14	11
XX/9	11	XXV/4	46
XV/19	10	XXV/13	27
XII/15	12	XXVI/8	28
XI/17’	30	XXVII/5	13
XIV/19	26	XXVII/14	19
XVII/18	9	XXVIII/5	23
XIII/16	18	XXVII/11	12
VII/10	13	XXIX/8	15
XX/14’	13	XXX/6	16
XXII/18	11	XXXI/9	14
XIX/17	34	XXXIV/2	17
XXII/8	16	XXXV/13	27
XXIII/13	8	XXXVI/17	20

In Phase 2 have been taken a total of 300 samples of the top soil layer of cca 10 - 40 cm in depth, according to a previously defined systematic grid (1 km x 1 km).

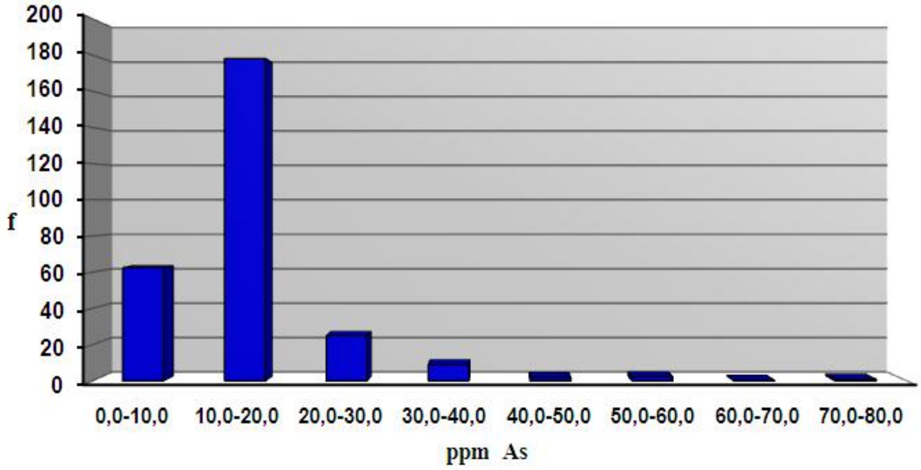


Figure 1. Histogram for As - distribution of the Skopje region soil

In compliance with the usual statistic procedure by log - normal methodology, ware evaluated statistical parameters.

Table 2: As - statistical parameters of the Skopje region soil

Statistical parameters of 300 samples	**As** [ppm]
Minimal detected content	< 3
Maximal detected content	70,1
Arithmetic mean	15,24
Median	13,4
Mean (by log procedure)	13,05
Standard deviation - σ (by log procedure)	1,56
Threshold (by log procedure)	16,2
Threshold's double value	32,4
Threshold's four times value	64,8
Anomalous mean	> 65

Based on the results from Phase 2 for the distribution of As in Skopsko Pole soils, there have been found indications of anomalous increase in As contents (>> 20 ppm) in particular samples around separate micro-localities:

1. Rudnici i Zelezarnica Skopje, - v.Smilkovci - v.Stajkovci - v.Arachinovo
2. OHIS factory - v.Gorno Lisiche - v.Dolno Lisiche - v.Drachevo - v.Ognjanci
3. Hipodrom, Skopje - crossroads: Skopje - Veles - Kumanovo
4. OKTA rafinery - v.Miladinovci.

In compliance with this, in Phase 3 there has been conducted more detailed eco-geochemical research (in a systematic grid of 333 m x 333 m) for determination of As distribution in agricultural soils in the abovementioned micro localities. According to the semi-detailed systematic grid from the top soil sample, in depth of around 20 - 30 cm, there have been taken total of 500 samples for analysis.

Based on the analytical data of distribution, i.e. determined As content in separate microlocalities, there has been made a systematic expatiation upon content and frequencies.

Table 3: As-contents presented in groups with corresponding frequencies for the treated soil samples of the micro-locality: Rudnici i Zelezarnica Skopje, - v.Smilkovci - v.Stajkovci - v.Arachinovo

Groups As [ppm]	0-10	11-20	21-30	31-40	41-50	131-140	
Frequency	42	97	20	5	0	1	Σ = 165

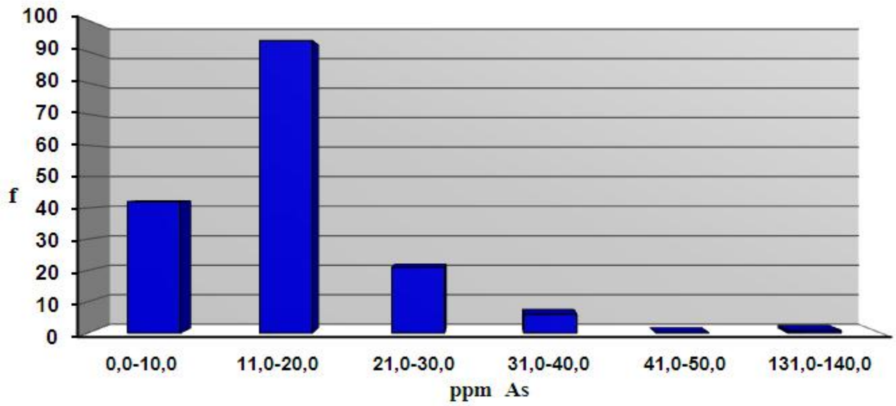


Figure 2. Histogram for As - distribution of the micro-locality: Rudnici i Zelezarnica Skopje, - v.Smilkovci - v.Stajkovci - v.Arachinovo

Table 4: As-contents presented in groups with corresponding frequencies for the treated soil samples of the micro-locality: OHIS factory - v.Gorno Lisiche - v.Dolno Lisiche - v.Drachevo - v.Ognjanci

Groups As [ppm]	0-10	11-20	21-30	31-40	41-50	
Frequency	24	104	74	28	9	
Groups As [ppm]	51-60	71-80	101-110	211-220	241-250	
Frequency	4	1	3	1	1	Σ = 249

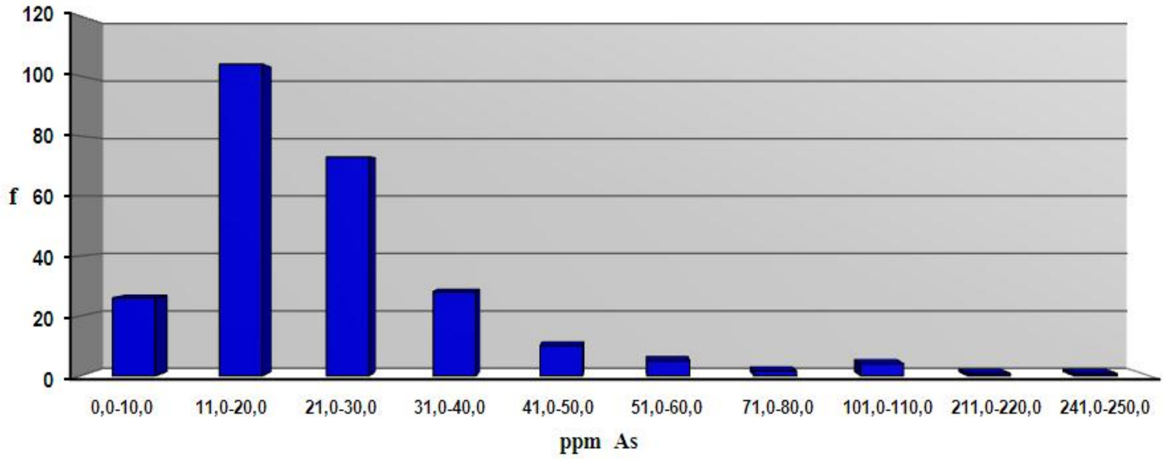


Figure 3. Histogram for As - distribution of the micro-locality: OHIS factory - v.Gorno Lisiche - v.Dolno Lisiche - v.Drachevo - v.Ognjanci

Due to small number of samples, there is absence of graphical figure in the form of a histogram for the micro-locality of Hipodrom Skopje - crossroad: Skopje - Veles - Kumanovo.

Table 5: As-contents presented in groups with corresponding frequencies for the treated soil samples of the micro-locality: Hipodrom, Skopje - crossroads: Skopje - Veles - Kumanovo

Groups As [ppm]	0-10	11-20	21-30	
Frequency	1	15	6	Σ = 22

Table 6: As-contents presented in groups with corresponding frequencies for the treated soil samples of the micro-locality:

Groups As [ppm]	0-10	11-20	21-30	31-40	41-50	61-70	111-120	
Frequency	36	22	2	1	1	1	1	Σ = 64

OKTA rafinery - v.Miladinovci

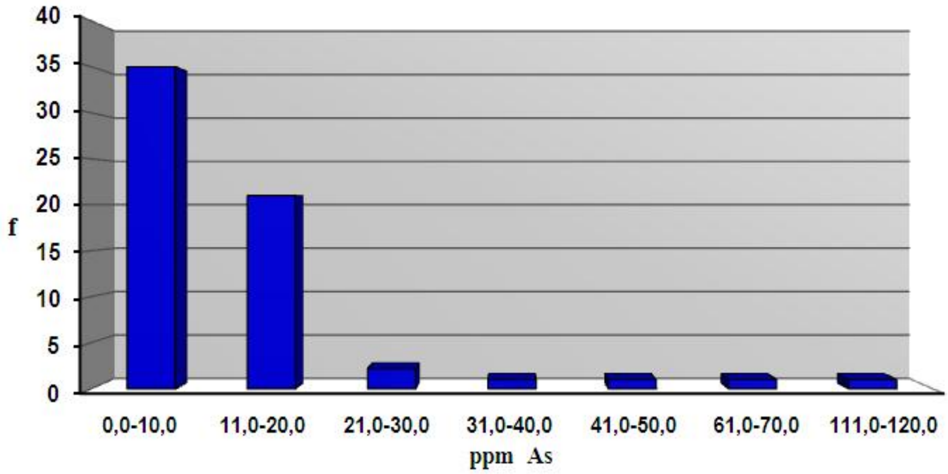


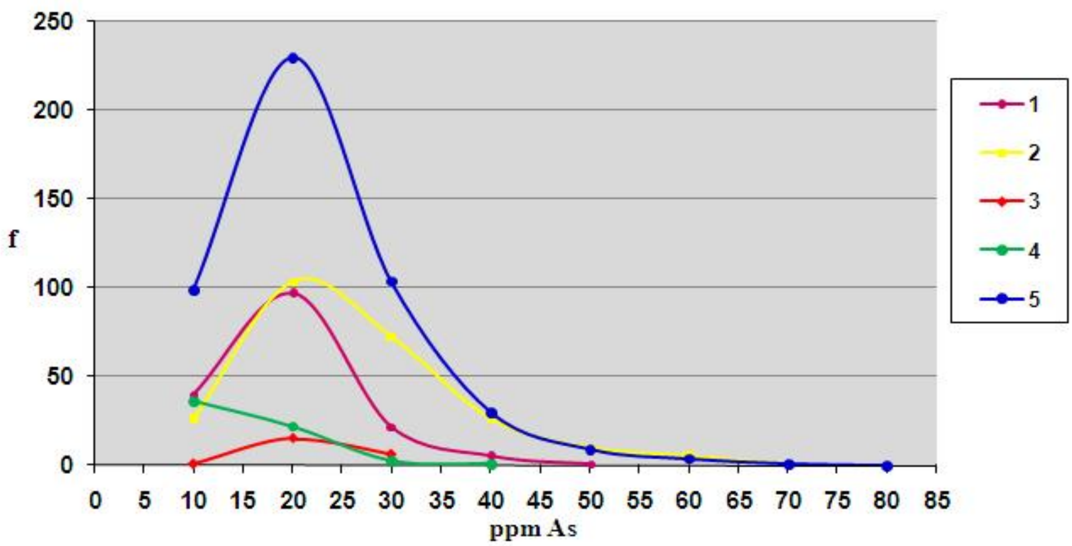
Figure 4. Histogram for As - distribution of the micro-locality: OKTA rafinery - v.Miladinovci

In compliance with standard statistical procedures there has been made a statistical evaluation of the research data (Table 6). A comparative review has been given due to the need of a fuller comprehension of some statistical parametres of the whole investigated area, as well as comprehension of the correlation between the same statistical parametres from various micro-localities. There have been noticed increased values of arithmetic mean, median, mean and threshold for the micro-locality in the nearest surrounding of OHIS factory, in comparation with a considerably lower values of the same statistical parametres in the rest of the investigated micro localities.

It can be said about the whole investigated area that As contents up to 20 ppm have the highest frequencies, and from 21 ppm further, the frequencies considerably decrease (Figure 5). For the micro-localities under influence of Rudnici i Zelezarnica Skopje and OHIS factory it can be said that their frequency polygons are similar, so that the frequency polygon of samples under influence of OHIS factory present higher values of frequencies for As contents in the region of 21 - 30 and 31 - 40 ppm, which is why it is treated as a contaminated region of a various (higher) contamination degree.

Table 7: Comparative review of statistical parameters of the investigated micro-localities

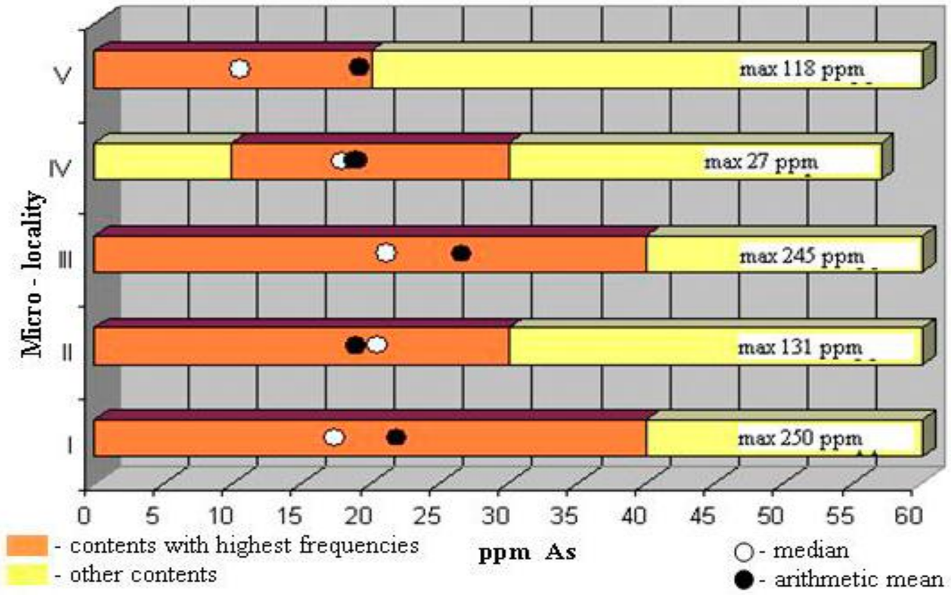
Micro-locality	1	2	3	4
Number of samples	165	249	22	64
Minimal detected content	< 4	< 4	7,63	< 4
Maximal detected content	131	244,7	27	118
Arithmetic mean	≅ 17	≅ 25	16,46	17
Geometric mean	12	19	16	11
Median	≅ 18	20,5	17,62	9
Mean (by log procedure)	13	≅ 20	16,4	9,3
Standard deviation – σ (by log procedure)	1,714	1,97	1,3	2,21
Threshold (by log procedure)	16,4	≅ 24	19	≅ 14
Threshold’s double value	32	48	38	28
Threshold’s four times value	64	96	76	56
Anomalous mean	> 64	> 96	> 76	> 56



1. Rudnici i Zelezarnica Skopje, - v.Smilkovci - v.Stajkovci - v.Arachinovo
2. OHIS factory - v.Gorno Lisiche - v.Dolno Lisiche - v.Drachevo - v.Ognjanci
3. Hipodrom, Skopje - crossroads: Skopje - Veles - Kumanovo
4. OKTA rafinery - v.Miladinovci
5. Whole investigated area

Figure 5. Comparative frequency polygon

In compliance with the comparative diagram of diapasons of contents with highest frequencies, arithmetic means and medians, in the whole investigated area and separate micro localities, it could be concluded that the micro-locality in the nearest surrounding (or under the influence) of OHIS, the area of maximum frequencies is with the diapason of 3 - 40 ppm and it is almost identical with the whole investigated area. It is also evident that the values of statistical parameters for the micro-locality near OHIS, are significantly higher in comparation with the same ones for the micro locality near Rudnici i Zelezarnica Skopje, Hipodrom and OKTA rafinery.



1. Rudnici i Zelezarnica Skopje, - v.Smilkovci - v.Stajkovci - v.Arachinovo
2. OHIS factory - v.Gorno Lisiche - v.Dolno Lisiche - v.Drachevo - v.Ognjanci
3. Hipodrom, Skopje - crossroads: Skopje - Veles - Kumanovo
4. OKTA rafinery - v.Miladinovci
5. Whole investigated area

Figure 6. Comparative diapason diagram

Based on the data of As distribution from separate micro-localities, there has been conducted a statistical evaluation of the whole investigated area.

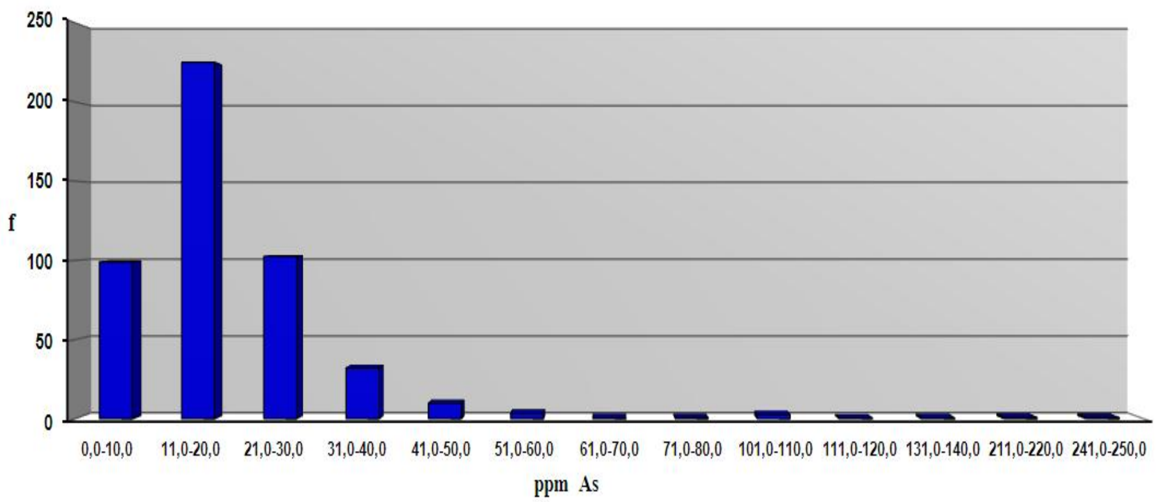


Figure 7. Histogram for As - distribution of the whole investigated area

Based on the standard procedure by the logarithm method, the rest of the statistical parametres have been evaluated and presented in Table 8.

Table 8: As - statistical parameters of the whole investigated area

Statistical parameters of 500 samples	**As** [ppm]
Minimal detected content	< 0,3
Maximal detected content	244,7
Arithmetic mean	≅ 19
Geometric mean	≅ 16
Median	≅ 16
Mean (by log procedure)	≅ 16
Standard deviation (by log procedure)	1,8
Threshold (by log procedure)	≅ 20
Threshold’s double value	40
Threshold’s four times value	80
Anomalous mean	> 80

CONCLUSION

Based on the above given data and their statistical evaluation for the distribution of As contents in soils of treated micro-localities, it could be concluded that there are anomalously increased contents of As (>> 20 ppm) in separate micro localities.

Micro-localities or agricultural alluvial soils around Rudnici i Zelezarnica Skopje, OKTA refinery and Hipodrom Skopje are considered globally as uncontaminated or low contaminated.

The micro-locality E, NE and SE from the OHIS factory i.e. to v.Gorno Lisiche - v.Dolno Lisiche - v.Drachevo - v.Ognjanci, due to increased frequencies of As contents in the range of 20 - 40 ppm As and increased values of statistical parameters is treated as a contaminated area.

The above stated data and regions of most frequent contents point out how a micro-locality with its high As content (increased values of statistical parameters) can statistically influence and increase the same values for the whole region.

The contamination of the above stated micro localities is of anthropogenous origin and as a result of: presumably productive activities of OHIS (a former pesticides manufacturer) Rudnici i Zelezarnica skopje, OKTA refinery, whereas in agricultural regions presumably and partly due to long - term, decades long use of agrochemical means (pesticides, artificial fertilizers etc.) in agriculture.

REFERENCES

Bowen, H. J. (1979). *Environmental chemistry of elements*. Acad. Press, London.
Šajn, R. (1994). Gech. atlas of the Ljubljana urban area, *3rd Int. Symp. on Env. Geoch., Krakow*.
Shacklette, H.T., Boerngen, J.G., & Keith, J.R. (1974). *Selenium, fluorine and arsenic in surficial materials of the conterminous United States.* U.S. Geol. Surv. Circ.
Kim, H. Ten. (2000). *Environmental soil science.* Univ. of Georgia, Athens, New York, Basel.
Alloway, B. J. (1990). *Heavy metals in soils*. Printed in G. Britain.
Bogoevski, S., & Jancev, S. (2007). Regional geochemical surveys on heavy-toxic metals (Pb, Zn and Cd) in soil samples from the Veles city area and its surroundings, *Journal of Environmental Protection and Ecology, JEPE, vol.* 8, No 1, 56-66.

Jancev, S., Bogoevski, S., & Hristova, E. (2007). Geochemical surveys on toxic heavy metals Pb, Zn and Cd in agricultural soil samples from Bashino village-Rechani at the Veles city area, Macedonia, *Journal of Environmental Protection and Ecology, JEPE, vol.* 8, No 1, 67-76.

Jancev, S., Bogoevski, S., & Bliznakovska, B. (2010). Results of the preliminary regional eco-geochemical mapping of the agricultural soil samples from the Skopje city area, *Journal of Environmental Protection and Ecology, JEPE, vol.* 11, No 3, 854-865.

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RELATION OF SECONDARY SCHOOL STUDENTDS FROM THE NORTHWESTERN SLOVENIA TO MUNICIPAL WASTE SEPARATION

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ABSTRACT

The results of the survey about the relation of secondary school students to the separate collection of municipal waste are presented in the paper. The survey was performed as a consisting part of campaign "Attention (!) for the Environment" which was initiated and sponsored by the Sava Tires company. The goal of the campaign was to promote separate waste collection among secondary school students. The survey was concerned with the relation of students to environmental topics, their view on the waste separation generally and some practical aspects of waste handling at their homes and at school. The survey was performed among students of seven secondary schools from the Gorenjska region (Northwestern Slovenia) via internet using the Limesurvey tool. The information gained from the results of survey can be useful for subsequent planning of waste collection and in the process of environmental education.

Key words: municipal waste, separate collection, secondary school students, environmental awareness, Gorenjska region.

INTRODUCTION

Like other countries which are new members of European Union (EU) or those which are approaching to become EU members also Slovenia was obligated to adopt their legislation in the field of environmental protection to the EU directives (Law 1, 2006; Regulation 1, 2000,2004; Regulation 2, 1998). One of the most important EU demands in the field of environmental protection is concerned with introduction of separate collection of waste.

The crucial factor for successful introduction of separate municipal waste collection is that the waste management system is adopted by the citizens. Irrespective of the fact how well the waste treatment system is prepared in other aspects it cannot bring positive results without active cooperation of citizens. However, this is connected with considerable difficulties as municipal waste is generated continuously by all categories of citizens and modifications in waste treatment require also changes of quotidian habits. This is particularly difficult by elder categories of people. It is not seldom that even responsible and disciplined persons hardly acquire new habits and therefore often do not put certain waste in the right waste bin.

On the other hand, young people are much more susceptible for changes in waste treatment. It should be emphasized that during the process of environmental education both motivation and information are important. Motivation including responsible relation to the environment seems as the necessary condition for successful introduction of separate collection. However, without adequate information including certain knowledge of municipal waste classification the system of separate collection could not function. The appropriate knowledge of waste topics presents the satisfactory condition for successful introduction of separate collection of municipal waste.

When regarding separate collection of waste and respective education in the Republic of Slovenia it was estimated that this field is quite satisfactorily covered among elementary school pupils. On the other hand, it seems that in the case of secondary school students there exist many possibilities to improve the situation. Therefore, it is reasonable to invest additional effort in environmental education of secondary school students.

This was also the reason of the campaign entitled "Attention to the Environment" (original title of the campaign, Pozor(!)ni za okolje – in Slovene) the part of which is briefly presented in this paper. It should be emphasized that the campaigne was initiated, supported and sponsored by Goodyear Dunlop Sava Tires Company. Sava Tires is well known as highly environmentally aware company which proves responsible relation to the environment. This is demonstrated in continuous effort to improve technological processes and reduce waste quantities. However, Sava Tires does not desire to limit its ecological activities only to its own industrial processes but wants to support positive environmental initiatives in the society.

Into this purpose also action "Attention to the Environment" was initiated. The goal of campaign was promotion of responsible relation to the environment and, particularly, of separated collection of waste among secondary school students. The entire campaign has incorporated a number of various activities. The core of campaign was a competition of secondary school students from the Gorenjska region in the separated collection of municipal waste. One of the accompanying activities was also the inquiry performed among secondary school students about their relation to environmental topics, to waste treatment and, particularly, to separated collection of waste. This paper is limited only to the this inquiry and other parts of the campaign are not discussed in this place.

CHARACTERISTIC FEATURES OF INQUIRY

Inquiry consisted of 22 questions which were divided into five groups. All questions except one were of closed type offering four to seven answers. The first group of questions was concerned with identification data (sex, type of secondary school, year of study). The second group of questions was related to the environmental awareness of student and their colleagues as well as their opinion about waste and separate collection. The third group contained more concrete questions regarding everyday practice of students in waste handling at their homes and the fourth group similar questions about waste handling at schools. The fifth group includes three questions which were like those in the second group concerned with student's personal view on the environmental issue.

The scope of inquiry was to get information about the relationship of secondary school students' population to the environmental issue and particularly to the separate collection of waste. It is expected that main obstacles for separate collection of waste can be recognized from the answers. This information can be helpful in searching possibility to improve the system and increase the efficiency of waste separation.

Survey was realized via internet with the open source tool Limesurvey (www.limesurvey.org) installed on swqlab.fov.uni-mb.si. Answers to survey provided students of seven secondary schools in Kranj and Škofja Loka. Total number of completed survey was 1617.. This number presents a considerable part of secondary school students in Gorenjska region and therefore collected data have some statistical value. In the present paper due to lack of space some basic characteristics of answers are discussed only. Deeper analysis including statistical treatment of collected data has still to be done.

RESULTS OF INQUIRY

The first circle of inquiryresulted in 1617 answered inquiries. The profile of students' population was about 74% male and 26% female and relation of grammar school to the other types of secondary school was practically 50% - 50%. The greatest part of students was from the first class 41%, 21 % of students were from the second, 16% from the third and 22% from the fourth class.

Students opinion about waste and waste separation

As mentioned above the first part of inquiry (questions 4 to 9) was concerned with the students' relation to the environmental issue, waste and waste separation. All these questions were of closed type. There was only one possible answer except by the questions 8 and 9 where students were able to choose mor answers.

When students were asked about environmental awareness of their colleagues (Question 4) about 4 % rate it as very high, 19% as high, 60% as medium, 14% as low and 4% as very low.

The relationship of their colleagues to waste treatment (Question 5) was from the greatest part of students estimated as satisfactory (48%), 26% of students estimate it as good, 18 % as unsatisfactory and similar number (about 4%) as very good or very unsatisfactory.

Question 6 was “What kind of association you have at the word waste?” The majority of students (54 %) describe the waste as something that they would like to get rid of; 24% of students designated waste as something that has influence on the environment, 7% as a possible source of secondary raw materials, 3% as something which causes expenses and 8% do not think over waste at all.

Question 7 asks students about their relationship to the separate collection of municipal waste. 58 % of students believe that separate collection is absolutely necessary, 12 % contrary believe that it is not important. 11% of students will separate waste when other people would do so, 9% think that separate collection is duty of municipal services and 8% do not think at all about separate collection.

Question 8 was about the responsibility for separate collection of waste (more answers were possible). The majority (75 %) of students are aware that everyone is responsible for waste separation, 38 % think that this is duty of municipal service, 30 % think that state and 18 % that local community is responsible for waste separation. 4% of students do not care about this.

Question 9 asked about main advantages of separated collection (more possible answers). Saving of natural resources seems the most important advantage (58%), 51 % think that separate collection is important because of adequate treatment of hazardous waste, 33 % because of energy saving and 32% because of prolongation of landfill lifetime. 3% do not see any advantage in separate collection.

Waste separation in households

Third part of survey (questions 10 to 14) asked students about waste treatment at their homes i.e. in households where they live.

Question 10 was concerned with the waste treatment at home and there was possible to select more answers. More than three fourth (77%) answered that they separate individual fractions (paper, glass, metal and plastic package, biological waste), 10% answered that they burn waste, 14% put all kinds of waste in the container for mixed waste and 27 % emit bulky waste in the case of collecting actions.

When students were asked to estimate the mass of waste produced daily per capita in their households (question 11) 40% could not decide for any answer, 5% do not care about this, 26 % think that mass is less than 1 kg, 23% between 1 kg and 2 kg and 5% more than 2 kg..

Question 12 was concerned with the frequency of separate collection of individual fractions of waste. Answers are shown in Table 1.

Table 1: Answers on the question about frequency of separate collection of individual fractions of waste in households

Fraction	always	Often	rarely	never
Paper	63%	22%	8%	6%
Glass	58%	23%	13%	7%
Plastic bottles	57%	27%	10%	6%
Cans	47%	28%	17%	8%
Package	50%	28%	14%	8%
Biological waste	55%	23%	13%	8%

79% of students believe (question 13) that separately collected fractions are actually delivered into recycling process, meanwhile 21% think that separately collected fractions are mixed and deposited on landfill.

Question 14 considered treatment of hazardous waste. 35% of students answered that they keep hazardous waste separately and emit them during the course of collecting action, 25% bring them in the collecting centre, 8% emit hazardous waste together with the other waste, 5% throw them away or pour them in the toilet, 17% do not know how they handle with hazardous waste and 10% did not answer this question.

Waste treatment in schools

The topic of fourth group of questions (questions 15 to 19) was waste treatment in schools.

When were asked to about waste treatment system in their school (question 15) 21 % of students estimate it as very good, 41% as good, 25% as satisfactory, 7% as bad and 6% as very bad.

In question 16 students were asked about motivation for more conscientious separate collection (more answers were possible). 34% of students answered that a greater number of waste baskets for separate collection would motivate them and 32% would like to contribute to cleaner school. More rigorous survey by teachers would motivate 9% of students meanwhile 17% answered that they could not be motivated by anything. 7% of students answered that some other things could stimulate them.

The greatest part of students (49 %) were informed about changes in waste collection system in school (question 17) when they had observed waste baskets for separate collection, 22% had got information from teachers, 3 % from other students. 7% heard announcement by loudspeakers, 3% read from the posters and only 2% were informed from the school webpage. 14% of students answered that they do not know anything about these changes.

Question 18 was exception as it was of open type. Students were asked about proposals to improve their relationship to the separate waste collection in schools. 99% of students answered the question. However, because lack of space these answers can not be discussed in the present paper.

When separate collection would be successfully introduced schools can considerably lower expenses of waste treatment. Students were asked into which purpose the saved money should be used. 40% would like to use this money for excursion, 20% for educational purposes, 16% for cultural events (concerts), 15% for sport competitions and 7% for some other purposes.

Final questions

The last three questions (20-22) were like those in the first part more oriented to some general aspects of waste treatment.

In question 20 students were asked about the possibility of pollution reduction with the change of habits. The majority (71%) answered that this is possible with separate collection of waste and recycling, 16% think that waste formation prevention is the most important and 3% favour waste incineration, 1% decided for some other ways. 4% think that decrease of pollution with the change of habits is not possible and 3% do not care about this.

In question 21 students were asked how they personally contribute to less polluted environment (more answers were possible). The majority of students (65%) collect the waste separately, 30% try to prevent waste formation, 20 % use paper bags or bags for repeated use, 21% cooperate in cleaning actions, 1% of students contribute in some other ways and 7% do not contribute in any way.

The last question (22) asked students to estimate their personal environmental awareness. 12 % of students rate it as very high, 48% as high, 35 % as medium, 4% as low and 1 % as very low.

DISCUSSION

As mentioned earlier deeper analysis of the data collected during the inquiry will be performed later. The present paper brings only brief discussion of answers.

It is interesting to compare the students' estimations about their own environmental awareness and environmental awareness of their colleagues. Results are graphically shown in Figure 1. It can be clearly observed that students have some better opinion about their own awareness than about awareness of their colleagues.

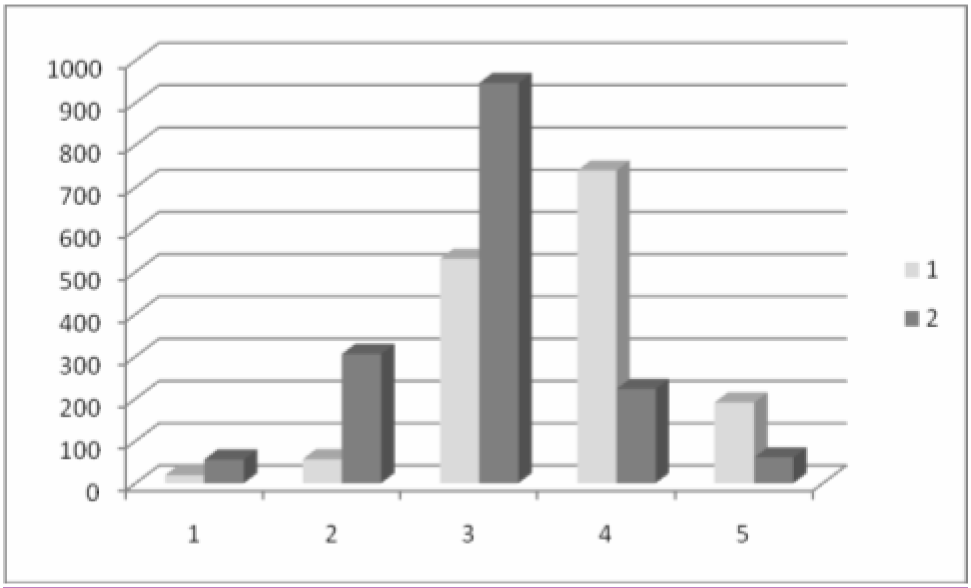

Figure 1. Evaluation of environmental awareness of students – 1 for their personall environmental awareness, 2 for environmentall awareness of their colleagues. Marks: 1 – very low, 2 – low, 3 – medium, 4 – high, 5 – very high.

More than one half (58%) of students believe that separate collection of waste is necessary and 75% of them think that everyone can contribute to separate collection. More than one half (58%) of students think that separate collection is necessary because saving of natural resources, about one half (51%) because of adequate treatment of hazardous waste and one third believe that separate collection is important because of energy saving as well as because of landfills' life time prolongation.

More than three quarters of students collect waste separately at their homes. When were asked about particular fractions the answers show that situation is similar for various fractions – something better is for collection of paper waste meanwhile collection of cans is under the average.

Answers regarding hazardous waste can be reason for certain preoccupation. 5% of students answered that they mix hazardous waste with other waste, 17% do not know how they threat hazardous waste and 10% did not answer this question.

The great majority of students are content with waste treatment system in their school as only 13 % estimated it as bad or very bad. It seems that disposition of waste baskets is very important as one third (34%) of students answered that greater number of waste baskets is the most important motivating factor for separate collection and about one half of students (49%) learned about changes in waste treatment system in school as they observed baskets for separate collection. About one fifth (22%) of students got information about separate collection from their teachers. It is interesting that very small ‘part of students learned about changes in waste treatment system from posters or school’s web page. It can be indicative that similar part of students answered that anything could not motivate them for separate waste collection (17%) and do not know anything about changes in waste treatment system in school (14%).

Almost three quarters of students (71%) believe that separate collection is the best way to decrease pollution meanwhile 16% mentioned waste formation prevention as the best solution. Relative small part of students thinks that it is not possible to reduce pollution with change of habits or is not interested about this problem. Besides separate collection students contribute to reduction of pollution with waste formation prevention (30%), collaboration in cleaning actions (21%) or with the use of paper bags/bags for repeated use. Only 7% of students answered that do not contribute in any way to decrease of pollution.

CONCLUSION

The results of inquiry show that the majority of secondary school students are aware of significance of responsible relationship to the environment and adequate waste treatment. However, before making some conclusions the more detailed analysis of the results of inquiry should be done as well as answers of the first and the second part of inquiry should be compared. Besides this some findings gained during the competition in separated collection can be used find some faultinesses of the waste treatment in schools as well as to improve the education system

REFERENCES

Law 1 (2006): Zakon o varstvu okolja (in Slovene: The Law of Environmental Protection). The Official Gazette of the Republic of Slovenia, No. 39/06.

Regulation 1 (2000,2004): Pravilnik o odlaganju odpadkov (- in Slovene: Book of Rules of Waste Deposition), The Official Gazette of the Republic of Slovenia No. 5/00, 43/04.

Regulation 2 (1998): Pravilnik o ravnanju z odpadki (in Slovene: Book of Rules of Waste Treatment) The Official Gazette of the Republic of Slovenia, No. 84/98.

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THE DINGLE OF THE ENDANGERED PEDUNCULATE OAK

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ABSTRACT

The pedunculate oak (Quercus robul or Quercus pedunculate) beside the Tisa river is the only one remaining oak out of rich Banat forests from before three hundered years. This oak zone spread out from Slavonia to the Rumanian part of Banat as well as even farther, all over Pannonia. Nowadays it is endangered, and according to the specialists' opinion it can not survive several years more.

Key words: pedunculate oak, ecologically endangered.

INTRODUCTION

The unique nature's creation – the oak from the pedunculate oak family, can be located in the yard of the pumping station beside the Banat side of the river Tisa. This region belongs to the area of the village of Kumane, in Novi Bečej municipality. The protected space on the whole is possessed by the waterpower engineering company "Gornji Banat" ("Upper Banat") from the town of Kikinda. The aim of this paper is to do the last attempt to save the last nature giant in this region of Vojvodina.

THE EXISTENCE OF NATURE RELICT

This pedunculate oak is the reality in this part of the Balkans. According to the feasibility study of the Institute for Nature Protection (Conservation) of Vojvodina, it is the finest specimen of this kind in Vojvodina. The pedunculate oak is highly spread in the larger part of Europe, from the Atlantic Ocean to the Ural, so it can be found as well as in the northern part of Africa. In the surrounding countries are being done great works in order to protect it ecologically. Only in Serbia they do not do much to save such a natural resource.

Table 1: The essential dendrometric characteristics of this exceptional oak are [1]

Stem height	33 m
Trunk height up to the first branches	3 m
Tunk size on the height of 1,3 m	6.75 m
Crown span	40 x 42 m

Besides their bygone spreading on the Banat territory, only this specimen of the pedunculate oak survived from the period of three hundred years ago. So is evaluated its age, although more detailed investigations by stem boring could give some more precise data of this dendroid's age. Namely, during the time of its emerging, the region of Banat was substantially richer with its forests, woods and groves, than now [2]. The geographical maps of that time, as well as the notes of the travel writers, unambiguously confirm the forest resources of this region. Considerably before major colonization of this countrysides, the forests filled besides marshes and steppe landscapes, especially on the transversal north – south, and naturally the Tisa river – sides. The belonging space in situated on the parcel 8531 number, of Novi Bečej municipality. The space of this nature monument is bordered by the oak crown span projection of 42 m radius, where the circle centre is the oak's trunk.

Figure 1. The penduculate oak at the pumping station near the Tisa river from the period twenty years ago (photo D. Letić)

The felling of trees was silent through decades ”witnesses and bills”, as they do it as well as today. It is a real wonder how that tree survived up to now. In the meantime, during the last ten years biological potential of this history witness is gradually being lost. It can be especially valued looking at its lush crown. It is now declined, and that is immediately noticeable to a usual visitor. Although the oak is fertile, it has lost several vital branches. A couple of branches were cut by vigorous thunderstrucks. Several branches were victims of their terrible enemies, that is, insects. On the north – west part of the stem are obvious a hundred holes bored by parasites, so its tissue is alarmingly endangered.

The woodworm caused that five brunches which directly came out of the stem, swooped down during several years (from 1991). Probably detailed investigations (by boring and like) would find substantial cracks, erosions and “caves” within the trunk. And for all that, the forestry specialists consider that it is in relatively good state, but that the tree needs healing and some measures necessary for the prevention of its decay. Meanwhile, these specialists’ opinions are twelve years old. The current state of this tree is rapidly making worse.

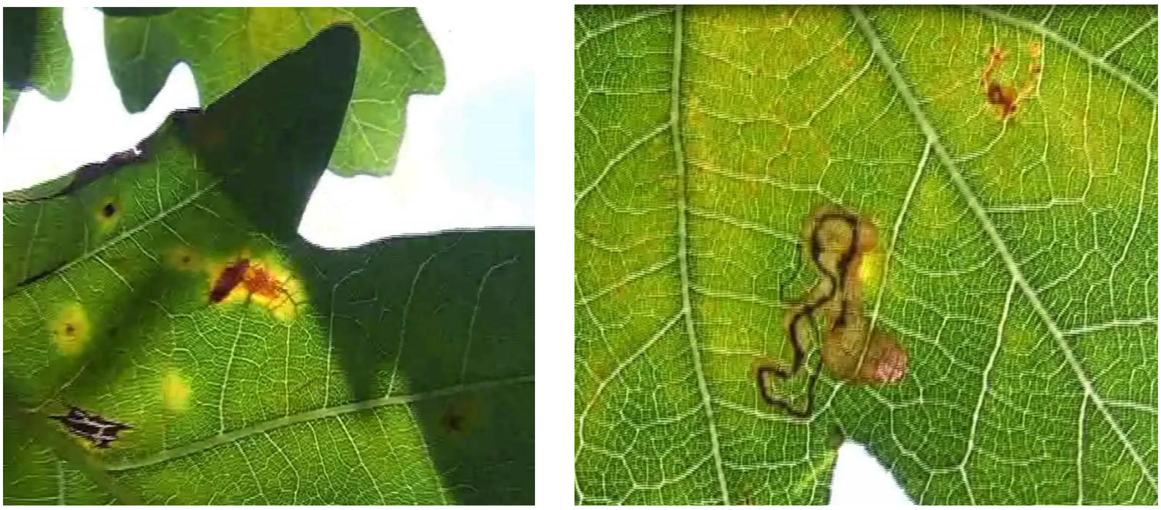

Figure 2. Spotted appearance of oak leaves is present in 70% of the volume of habitus (2010)

Figure 3. Marked wormholes in the tree and branches of oak (left), a colony of ants on damaged parts of branch (right)

Figure 4. Place of breaking branches of tree due to internal erosion of the tree (left), ground solid tree with a diameter of 850 mm (right)

CONCLUSION

Because of all above mentioned, the Institute for the nature conservation of Vojvodina appeals that the oak, besides the national protection, should be placed as well as under international protection, in order to be as soon as possible saved of progressive declining. Several building in its environment are, also, the objects of the pumping station dated from the nineteenth century. With them is preserved the technology of water pumping from the river Tisa, into the nearby canals. In view of the proposals of the water power engineering of this region, the "old" pump will be before long transformed in a special museum. Together with the surrounding ambience, this oak dingle certainly presents a potentional Mecca for hunting and environmental tourism.

REFERENCES

Radujkov, D. *Nature monument THE PEDUNCULATE OAK IN THE YARD OF T HE PUMPING STATION OF KUMANE*, *The Institute for the nature protection of Serbia, Belgrade, Section Novi Sad*, 1999.

Josifović, M. *The flora of Serbia II*, Serbian academy of science and arts, Section of science, Belgrade, 1970.

Jovanović, B. *Dendrology with the bases of photochenology*, Scientific book, Belgrade, 1967.

Vukičević, E. *Decorative dendrology*, Scientific book, Belgrade, 1987.

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IT IN EDUCATION AND PRESERVATION OF HEALTHY LIFE ENVIRONMENT DISPLAYED ON THE PRODUCTION OF ENERGY FROM ALTERNATIVE SOURCES THAT CAN BE USED IN EMERGENCY SITUATIONS

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ABSTRACT

The aim of this work is to present the possibilities of information technologies in education during emergency situations caused by ecological disasters, technical and technological disasters, floods, pandemic virus outbreak, which will result in closures of schools. The hypothesis of this paper is based on web and mobile technologies for the continuity of education in emergencies. The target group is the technical science in primary schools. The paper will review the request and the advantages of online learning and teaching management solutions and benefits in the long and short run on the example of education in the production of environmentally clean energy from alternative sources.

The aim of this paper is to present the distance learning and heuristic model of learning as a methodical innovation with a emphasis on individual learning, where every team member has to be aware of the significance of his work, must know and apply certain methodology and new IT technologies in teaching.
Heuristic approach to the problems of teaching in technical and IT fields of education should enable the team member the ability to creatively solve problems and acquire new knowledge, to learn, think and develop the capacity for learning with new information technologies (Internet and mass use of electronic resources knowledge).

It is, therefore, such an approach that is not based on passive observation of phenomena and impersonation performed by a teacher, but establishing an active relationship with the phenomena of thought and introduces team member (pupil, student, PhD student) in independent research heuristic
conceived of the problem (the problem with width range of solutions - in this case "Distance learning with heuristic model of education and alternative Energy from liquid accumulator" in function of education in Emergency situations.

The attempt of this paper is to use the heuristic models of teaching and distance education, for increasing the effects of learning and teaching in Technical and Information fields, and how can these models more effectively contribute to the training of personnel in emergency situations.
With the research of this innovation, the hypothesis is confirmed. The application of heuristic model of teaching in Technical and IT Education allows to achieve greater effects of teaching and learning, and their application in practice in education for action in emergency situations.

Keywords: IT - Information Technology, environmental disasters, alternative energy, emergency situations, e-learning.

INTRODUCTION

In the contemporary world of future (post-industrial, technological, informational) will require people trained, ready and able to use the new complex tools, quickly and efficiently adopt, build and implement a variety of knowledge, active and responsible participation in complex social and economic relationships and processes in everyday life, especially in emergency situations.

Starting from the framework of joint education and training projects designed for the European Union in 21 century, which contains basically: education for life, education, learning in a democratic society, education to develop creativity, critical thinking and discovery of talents, education for autonomy and freedom to work, as well as for self-education, and training for civil society with wide scope of educated, to the successful design of technological information and education through teaching Polytechnic science (technical, technological and IT education in primary, secondary and higher education, free technical activities of students, elective programs, and extracurricular activities through amateur radio clubs, voluntary fire brigades, dive clubs and other organizations concerned with education in the protection and rescue of people and material goods) and the creation of continuity in monitoring, training and future training of personnel necessary reformed Civil Defense, as part of the defense system of Serbia and Civil Protection within the Emergency Department, trained in institutions of civil society with new trends in Europe (education for democratic and civilian control of the army, as well as training of personnel of the existing system and future integrated system 112), we approached this study that was just in that scope. This approach provides a new quality and continuity in monitoring, training, training and education of future employees that will be necessary for future reformed Civil Defense, as well as to prepare them for further education in specialized military institutions if they wish.

In a world that is changing rapidly and in which knowledge is expanding on a daily basses and unsuspected sources of information multiply, data, information and facts can become irrelevant and outdated even before they are used. With the heuristic approach to the problems of planning and designing future systems in the function of emergency situations, we tend to overcome these problems. Personnel of those future systems 112 will collect information in accordance with the rules of the exchange of information through the list of questions. On the territory of local government (regions, municipalities) can appear all kinds of risks (war, threat of natural disasters such as floods, large-scale fires, earthquakes, landslides, epidemics, pandemics, etc..) and technical disasters in other words emergency situations that has to be discover in order to take steps on time for protection and shelter of people and material goods. Timely, accurate and precise information in these situations means life. Therefore, the staff working on these matters, a special attention, will be devoted when it comes to their training, skill in handling the most modern and diverse equipment, resourcefulness in emergency situations and timely transfer of information to the entities responsible for rapid intervention in the above mentioned situations.

DISTANCE LEARNING AND EMERGENCY SITUATIONS

The breakthrough of new information technologies, integration and concentration of electronic media in one system is the essence of multimedia systems for a new type of computer connected television, interactive video, teletext, telephone, sound and photography, computer networks and reprography will allow teaching and learning at the individual level and differentiated according to their abilities and capacities.

IT OPPORTUNITIES IN OVERCOMING EMERGENCY SITUATIONS

The aim of this work from the point of IT is to present the possibilities of education through information technologies in emergency: Severe epidemics of influenza and pandemic situation, which could cause the closure of educational institutions and quarantine.

Designing and creating a model in the case of an emergency pandemic include:

- Assessing readiness
- Formulating a plan to use e-learning
- Creating a model for online learning
- Short run solution
- Long run solution

E-LEARNING SOLUTIONS

Creating a totally online learning mode demands much dedication and effort in order to reach or exceed face-to-face effectiveness, so expectations of eLearning have to be tempered.

- Administration (Online curriculum, information via SMS, email, Twitter-like sites .., LMS / CMS)
- Teaching (Webcast & podcast, screencast ... Slideshare.com, Scribd.com)
- Communication and Collaboration (Skype, Blogs, Wiki, Google Docs, Chat room, Forum...)

PRELIMINARY E-LEARNING

Preliminary usage of E-Learning in schools, in terms of blended learning, meaning that some aspect of learning is conducted via IT-based methods of learning and conventional face-to-face teaching will certainly raise the level of preparedness and easier transition to a full online IT-based education in pandemic emergency situations.

Preliminary E-Learning will include conventional methods of teaching backed up by Information Technologies in interaction with students, such as:

5. Exchange of materials in digital form;
6. Research during the lecture;
7. Exercises, showcases;
8. Tests, etc.

Blended e-learning offers the possibility of changing the attitude on where and when the learning will take place and in terms of what resources and tools can be used. It offers the integration of different “spaces”, for example, we can use e-learning environments within physical teaching spaces. The potentials offered by online learning using the Internet to deliver or support learning activity, has been long recognized as offering important advantages in transition to full Online Learning of fully computer mediated courses.

Keys to the success of any Web-based Online Learning experience are the design and planning behind the program. Though the students do not necessarily realize it, the instructor's creative thinking and organizational skills become even more important when there is no face-to-face interaction. The core content does not change, but new strategies as well as additional preparation time are required for developing effective communication techniques and building an environment conducive to learning from a distance. Despite the fact that students have less encounters with the instructor, the instructor is still responsible for focusing on the learning objectives and determining the best ways to express the course concepts. The instructor must gauge student progress without any of the visual clues observed when working with a student face to face. To accomplish this, the instructor must construct the right combination of flexible, independent learning and guided instruction.

In order for all methods of instruction to be efficient and effective, more resources and training should be encouraged while proper integration of traditional distance education, face-to-face contacts, web-based delivery and formal systems should be regarded as complementary with each other.

ENVIROMENTAL DISASTERS

Ecological disaster is the result of negative and reckless human activities and therefore this concept is different from that of a natural disaster. The impact of people leading to widespread and long-term consequences, the ecological system, and the same people, animal and plant life. Earth threatened serious environmental damage from oil spills, the risk of nuclear radiation and nuclear waste, forest fires and other disasters. Ecology is the study of relations between living beings and the environment, or more precisely - it is the science that studies the relationships of living beings to the environment in which they live.

The sharp deterioration of nature, an increasing number of pollutants that are scattering atmosphere, soil and water bodies due to the enormous development of industry and motor vehicle traffic, with the unsparing use of fossil fuels coal, oil and natural gas, leads humanity into a great problems in the future. The increase in world population is getting higher, while reducing traditional energy sources and limited supplies of food, requires serious reconsideration of one's desire and ability to live harmoniously with the Earth and its nature, which are increasingly destroyed by human activities. Global climate changes, a growing increase in carbon dioxide in the atmosphere due to its high production in the industry, but also by reducing the protective forest belts of the Earth, the planetary effects of "greenhouse", the reduction of the ozone layer that stops the harmful ultraviolet radiation, with a simultaneous increase in radioactivity due to the increasing use of nuclear materials to obtain the necessary energy use and accumulation of nuclear weapons, demonstrate that mankind is at the great turning point: either to continue past the road that leads it to self destruction, or the actions and our lives will be adjusted to the planet.

HEURISTIC AS A TERM

While the term "heuristic" means "science of finding new ways of scientific knowledge. Heuristic approach to the problem of the empirical search or optimization method usually solves the problem, but there is no evidence that mathematicians and physicists accept. No one knows whether it will always give the best answer (solution). While meta-heuristics schematically method for finding good heuristics for particular problems, it is a term that often appears in the evolution (development) algorithms and fuzzy logic applications:

"What kind of setup parameters to use in order to get good results when applying the heuristic method of X on Y problem ?".
"How do I adjust the parameters heuristics X to get a better result Y ?".
"Which is better, heuristics X or heuristics Y ?".

Under the heuristic modeling involves the creation of such a heuristic model that has meaning and represents more originals in one model, ie. a model allows the identification of new knowledge and develop the creativity of students requiring this or that level of independence while respecting each student's individual knowledge (Example: hybrid generators of renewable energy-wind, solar, water, etc.). The heuristic model is determined by very few actions during problem solving so that leaves a team member (staff for emergency situations) the possibility of finding one or all possible solutions depending on the knowledge, degree of autonomy and his creative abilities. This approach to problem solving allows each team member (staff for emergencies) to achieve their best, as weak, average, and above-average, for talented team members. Installation problems heuristic strategy means that a member of the team put in a position to identify, using old experiences in new situations, knowledge is known to lead to a new situation (function), discovers new ways of creative problem-solving, see Figure 1.

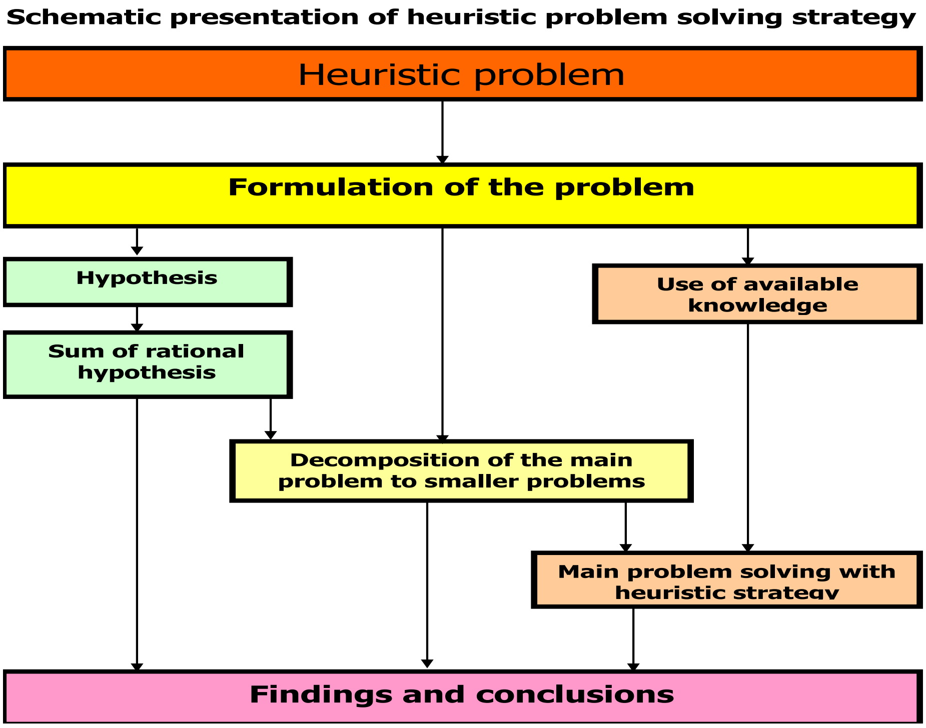

Figure 1: Heuristic strategy of problem solving

TEACHING TOPICS

Distance learning, heuristic model education and alternative energy sources with liquid battery

We chose to implement a number of teaching units within the chosen teaching subject, which contribute to the development of logical-dialectical thinking of the respondents, while teaching the technical and IT education provides scientific and dialectical character and orientation of the Polytechnic as a pedagogical-didactic categories derived from the goal of teaching the above topics.

Special attention was paid to the didactic-methodical approach to the class organization and creation of heuristic problem situations and the formulation of problems with the heuristic property of distance learning in the function of looking at the newly-defense system in emergency situations. Special emphasis is placed on the possibility of education through information technologies, for example, using alternative sources of energy in emergency situation: Severe epidemics of influenza and pandemic situation, which could cause the closure of educational institutions and quarantine. (instructions are given to educational leaflets).

HYBRID GENERATORS

This general overview of hybrid networks showing the basic layout and connectivity of each component. Although most systems have only one or two sources, in this case three renewable energy sources (wind, micro hydro and solar module generator) battery-powered liquid accumulator. Energy from liquid battery powered inverter that converts DC power into AC, suitable for household outlet. The controller battery - cordless power boiler and heater provides battery against overcharging. The meter displays system status. auxiliary generator is used as a complementary tool in cases where renewables do not have enough power to recharge the battery ie. maintenance.

LIQUID ACCUMULATOR

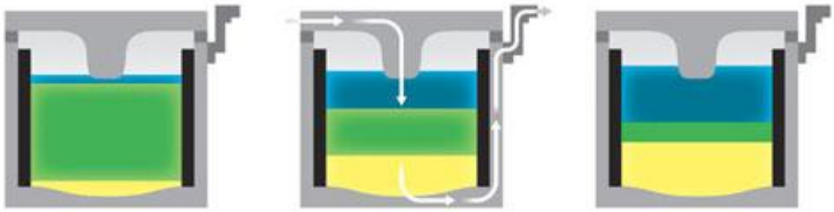

Figure 2: Liquid accumulator

Figure 2 shows the operation of the new battery. Left: Molten active component (blue - magnesium, green - an electrolyte, yellow - antimony) new types of batteries. Battery is ready for filling, with positive and negative magnesium ions dissolved in the electrolyte. Midfielders: Electric current flowing through the cell, the magnesium ions in the electrolyte and the electrons create appropriate the magnesium metal that is combined with the magnesium electrode. Right: The electrolyte is more expensive, and electrode growth.

Conventional batteries are using at least one solid active material. In the lead-acid battery in the figure 1, the solid plate electrodes are immersed in liquid electrolyte. Solid materials limit the conductivity and hence battery power supply that can circulate. They are also susceptible to cracking, decay and decline in performance over time, which reduces the time of use.

Without a suitable way to store electricity on a large scale, solar energy is wasted at night. One option that promises a new type of battery - the liquid battery, which is completely made of a liquid active materials. The prototype provides a cost that is only a third of today's best prices accumulator, and provides much longer life.

The first prototype consists of a casing surrounded by insulating material. The researchers added melted pure materials: antimony at the bottom, an electrolyte such as sodium sulfate or magnesium in the middle to the top. As each material has a different density, naturally remain in separate layers, which simplifies production.

Materials are cheap, and the design makes it easy to create.

Battery is not similar to any existing. The electrodes are molten metal and an electrolyte that conducts electricity between the molten salt. This results in unusually flexible device that can quickly absorb large amounts of electricity. The electrodes can operate with electric currents, "tens of times larger than ever measured (on batteries)" - a prototype of a team of scientists led by professor of materials chemistry at the prestigious Massachusetts Institute of Technology (MIT), Donald Sadovej. These liquid batteries have the advantage of the cheaper, longer lasting and more useful in a wide range of applications.

After prototyping, Sedvej and his team experimented with other metals as the electrodes, according to their estimates, the battery with liquid metal to the market appears to be the 2014th year.

CONCLUSION

Strengths and opportunities of IT and heuristic model of training in terms of problem solving in the field of emergency situations.

- Team work in solving problems in emergency situations.
- More people will bring different skills into the team, which improves efficiency.

- More knowledge and information
- Heuristic prediction problems
- Greater understanding and commitment to extraordinary problems, situations.
- Focus on problem
- Decision-making in stages with the corresponding activities. Phase of decision-making is a decision-making process and includes the following activities: problem analysis and definition of objectives, risk analysis, development strategies, development of models and simulations of behavior and decision-making and its transfer to the subjects.
- Application of heuristic techniques to solve combinatorial problems in emergency situations.
- The application of heuristic methods is focused in two directions: (1) to solve complex problems that can be presented in quantitative form but are so complex that their solution can not be found by using rigorous analytical techniques and (2) problems that can not be represented mathematical model because the variables in the model of quantitative nature. Heuristic goal is to provide methods of finding acceptable solutions to complex problems that can not be solved by classical methods.
- Solving problems heuristically conceived (the term means: the relative skill of using knowledge to achieve this objective, the transformation of the situation obtained in the desired or predefined by the problem of understanding and implementation of appropriate management actions. The term means understanding troubleshooting events and transformation of knowledge into appropriate action. Solving problems can be achieved in two ways: *using heuristic methods (solving the problem in terms of data management) and application of analytical methods (solving the problem in terms of governance models).*
- Develop models and methods that would improve the quality of quantitative decision-making means (software support), and for more rational use of resources (energy, money, time, labor, food, etc...) In all emergency situations. Proposing original solutions to be competitive and leading research in the field of emergency situations. Involving young researchers and train them in the future to be the leading national and world experts in the field of emergency situations.

Preliminary use of models in which the use of information technology during conventional lectures can have positive effects on:

- The willingness of students / pupils and teachers in potential pandemic situations,
- Easier transition to fully learning via the Internet or lectures that are supported by information technologies.

Such a model can be used for classes and education in rural areas where there are difficulties in transport / carriage or insufficient numbers of students.

Effects of education trough problem solving with heuristic in terms of increasing educational outcomes

The experimental problem was realized on the selected syllabus of technical, technological and IT education, suitable for processing heuristic approach that is conditioned adequate teaching methods, forms and means of work and constant learning. Implementation of work in experimental group E1 was carried out through the intense work of student thinking, respect for certain stages of work and increased cognitive effects.

The survey was conducted in classes V, VI, VII and VIII grade "Djura Jaksic" in Zrenjanin. The experiment included four classes of fifth to eighth grade and make an experimental group, "The experiment with one experimental group," where we want to determine how the students' progress in adopting the technical education curriculum using a heuristic model of these themes. The experimental program content selected classes were implemented using the heuristic model as a guide (guide) in the implementation.

Dependent variable of experimental studies have been defined as "increased effects of teaching technical education through the use of heuristic models."

The impact of using a heuristic model on the effects of teaching technical education is reflected in the results of testing students' knowledge.

By studying heuristics in teaching, analysis and selection was performed with the most appropriate choice of content, which ensures optimum use of the effects of teaching technical education in terms of combining frontal and individual work.

The results of experimental action factors obtained on the basis of the testing of pupils at the end of each lesson or a specific topic. To determine the effect of experimental factors clear from the results of the final state, ie. quantity of acquired knowledge, we took the initial state (what the students already knew) that. The results of the initial conditions which were identified at the beginning of subject testing these students. The experiment included 84 students, the arithmetic mean of the final state of all students $Xf = 4.29$, the arithmetic meat initial state of all students $Xi = 3.45$, therefore, the average efficiency factor of the experimental $XF = Xf - Xi = 4.29$ to 3.45, or 0.84 percentage = $XF\% = 17\%$. Of course, we did not manipulate the results of individual pupils, but we considered the mean. Based on this we can conclude that the pure effect of heuristic models about 17%, which means that the level of knowledge of students increased at the end of the implementation units, ie. block hours by 17% compared to the knowledge that students had at the beginning.

These results are used to design and draft curriculum for training of personnel to act in emergency situations, in order to create continuity in monitoring, training and future training of personnel necessary reformed to act in emergency situations in order to educate youth in the spirit of rational use of energy, through team work on a joint project that combines different ideas of team members for example - Hybrid generators in the production function using alternative energy sources (wind, solar, hydro, biogas, etc..), making these systems operational emergency and the transition to distance education .

REFERENCES

Amaldi, Eduardo; Capone, Antonio IEEE; Malucelli Federico (2003): "Optimization models with power control and algorithm", internet publikacija.

Bereš dr Paun, (2005): "Heuristički modeli nastave politehničkog obrazovanja u osposobljavanju kadrova za potrebe civilne odbrane", TF Zrenjanin.

Damjanović dr Vasilije, (1983):"Istračivanje u oblasti proizvodno-tehničkog obrazovanja", Novi Sad, PTF Zrenjanin, Zavod za izdavanje udžbenika.

Donaldom Sadovej (2009) “Tečni akumulator” Internet publikacija, Institutu za Tehnologiju Masačusets (MIT).

Knežević dr Vujo,(1981):"Modeli učenja i nastave", Beograd, Prosveta.

Kvaščev dr Radivoj,(1978):"Modeli procesa učenja", Beograd, Prosveta.

Landa, L. N,(1975):"Teorijski problemi algoritmizacije i euristike u nastavi", Beograd, Pedagogija.

Meyer Gerhard,(1968):"Kibernetika i nastavni proces", Zagreb, Školska knjiga.

Mužić dr Vladimir,(1982):"Metodologija pedagoškog istraživanja",Sarajevo, Svijetlost.

Mužić dr Vladimir,(1979):"Kibernetika u suvremenoj pedagogiji",Zagreb, školska knjiga.

Nadrljanski dr Đođe,(1986):"Kompjuteri, nastava i učenje", Novi Sad, NIRO Misao.

Hotomski dr Petar: “Sistemi veštačke inteligencije”, TF “Mihajlo Pupin”,Zrenjanin, 1995.

Sotirović dr Velimir; Adamović dr Mivoslav,(2002):"Metodologija naučnoistraživačkog rada", Zrenjanin, TF "Mihajlo Pupin".

Voskresenski dr Kosta,(1996):"Didaktika - Individualizacija i socijali zacija u nastavi", TF "Mihajlo Pupin" , Zrenjanin, Sloboda Vršac.

Voskresenski dr Kosta,(2004), "DIDAKTIKA" za profesore informatike i tehnike, TF "Mihajlo Pupin", Zrenjanin.

Popov Slobodan, PhD, Zarko Braunovic, Stankovic Jovan. *Management of institutions and education via e-learning in emergency situations* . Novi Sad : s.n., 2009.

Patrick, Susan. Continuity of Learning. *inacol.* [Online] 2009. http://www.inacol.org/col/index.php.

Ministry of Education, Canada. PANDEMIC RESPONSE FRAMEWORK And Pandemic Planning Guidelines for School Districts. [Online] 2009. http://www.gov.bc.ca/h1n1/attachments/pandemic_response_framework.pdf.

I. Rogers, Patricia. *Distance Education - Encyclopedia.* s.l.: Information Science Reference, 2009.

Hirtz, Sandy. *Education for a Digital World.* s.l. : BCcampus and Commonwealth of Learning, 2008.

Influenza A (H1N1) Preparedness - eLearning. *CIT.* [Online]
[Cited: 05 24, 2010.] http://www.cit.nus.edu.sg/flu-pandemic/.

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GREEN CORRIDORS AS ELEMENTS OF CONNECTION OF CULTURAL HERITAGE

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ABSTRACT

Many historical data describe glory, power, strong force and impressive arrangement of the Roman Empire. One of the most monumental fortifications was a limes - the boundary of the Roman Empire. Over 5000 kilometers long, in the form of rivers, wooden palisades, stone walls, limes provided a security to the Empire for centuries. Today, this monument slowly falls into oblivion, even it is an important part of the cultural heritage. Revitalization of an archaeological monument is followed by the landscape revitalization as well. The significance of the vegetation is greater because it allows the possibility to recognize the ideals of the Roman Empire by providing the opportunity to feel the smelts, to taste the fruit flavors and with landscape design to make the contacts with long ago destroyed Roman Empire. A green corridors as the linear belts by connecting the green surfaces, primarily they emphasize their ecological role, but they also have the function of connecting natural sites or cultural and historical monuments. This paper has the aim to present the possibility of cultural heritage visualization with the vegetation of the Roman period, in the form of green corridors as a modern element for improving the environment of urban areas.

Key words: limes, green corridor, visualization, environmental improvement, cultural heritage.

INTRODUCTION

A cultural heritage is an unique and irreplaceable cultural value of some nation. Created during the time, directly indicates the level of social and cultural development. The value of cultural heritage, whether it is a tangible or intangible, constantly increase due to its naturally stipulated time of duration, but also because of its unstable environment in terms of developing new technologies and changes in the style and ways of human life. Therefore, a concern about the preservation of cultural heritage, is not only an obligation of the competent institutions, but it is also a moral role of the whole modern society, who, by recognizing the importance of the cultural heritage, creates the conditions for its future preservation. It is not easy to preserve and restore cultural heritage of each. Very often, due to deficiencies of a certain fragments of some monuments, it is given up in the process of further renewal.

This paper aims to highlight the application of an alternative forms in the process of the reconstruction in order to present an ideals of the epoch to which the monument belongs. Specific types of the vegetation could be used for showing a symbolic, some objects, routes of movement, even life itself in the Roman Empire. But, on the other side, the vegetation could be utilized in order to improve the environment itself.

The subject of this work is presentation of process of the alternative reconstruction of the space line between two Roman settlements at the territory of today's republic of Serbia, Roman Singidunum and Roman Viminacium, including the Roman sites bteween them.

THEORY

A cultural monuments are important wealth of each nation. Created in one area during the historical process, they present a heritage of the past and material and cultural goods. They have a cultural and educational impact on the population, and by special legislative measures they have been protected in order to their further conservation. It is important that a monument is expressed only in the atmosphere of the epoch in which it was created (Kumaković, 1961). Therefore during the process of the reconstruction it should be taken into account the restoration of the environment that surrounds the monument. Certainly one of the world’s richest heritage are remains of the Roman Empire, scattered all over the world.

The Roman Empire at the height of its power, spread on several continents, and consisted of countries with different social development. For the easiest way of the management, the Roman Empire was divided into several provinces. In Serbia, there were two provinces Pannonia (its sub-province of Pannonia Inferior) and Moesia (with its sub-provinces of Moesia Superior and Moesia Inferior) (Vilovski Stefanović, 2006). In the province Moesia Superior there was no tradition of pre-Roman life, so the Roman towns provided the first settlements of urban type in this area. The largest number of Roman settlement was located precisely in the Moesia Superior, namely, at the territory between the major Roman settlements of this province, between the Roman Singidunum and the Roman Viminacium (Mirković, 1968).

Limes, originally meant a cross-time road through the woods or a swamp in the enemy country. Later, it was marked in the term of direction, parallel to the border, meaning that eventually it has been evolved into the concept of the limes frontier belt, with the road, palisades, moat and fortifications (Mirković, 1968). Limes in Serbia, had a natural character and it was the river Danube.

Plants were an integral part of the life in the Roman Empire. The Romans used to grow only those plants that they consumed in the food (Crnobrnja, 2006). Some of them were imported, and some of them were grown with grafting techniques. The grains that were used in the Roman Empire were: barley (Hordeum vulgare), rye (Seca cereale), wheat (Triticum aestivum), wheat (Triticum spelta), one-grain wheat (Triticum monococcum), two-grain wheat (Triticum dicoccum), millet (Panicum miliaceaum) etc. Literature sources further confirm about fifteen kinds of fruits, which are cultivated in gardens, some of them are: melon (Cucumis melo), apple (Malus domestica), medlar (Prunus domestica spp. institiia), (Prunus domestica spp. oeconomica), peach (Prunus persica), pear (Pyrus communis), (Sorbus aria), (Sorbus domestica), (Sorbus torminalis), vine (Vitis vinifera) and pumpkin (Lagenaria siceraria). There are distinguished some spices such as : dill (Anethum graveolens), celery (Apium graveolens), caraway (Carum carvi), coriander (Coriandrum sativum) and so on. It was noted the existence of the following species in the Roman gardens: hazelnut (Corylus avellana), hawthorn (Grategys laevigata), strawberry (Fragaria vesca), (Prunus spinosa), dog rose (Rosa spec.) (Rubus caesius), blackberry (Rubus fruticosus), raspberry (Rubus iadeus), (Sambicus nigra) and blueberries (Vaccinium cf. myrtillus), fig (Ficus carica), walnut (Juglans regia) (Tapavički - Ilić, Arsenijević, 2006). What is more Romans had also developed a plant cults. Branches of the fir and the pine, as well as a twigs from the other coniferous species, were used in the funeral rituals, when the houses of the deceased were decorated with them (Crnobrnja, 2006).

However, it is not an easy task to reconstruct an archaeological site, especially if it is weigh to its faithful view, and more accurate reconstruction of the environment that surrounds it; so, creating so-called "roman gardens" in the Roman sites with vegetation that was part of the Roman life, also would be a reconstructed picture of the life near the border, beside the limes. Over the centuries the orography of the terrain and climate were changed as well as landscape pattern, and therefore the process of presenting the life at limes is now very difficult. Namely, the vegetation can have multiple symbolic. A symbolism of the certain objects, certain smells and tastes, the symbolic of the life. Set in the space vegetation establishes a connection between visitors and long life in the shattered Roman Empire.

Watched from the another sight of the view, vegetation could have also an ecological role. Since the limes is the monument of line form, its markings by vegetation could be identified with a green corridor. On the other hand, vegetation placed in the aim to visualize the Roman sites, can link the different fragments within a single habitat, and thus once again serve as the green corridor. The role of a green corridors is manifold. They provide all necessary living conditions for certain species of plants and animals, the environment for movement of animals and environmental barrier, or filter, also a biotic source of influence on the modification of environmental conditions in the surrounding matrix. (Cvejić, 1999). Animals use corridors to move from one habitat fragment to another. Fragments of one habitat, connected to each other by corridors, are characterized by greater diversity of species compared to isolated fragments. Populations that live in connected fragments are characterized by lower extinction rates and higher population density.

Most countries now recognize that preserving biodiversity must encompass much more than just protected areas. Many countries are moving towards a landscape perspective, raising its strategy of preserving biodiversity, precisely nature to the next level by merging wideness. Green corridors are planted belts, made from both indigenous and non-indigenous species, the mediators between certain natural and cultural rarities. The aim of the development of green corridors is a common ecological networks and connectivity of habitats and biodiversity in all variety biogeographical regions (Cvejić, 1998).

The reconstruction of the Roman Empire, began late in the last century when it was in 1987. Hadrian's Wall was rebuilt in the UK and placed under protection as a UNESCO's world cultural heritage. In the year of 2005. to this list it was added the Upper German-Ratian limes, and in 2003. in Bratislava, it was established the group, whose primary task is to provide advice in the field of archeology and science in the domain of the limes (Breeze, Jilek, Thiel, 2005).

METHODS

The survey was conducted in the year of 2008. and 2009. in scope of preparation diploma thesis at the Faculty of Forestry, University of Belgrade. The object of the paper is the process of visualization a cultural heritage monuments in the landscape by using vegetation as an alternative form of markings in the space, also in order to improve the environment by forming green corridors. The survey included an analysis of space through field work and through the process of interviewing the space users and eminent experts in the subject area. Conducted interview was semi-structured and open-ended type, in this way in addition to issues of space and prepared questions it is left enough room for a short spontaneous questions. Questions were related to the current state of the limes remains, at its current visibility in the space and opportunity for improvement and maintenance in the future. For the conducted survey it is given the photo-analyze (photographic presentation of the current situation in space). With systematization of the study results and comparative analysis with previous researches with similar issues, conclusions have been made and the idea further was developed .

FINDINGS

The research area of this work is the territory of the province Upper Moesia, where there were the following Roman sites: Singidunum, Tricornium, Aureus Mons, Vinceia, Margum and Viminacium. The area of the Upper Moesia was militarily the most important area in the defense line of the limes at today's territory of the republic of Serbia (Figure 1 and 2). The results of two-years study haven’t shown encouraging results at all, because it was determined that more than 80% of Roman sites, included in this study, lies under the ground surface, and perhaps forever it will, destroyed and forbidden (Table 1 and Table 2). The reasons for this are neglected archaeological excavations, intensive urbanization, economic development and man's indifference.

During the archaeological excavations at certain points of the former Roman settlement - Roman Singidunum (Figure 3), it is noted that domination of the Turkish period from the time the seventeenth to the nineteenth century. Many basements of Turkish houses are built on the remains of Roman fortifications. Roman Singidunum, or what it is left of it, is still deep in the ground with his inability to ever again at this site shows its military camp and to reconstruct it at all. A great part of the Roman site Tricornium was demolished by the force of the river Danube. There have been left some insignificant traces of the Empire at this site. Roman sites Aureus Mons and Vinceia, once a Roman settlements, today they are dense populated villages within the territory of the city of Smederevo. These sites are partially explored and not reconstructed at all, the only remaining of the Roman site VInceia is the old Roman well (Figure 7). For Roman site Margum (Figure 4) it could be said that it is one of the rare Roman sites in the study area, which is now in a position to be open for further archaeological excavation. The former capital of the Roman province Upper Moesia, Viminacium (Figure 7), is now slowly rising from the vast farmland of the village Stari Kostolac and its surroundings and thus becomes an archaeological monument, which strives for a reconstruction (Figure 5 and 6,).

Big problem of Roman sites in Serbia is their position. They are located in the territory of urban places, and therefore the process of reconstruction becomes more difficult. One of the alternative process of the reconstruction is setting the vegetation of the Roman period.

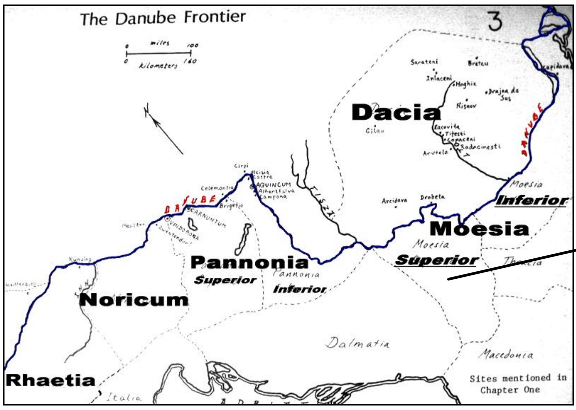


Figure1. Mapof the Roman provinces along the Danube limes (source: Lander, J., 1984)

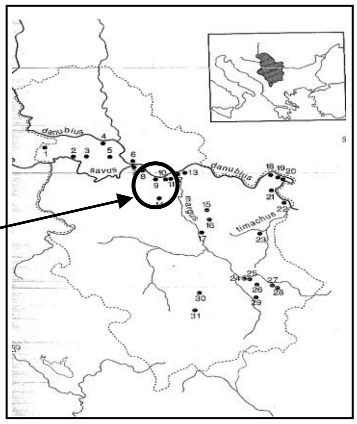
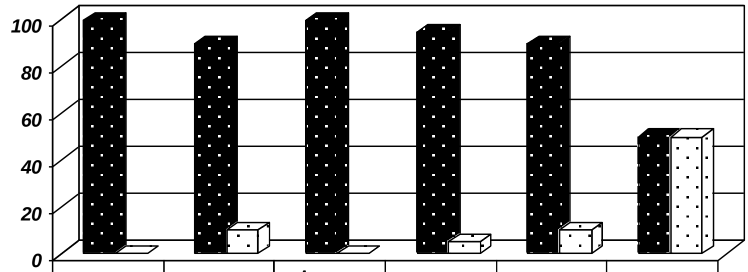


Figure2. Map of Serbia with a position of studied sites (source: Srejović, D., 1993)

One of the ways of connecting the Roman sites in Serbia is establishment of green corridors as a visual signs of Roman Empire besides the limes. Romans used mostly vegetation that is typical for garden growth, so it could be hardly said about their usage in some larger scale, such as the visual markings in the space. However, the combination of bushy and fruit species and some other species that represented life in the Roman Empire, with species that have proved as a native species in the study area will certainly produce a positive effect. In the case of forming the protective environmental belt (noise, pollution, etc.) certainly it must be take into account the gradient, namely, only the combination of high-altitude plant species, it is achieved the effect that they are intended for.

The study has shown that in the researched area there is a significant presence mainly of deciduous forms, as well as a wooden and bushy plant species, so that on the one hand, the introduction of coniferous species, such as Abies sp., Pinus sp., constituted a contribution to landscape painting, and on the other a symbol of Roman life. Table 3 shows the species that are suitable for the formation of the green corridors in the study area, and which can be fitted with species that were an integral part of Roman life.

Table 1: Presentation of visibility of the Roman sites today



	Singidunum	Tricornium	Aureus Mons	Vinceia	Margum	Viminacium
■ visible (%)	100	90	100	95	90	50
□ unvisible (%)	0	10	0	5	10	50

Table 2: Presentation of a current state of the Roman sites in the study area

site	unreconstructed	partly reconstructed	tends to complete reconstruction
Singidunum	x		
Tricornium	x		
Aureus Mons	x		
Vinceia	x		
Margum	x		
Viminacium		x	x

Table 3: Presentation of the species, suitable for urban corridors formation

species	life form	high(m)	role
Juniperus sp.	tree or shrub - conifer	0.5 - 12	submitted by poison gases
Ulmus pumila	tree -deciduous	10	agricultural protected belts
Celtis australis	tree -deciduous	20	agricultural protected belts, afforestation
Corylus colurna	tree -deciduous	25	agricultural protected belts, windscreens belts
Pinus nigra	tree - conifer	40	afforestation, urban conditions
Pinus sylvestris	tree - conifer	40	afforestation, urban conditions
Cotoneaster horizontalis	half-evergreen shrub	lie down type form	submitted by poison gases
Tsuga occidentalis	tree or shrub - conifer	30	urban conditions
Tilia cordata	tree -deciduous	30	urban conditions
Cupressus arizonica	tree or shrub - conifer	12	urban conditions
Cupressus sempervirens	tree or shrub - conifer	25	urban conditions

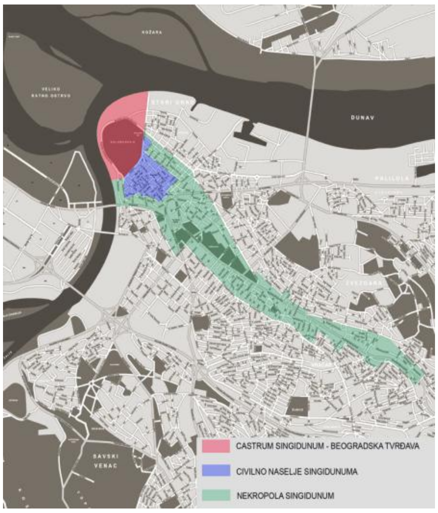


Figure 3. The map of archeological analyzes of located Roman remains at the Roman site Singidunum (source: www.belgradeheritage.com/)

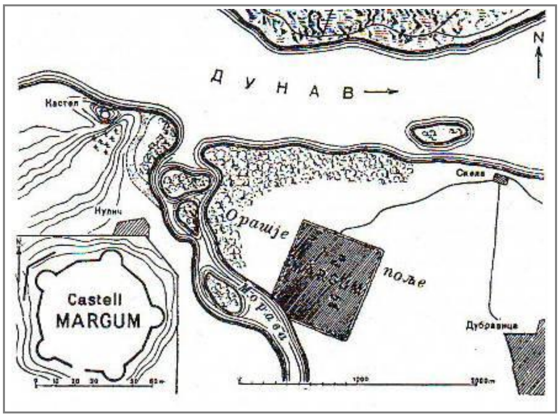


Figure 4. Roman site Margum and its castel (source: Kanic, F., 2007, p.p 159)

Figure 5. Roman site Viminacium after archeological excavations (left: part of the excavated necropola, right Roman bathroom) (source: Ivana Blagojević, 2009)

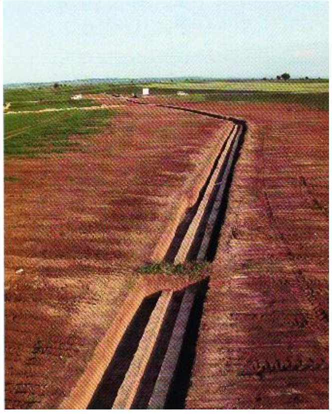


Figure 6. The excavated aqueduct in Viminacium(source: Korać, M., 2008/09)

Figure 7. Roman site Vinceia present – rests of the Roman well (source: Ivana Blagojević, 2009)

DISCUSSION

The European Green Belt is a unique initiative that aims to transform the former "Iron Curtain" in a network of protected areas. Started in the year of 2003rd it encourages the cross-border cooperation in nature conservation and sustainable regional development along its course of about 8400km. This is an ecological network, but also a living museum. "Iron Curtain" divided the Eastern and Western Europe, and broke contact between people over a period of 40 years. Nature has taken under its control abandoned border areas and gets the best out of this conflict. Today a number of beautiful habitats with rare plants and animals associate regions of Europe and forms of life and create the cultural heritage monument of Europe.

The European Green Belt initiative has the vision to create the backbone of an ecological network that runs from the Barents to the Black sea, spanning some of the most important habitats for biodiversity and almost all distinct biogeographically regions in Europe. By following a course that was in large sections part of the former east-western border - one of the most divisive barriers in history - it symbolizes the global effort for joint, cross border activities in nature conservation and sustainable development. Moreover, the initiative shall serve to better harmonies human activities with the natural environment, and to increase opportunities for the socio-economical development of local communities. A Green Belt network of protected areas will contribute to the conservation of biodiversity – first of all by harmonizing management methods on both sides of the border. The Green Belt connects National Parks, Nature Parks, Biosphere Reserves and trans-boundary protected areas as well as non-protected areas along or across borders and it supports regional development initiatives based on nature conservation.

The Green Belt is an initiative that is tailored to fit the current political situation and the development taking place now, focusing on some of Europe’s most impressive and fragile landscapes. The European Green Belt has the chance to take one of the world's leading symbols of human division and transform it into a model of future nature conservation in Europe. The Balkan Green Belt is an extremely heterogeneous, but mostly natural corridor. The Green Belt links important wetlands such as coastal areas, rivers and lakes with the mountains in the very center of the Balkan.

The European Green Belt is a good example of a connection between the green corridor and the heritage of the past. Led by this idea this work seeks to the creation of the bridge between these two elements. On the one hand it connects the historical sites, raises the level of communication at local, regional and international level, and encourage the socio-economical development, while on the other side by creating a green corridors in order to improve visualization of the objects by the site the biodiversity and the environment is developed as well.

CONCLUSIONS AND IMPLICATIONS

A cultural heritage is the legacy of the past of a certain area, a certain people. A heritage is irreplaceable and besides its tourist value, its educational role is emphasized as well. There is a fact that present generation will left some cultural wealth behind, but undoubtedly, it will be no sacred type, such as the monuments of the past are. For this reason, a cultural heritage should be protected and preserved from further destruction and their permanent oblivion.

The green belt can be seen as a corridor which connects the different landscape habitats, both at local and regional levels. This is a belt that contributes to the biodiversity conservation and nature protection; link between a history and a culture of a people, and thus provides a cross-border cooperation and help maintain and develop nature and cultural landscapes of European importance. The green corridors can be and they are a joint of cultural heritage of certain space. Their applicative role is multiple and as such should be applied more frequently in spatial planning.

Visualization of the Roman sites and linking the Roman sites of the province Upper Moesia, in whole, by using the green corridors, partially composed of vegetation of Roman period, contributes to the preservation of the cultural heritage, improves the environment, but also represents one of the innovative ways of the restoration the cultural monuments, connection between the past and the present.

REFERENCES

Bell, S. (2004): Elements of Visual Design in the Landscape, *second edition, Routledge Taylor&Francis Group*, London and New York, 117 - 125.

Bishop, I., Lange, E. (2005): Visualization in Landscape and Environmental Planning, *Taylor&Francis Group*, London, 56 – 65.

Breeze, J. D., Jilek, S., Thiel, A. (2005): Frontiers of the Roman Empire, *Historic Scotland, UK and Deutsche Limeskommission*, Germany; Edinburgh- Esslingen – Wien, 1 - 20.

Vilovski Stefanović, T. (2006): Singidunum, *Srpska književna zadruga*, Beograd, 9-15.

Vukičević, E. (1996): Dekorativna dendrologija IV izdanje, Šumarski fakultet, Univerzitet u Beogradu, Beograd.

Kumaković, Z. (1961): Šta je spomenik kulture, *Zemaljski zavod za zaštitu spomenika kulture i prirodnih rijetkosti*, NR BiH, Sarajevo, 80 – 86.

Mirković, M. (1968): Rimski gradovi na Dunavu u Gornjoj Meziji- doktorska disertacija, *Arheološko društvo Jugoslavije*, Beograd, 50 - 150.

Ocokoljić, M., Ninić-Todorović J. (2003) Priručnik iz dekorativne dendrologije, *Šumarski fakultet, Univerzitet u Beogradu*, Beograd.

Tapavički - Ilić, M., Arsenijević, M. (2006): Poljoprivreda centralnog Balkana na prelasku iz stare u novu eru, *oblast Arheologija i prirodne nauke, www.viminacium.co.yu*

podaci preuzeti sa sajta, tekst, autori:

Cvejić, J. (1998): Turizam i rekreacija, III deo*, Šumarski fakultet, Univerzitet u Beogradu*, Beograd, 264 – 266.

Cvejić, J., (1999): Tipologija predela, *Šumarski fakultet, Univerzitet u Beogradu*, Beograd, 97–98.

Crnobrnja, A. (2006.): Kultna namena rimskih žižaka u Gornjoj Meziji, *Filozofski fakultet, Centar za arheološka istraživanja, Muzej grada Beograda*, Beograd, 5, 101 - 105.

ICT IN THE ECOLOGY OF URBAN AREAS

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MODERN INFORMATION TECHNOLOGIES AND MUNICIPAL WASTE TREATMENT

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ABSTRACT

According to directives of the European Union Slovenia has introduced separate collection of municipal waste. Nevertheless, degree of waste separation in Slovenia is still not satisfactory. Therefore, in Ljubljana a new system of municipal waste treatment has been introduced recently. This system is supported by RFID technology which helps to determinate the quantity of waste generated by individual user. This will present the basis for waste treatment service accounting which should ensure that the price paid by a particular user is proportional to the quantity of generated waste. In such a way it is possible to stimulate waste formation prevention and waste separation. The present paper describes briefly some aspects of this municipal waste treatment system.

Key words: municipal waste, waste separation, RFID technology, recycling, underground containers.

INTRODUCTION

As all countries which are new members of the European Union (EU) or will become members in the future also Slovenia is confronted with the problem of introduction of municipal waste separation. However, particularly because of the lack of landfill space in Slovenia, waste separation and efficient reduction of deposited waste quantities presents the only possible solution. Therefore, EU demands in Slovenia have only accelerated introduction of important changes in waste management system which would be unavoidable in every case.

Active cooperation of citizens is of crucial importance for successful introduction of municipal waste separation. Many systems of waste separation failed just because they were not accepted by citizens nevertheless they were well prepared in some other aspects. Both motivation and information are important. One of efficient ways of motivation is by a policy of prices. When the costs of waste treatment service are proportional to the quantity of mixed waste deposited in a bin, citizens are motivated to reduce waste quantity – by waste formation prevention or by consistent separation of waste.

Therefore, it is necessary to introduce system which enables accelerate measurements of waste quantity deposited by a particular citizen or household and their registration which presents the basis for the account of waste treatment costs. It is important that citizens recognize that the system enables honest determination of waste treatment service costs and that they adopt the system.

WASTE MEASUREMENT SYSTEMS

In European normative EN 14803(Identification and Determination of Quantity of Waste) demand of municipal waste quantity measurement is expressed. There is not exactly prescribed the way of waste measurement (mass, volume or some other way) and remains the option of company responsible for waste treatment.

Individual houses or households usually posses their own waste bin, or eventually more households share the same bin/container. In such cases it is important that all containers are identified by a code number and registered in data bases. Every container is also equipped with a RFID chip. This enables identification of the container during the process of waste collection. After identification of the container the waste quantity (mass or volume) is measured and simultaneously registered in the data base. Therefore, the waste deposited by the individual owner of the container can be followed and this is the basis for waste treatment service account.

MUNICIPAL WASTE MANAGEMENT SYSTEM IN LJUBLJANA

Company Snaga, d.o.o. is responsible for the municipal waste treatment service in the city of Ljubljana as well as in nine other communities in the vicinity of the Slovenian capital. The Snaga company invests much effort into efficient introduction of separate collection of municipal waste. Following fractions are collected separately (Snaga, 2009):

- Waste paper, cardboard, glass and packaging (ecological points)
- Biological waste (brown coloured containers for biological waste)
- Bulky waste (collecting centres or movable collecting points during actions of bulky waste collecting)
- Hazardous waste (collecting centres or movable collecting points during actions of hazardous waste collecting)
- Electronic waste (collecting centres)
- Remaining fraction /mixed waste/ (black coloured containers for the remaining waste)

As mentioned waste management system should stimulate users (citizens or households) to separate waste and minimize the quantity of mixed fraction (waste which is not separated). The environmental awareness and the level of environmental education of citizens are important. However, it is not possible to build up the entire strategy on their ecological enthusiasm. Citizens as users of municipal services should be stimulated by adequate policy of prices which should follow the “polluter pays” principle. Every customer (household) should pay proportionally to the amount of waste formed. Separately collected fractions, which can be simply included into recycling processes and are therefore interesting for recycling companies as secondary raw material, do not cause additional expenses. Therefore, separate fractions should be exempted from the account. The cost of waste treatment will therefore include only biological fraction and mixed (remaining) waste. The most important task is to establish a reliable system for measurement of waste quantities. The measured mass or volume of waste will than present a basis for account of the waste treatment costs like in the case of electric energy, water, telephone calls etc.

The system named “POTKO” has been developed just into this purpose. This system enables reliable measurements of waste quantity generated by particular user (household) (Naglič, 2010).

CHARACTERISTICS OF THE SYSTEM “POTKO”

The important feature of the system is that all containers as well as all users of municipal waste treatment services (citizens/households) are included into the informational system. It means that every waste container (bin) is equipped with a chip. This enables identification of the container (bin) and therefore recognition of the owner of the container. This presents together with the waste quantity measurement the ground for account of municipal waste treatment service. Containers or bins which are not equipped with a chip are excluded from waste collection process.

However, something different situation is in the centre of city. There is, because of high density of settlement, very difficult to find place for waste containers belonging to individual houses. Therefore in such locations underground containers are used. Every user (household) has access to certain container which should be located in the distance not greater than 150 metres from his residence. The access to the container is possible only by the user registration card. Therefore people which are not residents of a particular district have not access to a particular container.

Use of RFID chips on containers

The POTKO system is based on the RFID technology (Radio Frequency IDentification). During the first phase of project introduction containers for biological waste were equipped with RFID chips. In the case of plastic containers chips are located on the special position in the front side of container. By metal containers chip is also attached by screws in the front side.

Generally, two types of RFID chips can be used: FDX (full duplex chips) and HDX (half duplex chips). FDX chips are continuously receiving and emitting signals which means simultaneous flow of communications in both directions. Contrary, HDX chips are receiving radio signal from the reader and are saving power in the capacitor. The flow of communication runs only in one direction simultaneously (Naglič, 2010). HDX chips exhibit broader operational range (up to 50 percents) and are quite resistant to thermal (temperature changes) as well as to mechanical stress (dust or metal particles). Therefore, HDX chips are more often used in practice for the identification of containers (C-trace, 2009).

HDX chips are called also passive chips as they do not have their own source of electricity. They have the following important properties (Naglič, 2010):

- They present an alternative to barcode or can be designated as successors of barcode
- Operation by frequencies 125 kHZ and 134,2 kHz
- They have not own source of voltage
- Plastic housing
- Stability to weather changes (temperature range from – 40 to + 90 ^{o}C)
- Good resistance to mechanic stresses
- Range of reading 50-100 mm.

Passive systems for following of waste containers include RFID chip, label with the chip data, label with the data of the owner of the container, identification equipment for municipal service vehicles and program equipment.

However, the RFID chip on the container cannot function without RFID reader which is placed on the municipal service vehicle. RFID reader emits radio waves. After receiving these waves RFID chip gets energy to send signal to the reader which can thus identify the container. After identifying the container can be simultaneously weighed before and after emptying and all the data can be saved in the database.

It is necessary to equip the municipal service trucks with adequate equipment and to assure that containers are equipped with RFID chips. This can be achieved in two ways: attaching the RFID chips on the existing containers or with delivering of new containers which contain RFID chips.

In Ljubljana the Snaga company already has provided about 17 thousand of plastic containers for organic waste with RDIF chips. In 2008 about 10.600 tones of waste (or about 6,8 mass per cent of the total waste from households) were collected in these containers (Snaga, 2009).

Underground containers

As mentioned above, in certain locations it is suitable to substitute conventional containers with undergraduate containers. These underground containers exhibit many advantages. One such container has volume 5 000 litres and can replace from 5 to 20 conventional containers. In such way it is also possible to reduce noise, avoid unpleasant smelt, improve traffic safety and promote waste separation. Every citizen (or household) included in waste collection in underground containers receives his own RFID identification card which enables access to the container (Kliko, 2009).

Therefore, unauthorized users have not access and only users which are registered can emit the waste in the container and every time the volume of waste (usually 50 litres), time and date of disposal and the identification number of user are registered. This enables accurate and fair account of waste treatment service.

It should be mentioned that specially equipped trucks are provided for collecting waste from underground containers. This highly automated equipment enables that only one worker (driver) can manage the entire process instead of three workers necessary by conventional system. He can guide and control the process with the use of special cameras and does not need to leave the truck's cab at all. This presents considerable improvement of working conditions for municipal service workers.

INFORMATIONAL ASPECTS OF SYSTEM

It is of crucial importance that all waste containers are included in the data bases and that data bases are simultaneously updated. Necessary condition for the correct account of municipal service expenses is that owners of conventional containers are known and all changes (by example migrations) are accurately registered into data bases. Besides this, all damages of containers, errors on chips as well as desires of users (when they need smaller, bigger or one additional container) can be detected. Containers which are not included into the system (so called "black containers") are excluded from the process of waste collecting.

As is shown in Figure 1, before the process of emptying of the container, RFID reader emits radio signal (Ekoplus, 2008-2010). After receiving returned signal from the RFID chip reader recognizes the container. Before and after emptying the container is simultaneously weighed and, normally, from the difference the mass of waste is determined. All these data are collected into database and are then transferred to the central application.

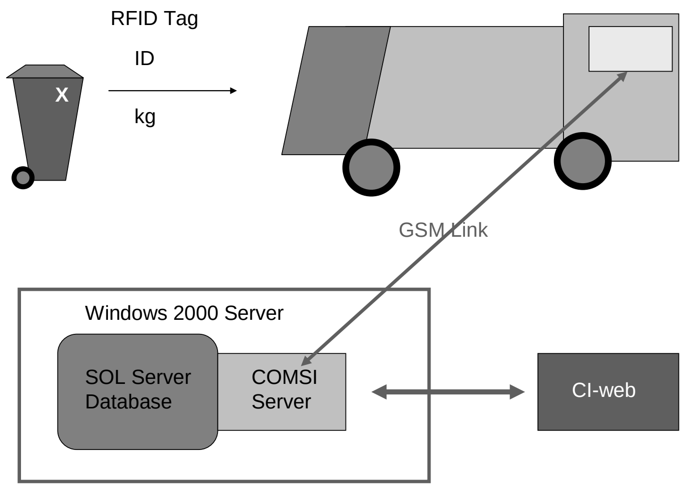

Figure 1. Schematic presentation of data transfer from truck to the central server of application (Ekoplus, 2008-2010)

In the case of underground containers, as mentioned, identification cards permit only authorized users to emit the waste. Every such event is registered (user identity, date and time, waste volume), data are collected and via GPS/GPRS technology are send to the central application. All important parameters regarding particular underground container are followed, especially the remaining capacity of the container. Therefore, waste can be collected only from those containers which are full and thus logistic processes can be optimized.

The application is relatively simple for use and can be easily surveyed. Therefore, also education of workers in municipal services does not present an important problem. Application, which principle is structurally shown in Figure 2, enables to control simultaneously to control the entire system including all containers and users. Every emptying of the container, waste fraction, waste quantity, time and date of disposal etc can be followed which is the base for correct calculation of waste treatment costs.

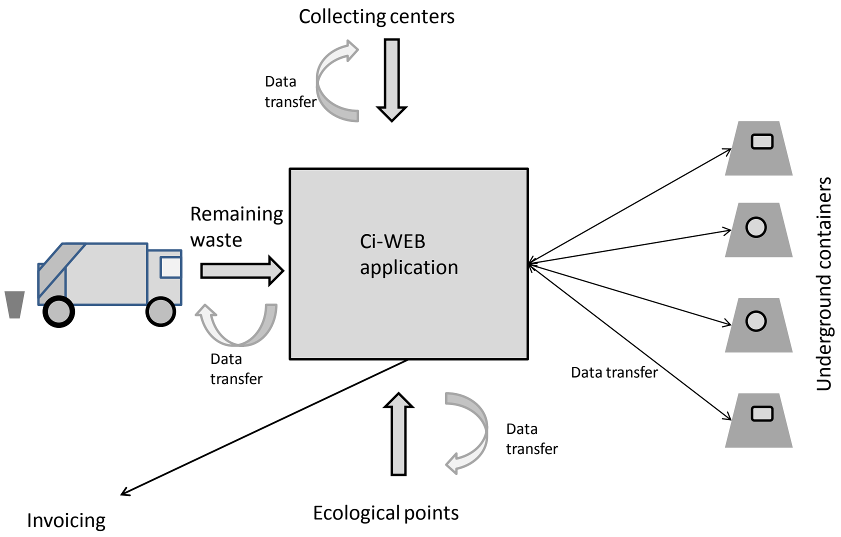

Figure 2. Structure of the system for surveying the use of municipal services (Ekoplus 2008-2010, Waste in Slovenia 2010)

CONCLUSION

There are many positive results brought by the introduction of the system POTKO. The most important is increased quantity of separated waste fractions and reduction of remaining (mixed) waste. This is the right way to the main goal: decrease the quantity of waste which is destined to landfills and lower the costs of waste treatment.

However, there are some other positive effects:
- Transparency of the system
- Exclusion of nonregistered (“black”) containers from the system
- Correct (fair) account of waste treatment costs (proportionally to the deposited waste quantity and therefore higher contentment of users)
- Automating of processes (b.e. invoicing)
- Establishment of data bases
- Optimization of logistic processes (as is rationalization of data collection).

There is very important that system motivates users to responsible waste treatment – waste formation prevention and consistent waste separation. This can be achieved when the account of waste costs is performed in adequate way. The information and education of citizens is also very important.

REFERENCES

C-trace (2009). C-trace GmbH :*Identification systems in waste business*, Internal presentation
Ekoplus (2008-2010). *Archives of the company Ekoplus*, d.o.o.
Kliko (2009): Kliko WTS B.V. *Katalog: Inzamel Technologie*
Naglič. S. (2009). *Introduction of electronic technology for system of mixed municipal waste collection in the company Snaga, d.o.o* (in Slovene: *Uvajanje elektronske tehnologije za sistem zbiranja mešanih komunalnih odpakov*) – graduation thesis, University of Maribor
Snaga (2009) *Annualy Report for the Year 2008*, Snaga Company (in Slovene).

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DATA ACQUISITION FOR ENGINE CONTROL AND MEASUREMENT SYSTEMS

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ABSTRACT

In this paper one aims to achieve an integrated solution for the diagnosis of various sensors in the automotive industry. One refers to sensors for the following parameters: temperature, mass air flow. Operation diagnosis is based on comparison of data measured by these sensors with some limits, which are stored in the 68hc11 microcontroller. Operations are running simultaneously and in parallel with other applications such as ignition or injection. We propose a system for diagnosis of automotive sensors, which on a screen and two-digit seven-segment indicator sensors. This device is designed to assess eight sensors and status of these sensors is shown in the second message indicating whether the sensor is working or not. Diagnostic system allows the user to see signals from sensors in real time, which is very important in the functioning of the electronic system. Diagnosis result can be displayed on a portable pc to see signals in a graphical interface.

INTRODUCTION

DIAGNOSIS OF AUTOMOTIVE systems allow the users to tune their cars more precisely by monitoring and recording engine data as the car is being driven. This is usually not possible with traditional measurement and diagnostic equipment. is a state-of-art diagnostic system that delivers more accurate, more stable, more comprehensive, easier and faster diagnosis. The new generation platform stands out in a variety of tools by providing incredibly high performance with intuitive operation. For the first time, workshops and technicians could find an OE-level diagnostic solution designed for the aftermarket. The DS708 is the key to gain customer confidence and boost your bottom-line.

THEORY OF DATA ACQUISITION FOR ENGINE CONTROL AND MEASUREMENT SYSTEMS

An engine control and measurement system must monitor many different engine parameters. Some parameters of interest are *engine loading* (intake manifold pressure and throttle position), *engine speed* (RPM*), ignition timing* (spark advance and dwell), and *critical temperatures* (air and coolant). The measurement system monitors these parameters so that it can be expanded into a full engine control system.

The crank (CRK) sensor signal is probably the most important signal in a modern automotive engine control system. This signal provides the ECM with crankshaft speed and position, as well as a cylinder # 1 reference point. There are various names given to this signal. The distributor reference, CRK signal, CAS, PIP, etc (depending on the manufacturer). The way this signal reaches the ECM will affect the approach that is taken to a proper diagnostic procedure. By analyzing the signal path to the ECM using a wiring diagram and an oscilloscope, the correct diagnostics determination can be made.

The CAM sensor signal is found on systems with sequential fuel injection, in which the ECM triggers the injectors independently instead of in group mode as in older systems. The CAM signal is also called CID, TDC, etc, depending on the manufacturer. The CAM sensor provides the ECM with camshaft position so that it can determine the correct injection and ignition sequence. Some systems (with distributors) do not need the CAM sensor to start the vehicle, and can simply start in non-sequential mode. However COP and most DIS systems do need the CAM sensor so that the ECM can determine the position of cylinder # 1 TDC on compression stroke and fire the correct coil.

The relationship between CAM and CRK signal is very important for proper ignition sequencing to occur. A stretched or jumped timing belt/chain will create severe engine performance problems on DIS/COP systems, since the ECM doesn't know when to trigger the coils. On other systems the ECM will shut down ignition entirely if it sees a discrepancy between these two signals.

CAM and CRK sensors come in four different varieties: MAGNETIC, HALL EFFECT, OPTICAL AND MAGNETO-RESISTIVE.

The magnetic sensor actually produces its own signal. It is in essence a small generator. A coil winding inside the sensor picks up the magnetic fluctuations from the vibration damper or the flywheel (or both in some cases). A toothed reluctor wheel on either the damper or flywheel induces a voltage signal to the sensor. Magnetic sensors work on the principle of induction, which states that a metal object or magnet when placed across a coil winding will induce a current on that coil. Magnetic sensors are heavily dependant on the air gap between the sensor and reluctor wheel, and on the speed of rotation. The air gap has to be set as close as possible without touching the reluctor, and the engine cranking rotational speed has to be fast enough to produce the right signal amplitude. It is common to see vehicles that will not start due to a defective starter that is cranking the engine slower than normal. Systems that employ a magnetic sensor also have a threshold voltage, which is the voltage value at which the signal is first recognized by the ECM. Most distributor pick-up coils are of the magnetic type although Hall Effect distributors pick-ups are also found on some systems.

Once the signal reaches this pre-programmed voltage the ECM recognizes the signal and will act upon it (pulse the injector, etc). Magnetic sensors are usually shielded or with its wires twisted to prevent electromagnetic interference. On some systems the ECM provides a small bias voltage for diagnostics purposes. If the ECM sees a problem with this bias voltage, it will set a code for either a shorted or open circuit. Special attention should be paid to the polarity of these sensors. They are polarity sensitive. If for whatever reason the polarity (wires) is inverted, the vehicle will not perform properly or will not run at all.

The hall effect sensor requires its own voltage and contains a switching transistor within the sensor casing. This type of sensor needs a voltage supply, reference voltage and a ground to operate. Transistors are electronic switches that turn ON or OFF when a current is applied to one of its three leads (Base lead). The sensing semi-conductor device or miniature coil in a hall-effect sensor is tied to the base lead of this internal transistor.

When the triggering mechanism (reluctor wheel) comes close to the hall effect sensor the magnetic lines cut across the sensing semiconductor device, which triggers the small internal transistor. This internal transistor then toggles the reference signal between ground and reference voltage. Hall effect sensor outputs a square wave signal simply because all they do is toggle their reference voltage to ground. In essence they are magnetic sensors, with an added internal switching transistor so that the sensed signal goes to the base lead of the internal transistor to trigger it instead of straight to the ECM, like a regular magnetic type sensor. Some hall effect sensors actually employ their own permanent magnet within its casing. This variation uses a shutter type triggering wheel that breaks across the magnetic field. The momentary interruption of this magnetic field is what triggers the base of its internal transistor. Regardless of what hall effect sensor variation used, they all output a square wave. Hall Effect sensors are not affected by slow engine cranking speeds. They will simply toggle the reference voltage to ground, regardless of cracking speed.

The optical sensor uses a principle somewhat similar to the Hall Effect sensor, but instead uses light as its triggering method. Optical sensors are light activated devices. These sensors use an LED (light emitting diode) as their light source, and a phototransistor as their triggering component. Optical sensors always have a shutter disk with small holes. Due to the more sensitive nature of the phototransistor, these holes are fairly small and can detect tiny amounts of engine speed fluctuations. Optical sensors are much more exacting in their operation and are able to detect very small engine variation problems much faster than any of the other two of sensor variants.

Optical sensors also put out a square wave. They need a supply voltage and ground to feed the LED light source and phototransistors, as well as a reference voltage. The shutter wheel passes between the LED and the phototransistor; and as this shutter wheel turns, it momentarily breaks the light beam emitted by the LED. This light beam breaking action is detected by the photo-transistor, which instead of having a base lead has a small lens or eye that is always looking for the light source. The action of the shutter wheel breaking the light source also triggers the phototransistor, which in turns toggles the reference voltage to ground. Optical sensors may also have two LED light sources. One for the 360º of crank rotation and the other with 4-6-8 slots to denote each cylinder position depending on the amount of cylinders on the engine. It is fairly common to see dirt and oil contaminate the small holes on the optical triggering wheel and cause erratic or no signal output at all. Neither optical or hall effect sensors are affected by slow engine cranking speeds.

The newer styled magneto-resistive sensor is yet another derivative of the hall-effect sensor. This sensor also puts out a square wave, but with one fundamental difference. Magneto-resistive sensors DO NOT ground their reference voltage. They are constructed with two internal sensing pick-up devices one besides the other. When the reluctor wheel tooth comes into proximity with the sensor, the first of the two sensing pick-up devices will trigger the base of the transistor and toggle the output signal high (i.e. 5 volts). A split second later, the second of the two sensing pickups will then toggle the output signal low (0 volts) or ground. This sensor uses the leading and trailing edges of the reluctor tooth to output a square wave. The leading tooth edge toggles the sensor high and the trailing edge toggles it low. The output is a regular square wave. Magneto-resistive sensors are also not affected by slow engine cranking speeds.

The following Conditions that Affect Operation should be used as guidelines affecting all CAM & CRK sensors mentioned here. It is always important to determine the specific vehicle operation before making a diagnostics decision. Keep in mind that the way the CAM or CRK signal reaches the ECM will determine the diagnostic route to follow. These signals will either go to the ignition module first then to the ECM or just straight to the ECM. If a CAM or CRK code is set, careful consideration should be given to the particular vehicle strategy. A signal that first goes to the ICM and is not reaching the ECM could be due to it being shorted/open circuited at the ICM. Furthermore, on most of the sensor-ICM-ECM type of systems the actual hall effect voltage reference is provided by the ICM itself. These smart ICMs make all the decisions after processing the actual CAM/CRK signal and only then send a reference position signal to the ECM. A quick glance at the wiring diagram should be the first step. Learn and study the particular system before attempting to perform a diagnostic.

Magnetic sensor signal output strength (amplitude) is very dependant on the air gap between it and the triggering mechanism (reluctor wheel), and also the speed of engine rotation. The air gap usually comes out of adjustment over time due to engine vibration. Although the air gap on most magnetic sensors is not adjustable, dirt and metal filing tend to stick to the tip of the sensor and cause air gap sensing problems. A simple cleaning sometimes fixes the problem. Engine cranking speed is greatly affected by battery and starter condition. A slow cranking speed problem might make the vehicle not start at all. The lower cranking speed will also lower the sensor’s signal amplitude. Internal sensor coil condition is also a main cause of magnetic sensor failure. Water and moisture get into the casing and corrodes the sensor’s internal coil.

ARCHITECTURE WITH MICROCONTROLLER 68HC11

The 68HC11 is a powerful 8-bit data, 16-bit address microcontroller from Motorola with an instruction set that is similar to the older 68xx (6801, 6805, 6809) parts. Depending on the variety, the 68HC11 has built-in EEPROM/OTPROM, RAM, digital I/O, timers, A/D converter, PWM generator, and synchronous and asynchronous communications channels (RS232 and SPI). Typical current draw is less than 10mA.

The M68HC11 is optimized for low power consumption and high-performance operation at bus frequencies up to 4 MHz. The CPU has two 8 bit accumulators (A & B) that can be concatenated to provide a 16 bit double accumulator (D). Two 16 bit index registers are present (X & Y) to provide indexing to anywhere in the memory map. Having the two index registers means the 68HC11 is very good for processing data. Although an eight bit processor, the 68HC11 has some 16 bit instructions (add, subtract, 16 * 16 divide, 8 * 8 multiply, shift, and rotates). A 16 bit stack pointer is also present, and instructions are provided for stack manipulation. Typically multiplexed address and data bus include:

- Powerful bit-manipulation instructions
- Six powerful addressing modes (Immediate, Extended, Indexed, Inherent and Relative)
- Power saving STOP and WAIT modes
- Memory mapped I/O and special functions

The Motorola 68HC11 microprocontroller serves as the controller for the system.
The measurement system has two main functions:

1) to display the engine data in real time;
2) to log engine data to memory for future analysis.

The PD 68HC11 evaluation board interfaces the microprocessor to external devices.

The PD 68HC11 board is configured in expanded mode, which allows the microprocessor to access the external 32 kilobytes of RAM used for program storage and data logging. The analog to digital converter (A/D) and input capture (IC) features of the microprocessor are used to interface the engine sensors.

The function of the PD8HC11 board is based on the existens of the next software components: monitor Buffalo in EPROM’s of the board, on IMIITC monitor as file in S on PC, INTROL package on PC and a serial comunnication program.

There are two housings for the measurement system of the automotive engine’parameters:

- the module houses the microprocessor and sensor interface circuitry,
- the module houses the user interface.

Housing the system in a metal chassis shields the system from engine noise that may interfere with the digital circuitry. The microprocessor and signal conditioning board are mounted in a aluminum chassis. This housing also contains a power switch and a switch for booting up the board in run mode or maintenance mode. Maintenance mode allows the programmer to modify the program and data tables in memory using Motorola's BUFFALO monitor program in the 68HC11's ROM.

The secondary housing contains the PC. A diagram of the housing layout is illustrated in Fig. 1.

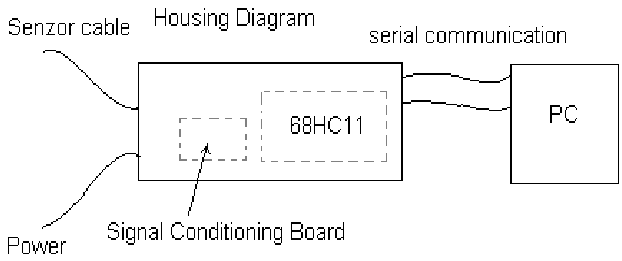


Figure 1. Housing Diagram
Source: Motorola Center: Intelligent Sensor Solution, [2]

CONDITIONING SIGNALS

Ignition Signal (IGN)

The source of the ignition signal is the breaker points of a traditional ignition system. When the breaker points close, the ignition coil builds up energy. When the points open, a high voltage is induced in the secondary coil winding, which creates a spark across the spark plug gap. Spark dwell is the number of degrees of distributor rotation that the breaker points stay closed. The measurement system calculates dwell by measuring the duty cycle of the ignition signal, and scaling it accordingly.
Spark advance is the number of degrees of engine rotation between the time a spark plug fires, and the time that the piston in that cylinder reaches top-dead-center (TDC). Spark advance is calculated by measuring the ignition period and the period between a crank sensor rising edge and an ignition rising edge. This is also converted to a duty cycle and scaled. Engine speed is calculated by measuring the period of the ignition signal, and then converting it to frequency in revolutions per minute.
The ignition signal is very noisy, due to the large inductance of the ignition coil. Because of this noise, the signal is heavily filtered before it gets to the microprocessor. The filtering consists of clipping the negative peaks off of the original signal with a diode, low-pass filtering the signal with an RC filter, and then limiting the voltage to 5 volts with a zener diode. The signal is then buffered and cleaned-up with a 74HC14 Schmitt trigger before entering the 68HC11 via an input capture pin. The ignition schematic is shown in figure 2.

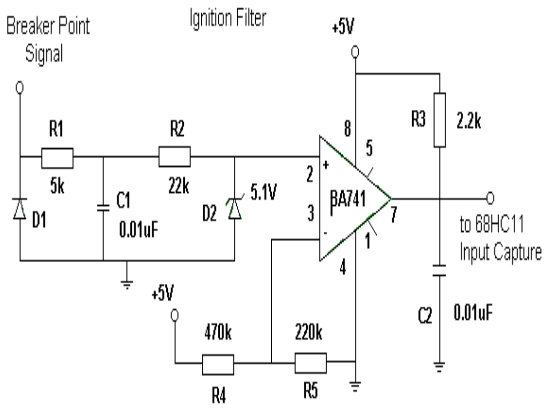


Figure 2. Ignition Filter
Source: Motorola Center: Intelligent Sensor Solution [2]

Crank Position (CRK) sensor

The purpose of the crank sensor is to determine the position of the engine. This measurement is required to determine the spark advance of the ignition signal. The standard reference for engine position is when the piston in cylinder 1 is at top-dead-center (TDC). The CRK sensor is an infrared emitter/detector pair that senses a mark on the timing pulley. The CRK sensor is mounted to the engine just before the timing mark.

Table 1: Temperature sensor and voltage

Temperature [0C]	**Sensor Voltage [V]**
120	0.25
100	0.46
80	0.84
66	1.34
60	1.55
40	2.27
30	2.60
20	2.93
0	3.59
-20	4.24
-40	4.90

Table 2: Mass Airflow sensor and voltage

Mass Airflow [gm/sec]	**Sensor Voltage [V]**
0	0.2
2	0.7
4	1.0
8	1.5
15	2.0
30	2.5
50	3.0
80	3.5
110	4.0
150	4.5
175	4.8

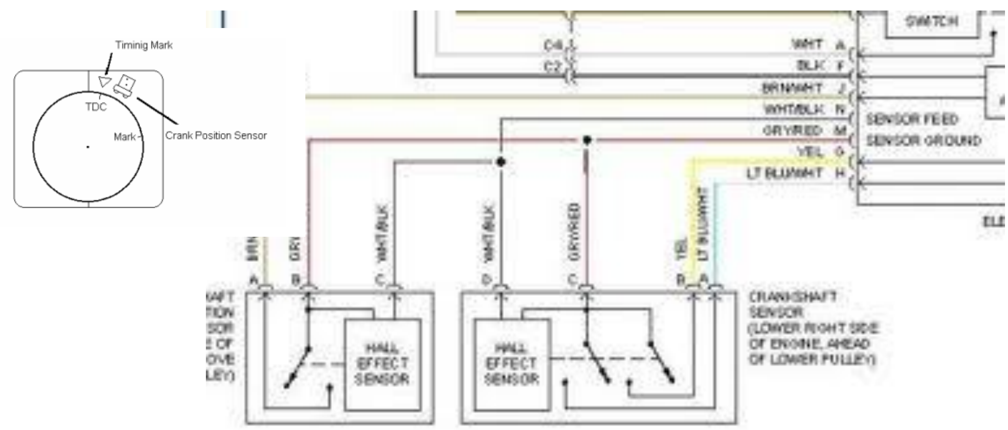


Figure 3. Crank sensor
Source: Motorola Center: Intelligent Sensor Solution [2]

The mark on the pulley is placed at about 60 before TDC. A diagram of the sensor's mounting location and bracket are presented in Figure 3. A crank system [11] comprising a pair of spaced, rotatable crank shafts, the axis of rotation of each crankshaft lying in the same horizontal plane as the axis of the other crankshaft and being parallel thereto, the crankshafts being interconnected together by gears so that the shafts have oppositely coordinated inward rotation, one shaft being rotatable in a clockwise direction while the other shaft is rotatable in an anticlockwise direction so that the two shafts turn inwardly toward each other from top to bottom; a crank pin provided eccentrically on each shaft in a position corresponding to the position of the crank pin on the other crankshaft, with the crank pins in a position 90° from the vertical and on a plane horizontal and passing through the crankshaft axes; a pair of first link arms, one hingedly attached to each crank pin and being hingedly connected together to form an obtuse angled V; a pair of second link arms, one hingedly attached to an approximately midway along each of the first link arms to form an inverted acute angled V; a pair of piston rods hingedly attached to the V point of the said inverted V, each piston rod being oppositely aligned in a horizontal plane to the other piston rod and being operable to actuate a piston moving in a cylinder of an internal combustion engine, such that rotation of the crankshafts reciprocates the piston rods in a straight line in a plane at right angles to the plane of the axis of rotation of the crankshafts.

Power output, the product of torque and pedal velocity, is a key determinant of cycling performance. Torque is determined by the effective force applied perpendicular to the crank arm and by crank arm length [9]. The maintenance of a constant effective force would optimise torque, and hence, power production, [10], [11]. However, anatomical and gravitational constraints mean that torque is actually produced in a nearly sinusoidal manner with minimal torque being produced at the top and bottom dead centre points of the crank cycle. Any optimisation of this crank cycle would necessarily lead to higher net torque and, therefore, power output (assuming an equivalentcadence).

One analyzes several sensors, for which the functioning characteristics are given in the Table 1 and 2.

Distributor less ignition systems (DIS) have been around for almost a decade now, and have eliminated much of the maintenance that used to be associated with the ignition system. No distributor means there is no distributor cap or rotor to replace, and no troublesome vacuum or mechanical advance mechanisms to cause timing problems. Consequently, DIS ignition systems are pretty reliable.

Even so, that does not mean they are trouble-free. Failures can and do occur for a variety of reasons. So knowing how to identify and diagnose common DIS problems can save you a lot of guesswork the next time you encounter an engine that cranks but refuses to start, or one that runs but is missing or misfiring on one or more cylinders. If an engine cranks but will not start, is it fuel, ignition or compression- is a problem to be answered. Ignition is usually the easiest of the three to check because on most engines, all you have to do is pull off a plug wire and check for spark when the engine is cranked. On coil-over-plug DIS systems, there are no plug wires so you have to remove a coil and use a plug wire or adapter to check for a spark.

No spark in any cylinder would most likely indicate a failed DIS module or crankshaft position (CKP) sensor. Many engines that are equipped with electronic fuel injection also use the crankshaft position sensor signal to trigger the fuel injectors. So, if there is no spark and no injector activity, the problem is likely in the crank position sensor. No spark in only one cylinder or two cylinders that share a coil would tell you a coil has probably failed.

HARDWARE IMPLEMENTATION

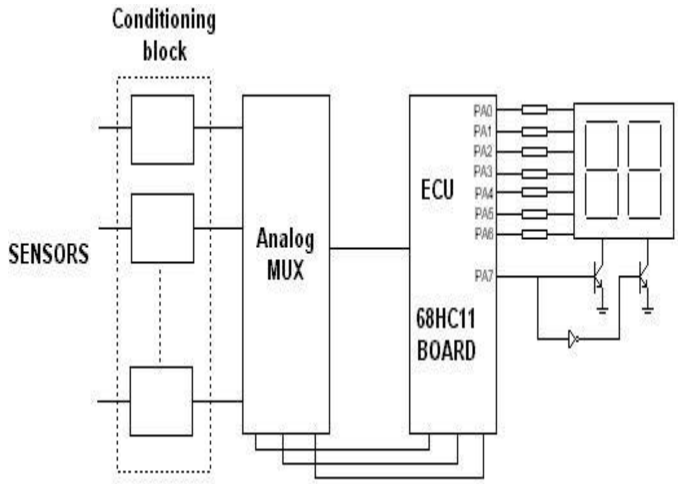


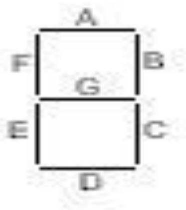
Figure 4. Block diagram of diagnosis system
Source: Motorola Center: Sensors for Auto [1]

Electronic control unit is a 68HC11 microcontroller. This microcontroller, realized in HCMOS technology, with noise immunity is usually used in many automotive applications. The analog to digital converter and input capture features of the micro-co-processor are used to interface the sensors. The A/D system is an 8 channel, 8 bit, successive approximation converter with ±1/2 least significant bit accuracy over the complete operating temperature range. For acquisition of the engine signals we use a sensor interface circuitry for conditioning of signals from these sensors. The block diagram of diagnosis system is shown in Fig. 4.

One can use a seven segment display with two digits for indicating the functioning status of the sensors. A parallel port could be used to send the appropriate character codes to seven segment display. HCMOS technology, with noise immunity, is usually used in many automotive applications. The analog to digital converter and input capture features of the micro- co- processor are used to interface the sensors. The A/D system is an 8 channel, 8 bit, successive approximation converter The signals from the sensors are connected to PORT E. The reference high and reference low inputs of the A/D are set at +5V and 0V respectively.

The A/D result register is ADR1, an 8 bit register that contains one of 256 possible values. The limit values of the sensors are stored at known locations. The compare routine makes possible to compute the difference between the measured values and limit values of the sensors. If the measured values are not in this interval, the sensor is bad.

The DISPLAY routine calls the compare routine, which determines the number that will be displayed. When the polling routine finds the appropriate match, the data to turn on the segments for that particular number is stored in PORT A. The information from PORT A is routed to the seven segment display for visual monitoring (figure 5). Figure 4 shows the interfacing requirements for the seven segment display.



Segment	Port A bit
A	6
B	5
C	4
D	3
E	2
F	1
G	0

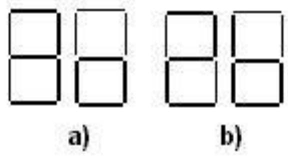


Figure 5. Status of sensors *Figure 6. Display status*

Source: Motorola Center: Sensors for Auto [1]

The result of the comparison can be displayed on a portable PC, too. The first digit of the display shows the number of the sensor that is analyzed at this time. Because we use a single digit for identifying the sensor, it means that we can process the information from a maximum number of ten sensors. The second digit of the display shows the functioning statues of the sensor, which is referred by the number displayed with the first digit.

RESULTS AND CONCLUSIONS

The diagnosis system of the automotive sensors displays all the sensors readings and makes the comparison between the measured values provided by these sensors with some limit values, which are stored in the memory of the 68HC11 microcontroller.

This sensors’ system allows a user to friendly monitor the signals of the sensors in real time that is very important in a good functioning in systems as electronic fuel injection or automatic spark control.

REFERENCES

Motorola Center: *Sensors for Auto Apps R1*, 1998.
Motorola Center: *Intelligent Sensor Solution*, 1998.
Randy Frank, *Understanding Smart Sensors*,.: Artech House, Boston, MA, 1996.
Dragan Mladenovic, Rajan Verma, and Randy Frank: *EMC Consideration for Automotive Sensors*, Motorola Center, 1997.
Robert Bosch Gmbh: *Automotive handbook*, Stuttgart, 2000.
SAE Technical Paper Series, 1999, Detroit.
http://www.hc11.demon.nl/thrsim11/68hc11/about1.htm
http://www.diycardoctor.com/cam_sensor.htm
Bertucci, W., Grappe, F., Girard, A., Betik, A. and Rouillon, J.D. (2005b) Effects on the crank torque profile when changing pedalling cadence in level ground and uphill road cycling. *Journal of Biomechanics* 38, 1003-1010.
Simon A. Jobson , James Hopker, Andrew Galbraith , Damian A. Coleman and Alan M. Nevill, Effect of the Rotor crank system on cycling performance, ©Journal of Sports Science and Medicine (2009) 8, 463-467.
Patent, 1974, CRANK SYSTEM, United States,3808897, http://www.freepatentsonline.com/3808897.html
Iacobescu, Florin, Ionel Ioana, DIAGNOSIS OF AUTOMOTIVE SENSORS USING MICRCONTROLLERS, sent for publication and accepted in TERMOTEHNICA Journal, Romania, 2011.

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GREEN IT APPROACH TO DISTRIBUTED SOFTWARE PROJECT MANAGEMENT

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ABSTRACT

This paper deals with Green IT approach to distributed software project management. Collaborative teamwork in software industry is organized at many geographically distributed locations. This brings improvement of efficiency of process and quality of product in software engineering. Software project management in distributed working environment has many challenges and issues. One of important considerations is ecology impact. Green IT is new technology approach to information technologies, among which is aspect of using IT technology to improvement of business processes so they are more efficient and less power required.

Key words: Software project management, distributed computing, Green IT

INTRODUCTION

"Supporting long-term environmentally sound practices goes by many names — going green, corporate social responsibility (CSR), sustainability and many more." (Martinez, Bahloul 2008) The role of IT in green movement to sustainable development for environmental protection has been presented by many researchers in several aspects. One of the approaches point out that information technology itself could be improved for environmental protection, firstly with better technical performances, in aim to minimize power consumption. They call this approach - cleaning IT. Other aspects see IT as tool to improve business performance of an organization which could lead to better environmental impacts. Third approach point out IT as a way of cleaning up the organization by moving from material oriented to digital oriented business processes and developments. (greenIT) Going green is much about changes in human behaviour, management and technology. (Martinez, Bahloul 2008)

In this paper we explore Green IT motivators and initiatives. We focus on Green IT approach to distributed software engineering and software project management. Distributed computing brings many issues and challenges, while making improvements in efficiency and quality of process and products of software industry. In this paper we present Green IT initiatives and how they could be applied to distributed computing, collaborative development and distributed software project management.

GREEN COMPUTING

"Green computing is considered as a major contributing factor to green environment. Green computing is the study and practice of using computing resources efficiently and that the main objective is to minimize the pollutions of environment. Green computing has a significant impact in green environment because modern societies dependent on IT for works and operations, and that the production and disposal of computer wastes would directly poison our green environment. There is no easy solution to green computing because it is complicated mix of people, IT hardware, and production." (Chow and Chen 2009) Green computing could be defined as "The practice of maximizing the efficient use of computing resources to minimize environmental impact. This includes the goals of controlling and reducing a product’s environmental footprint by minimizing the use of hazardous materials, energy, water, and other scarce resources, as well as minimizing waste from manufacturing and throughout the supply chain. Green computing goals extend to the product’s use over its lifecycle, and the recycling, reuse, and biodegradability of obsolete products. We define sustainable IT services in broader terms to include the impact of IT service strategies on the firm’s and customers’ societal bottom line to include economic, environmental, and social responsibility criteria for defining organizational success." (Harmon and Auseklis, 2009)

Harmon and Auseklis (Harmon and Auseklis 2009) describe history of green computing as:

1. Green computing - first wave
   - Factors driving the adoption of green computing: rapid growth of Internet, increasing equipment power density, increasing cooling requirements, increasing energy costs, restrictions on energy supply and access, low server utilization rates, growing awareness of IT's impact on environment,
   - Implementing green computing strategies: data center infrastructure, power and workload management, thermal load management, product design, virtualization, cloud computing and cloud services,
   - Green computing metrics -energy efficiency, environmental impact.
2. Sustainable IT services - second wave
   - From software programs to software as service,
   - Sustainable IT services - service sustainability, temporal sustainability, cost sustainability, organizational sustainability, environmental sustainability,
   - From business value to customer value to societal value,
   - Developing sustainable IT strategy,
   - Environmental regulations.

GREEN IT MOTIVATORS

The main reasons why IT companies and professionals go green have been researched by FreeForm Dynamic Ltd. with 1474 IT professionals. Those motivators are presented at Figure 1.

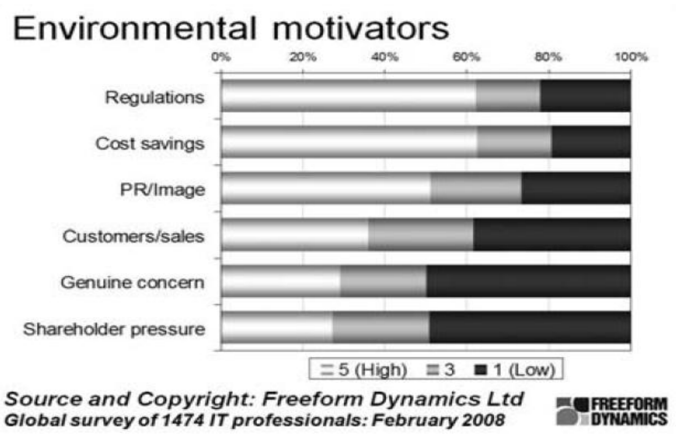

Figure 1. Motivators for environment protection in IT (Tebbutt et al. 2009)

Another extensive end-user survey of 459 European IT directors of organizations with more than 1,000 employees and operating at least one data-centre, sponsored by Dell, has been conducted in year 2008 regarding Green IT application and strategic plans (Martinez et al 2008). Respondents were split across France (100), the UK (74), Germany (80), Italy (52), Spain (51), the Netherlands (51) and the Nordics (51). The sample included organizations in the services sector (149), the public sector (140), manufacturing, construction and utilities sectors (131) and in the retail and wholesale sector (39). The distribution of the sample by company size was as follows: 1,000–4,999 employee organizations (369), 5,000–20,000 employee organizations (76) and 20,000 employees and more organizations (14). Results regarding the Green IT strategy and motivators are shown at Figure 2 and Figure 3.

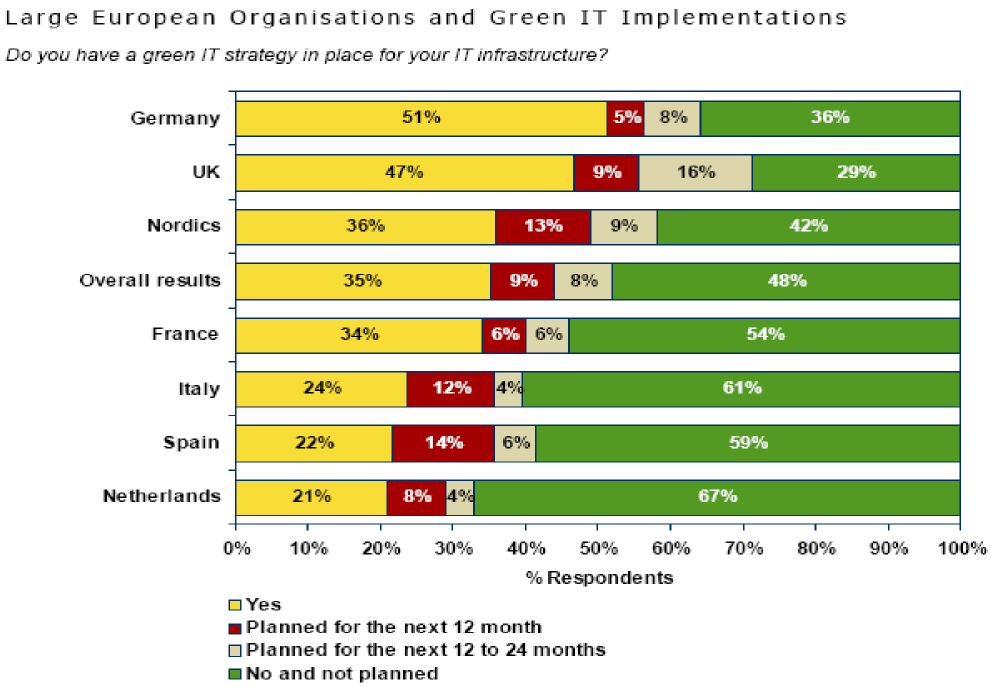

Figure 2. Green IT strategy in European countries (Martinez, Bahloul 2008)

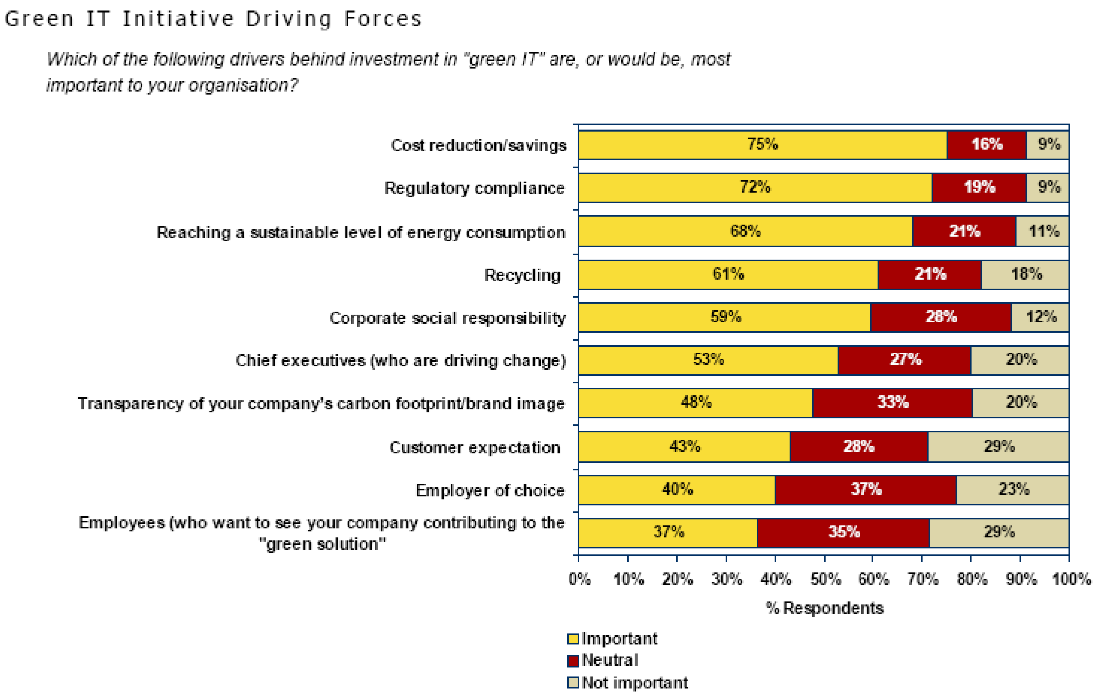

Figure 3. Green IT initiative drivers (Martinez, Bahloul 2008)

GREEN IT IMPACT FACTORS

Factors that influence environment and are related to IT are called Green IT impact factors. Laszewski and Wang (Laszewski and Wang 2009) point out four categories of factors (Figure 4):

- Hardware - processors and other computer units, consumption of energy and producing heat
- Software - n-tier layers software, software as service, efficiency of using hardware resources, speed of algorithms
- Environment - working environment for hardware, design of buildings, heat, ventilation and air conditioning (HVAC), computers rack
- Behaviour - definition of metrics for green impact, people behaviour directed by education and policies

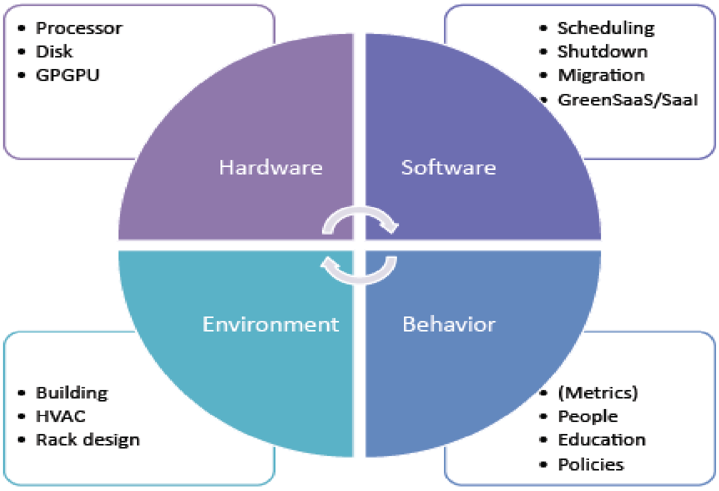

Figure 4. Green IT impact factors (Laszewski, Wang 2009)

GREEN IT INITIATIVES

Green IT initiatives are taking actions at various aspects and levels. Some of these initiatives and activities are described regarding the four impact factor groups, defined by Laszewski and Wang.

BEHAVIOUR ASPECT

- International and country-level metrics and quality standards and policies - Corporate Sustainability Index (CSI) has been defined for benchmarking IT companies and it measures the environmental initiatives of 40 companies in the computer hardware, software, professional services and network and telecommunications. In 2009. benchmarking report from Technology Business Research company Dell took the No. 1 position (Chakraborty, 2009)
- Company level policies and procedures for implementation, internal recycling programmes, conducting energy audits in the workplace including the datacentre (Adamson et al. 2005), encouraging remote working and teleconferencing as a travel replacement (Martinez et al., 2008), computer production procedures
- Education - Green IT seminars, Green IT graduate diplomas and professional certificates for IT professionals (greenIT), research on educational impact (Katz 2010) and role in computer science curriculum (Talebi and Way 2009)
- Personal attitude and behaviour - using fewer IT resources such as printing paper and read only DVD/CD, power off computer when not using it, dimming the PC brightness (Chow and Chen 2009)

COMPUTER PRODUCTION LIFECYCLE ASPECT

When computer manufacturing is concerned, green initiatives are taking actions in all three mayor product lifecycle phases (Tebbutt et al. 2009):

- Before and during creation (at manufacturing of products using reduced amount of materials and using those materials that could recycle; when materials are concerned, crucial words are: reduce, reuse and recycle; in efficient manufacturing process; at buying products - checking

for their compliance with ecology standards; Energy Star gives certification to produced IT devices according to energy preserving standards. (sing)
- During operation (making operations be more efficient, using less material and energy)
- At end-of-life (extend working life if products, reuse, upgrade instead of replacing with other and recycling).

HARDWARE ASPECT
- Investing in technology such as hardware and software virtualization to increase datacentre efficiency (Martinez et al., 2008)
- More efficient processors, flat monitors, smaller hard disks use less energy (Roy and Bag), consolidation of storage (Katz 2010)
- Devices are designed to have idle/sleep mode (Tebbutt et al. 2009), remote shut down of computers (Katz 2010)
- Networks - centralization of printer devices, database and processors with thin clients
- Mobile devices - mobile phones, PDA, laptops - less time of charging, recycling...
- Reusing heat from air-conditioners
- While travelling / using sattelite/communications devices and software for navigation and shortest travelling routes.
- Using sensors that could remotely measure and control devices
- Substitution of physical process to digital.

SOFTWARE ASPECT
- Scheduling algorithms (Laszewski et al. 2009)
- Creating autonomous software controllers of quality of service and energy management (De Palma et al. 2010)
- Having software monitor state of usage of hardware devices and optimize its usage (Tebbutt et al. 2009)

Figure 5, and figure 6 shows results of Green IT initiatives from Dell's research regarding European IT companies Green IT strategies.

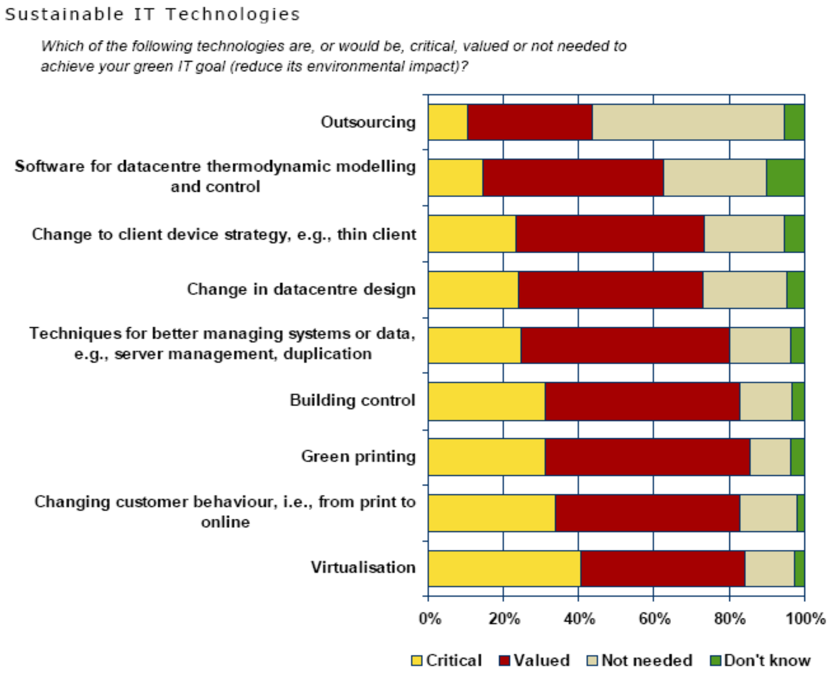

Figure 5. Green IT initiative technologies (Martinez, Bahloul 2008)

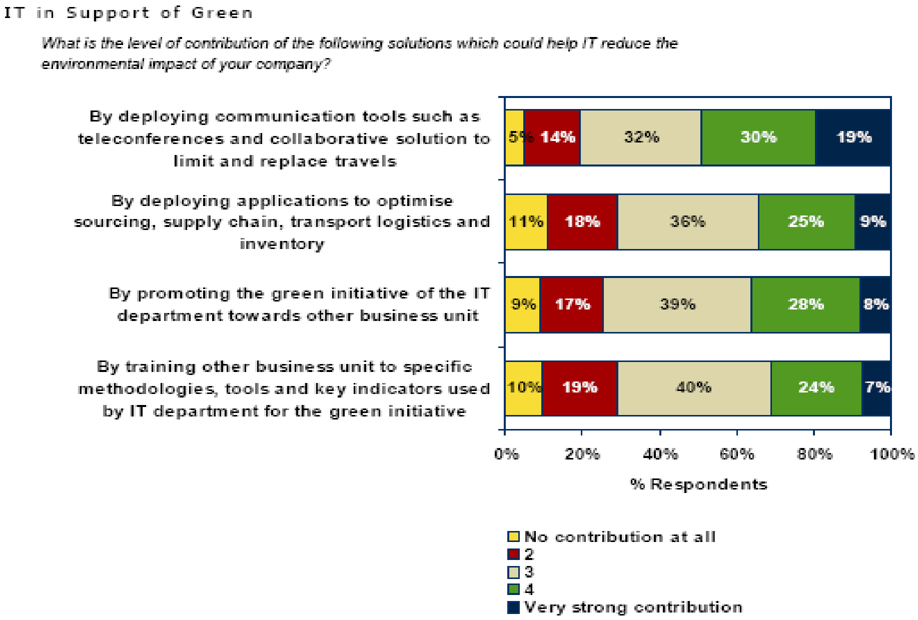

Figure 6. Evaluation of Green IT solutions for enterprises (Martinez, Bahloul 2008)

GREEN IT IN DISTRIBUTED COMPUTING ENVIRONMENT

"Distributed systems and Internet services usually require a variety of software systems that are organized in complex architectures based on replication and multi-tier organization. The administration of such systems must take into account the impact of green computing on the traditional distributed system issues like dependability or scalability. In particular, administrators have to manage the trade-off between system performances and energy saving goals." (De Palma et al. 2010)

Dell's research over European companies in 2008 covered also green IT policy and strategy related to distributed computing environment (Figure 7 and Figure 8).

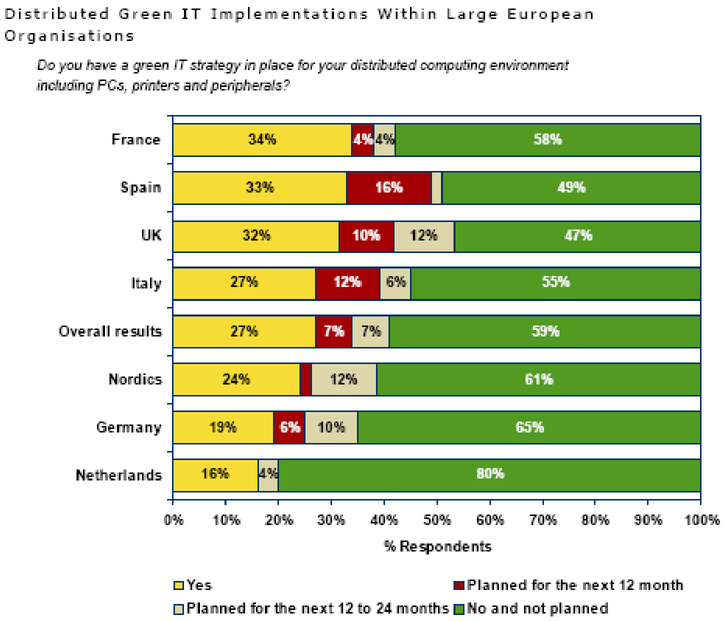

Figure 7. European countries Green IT strategy and distributed computing environment (Martinez, Bahloul 2008)

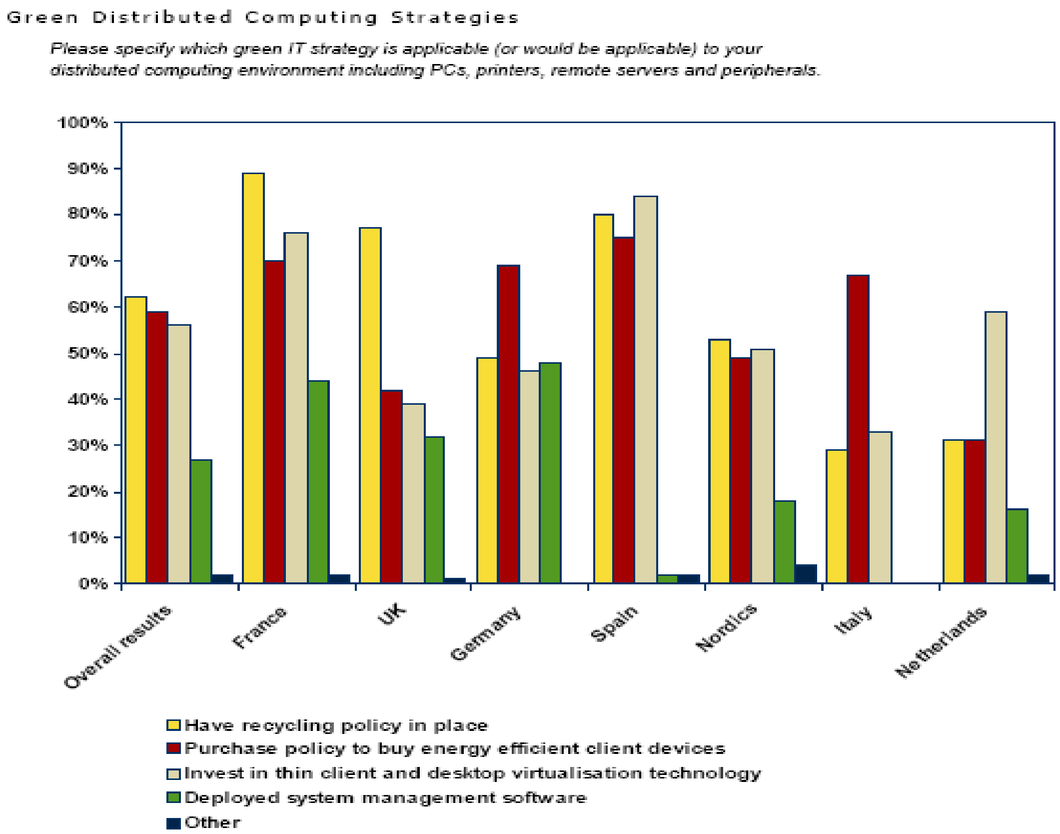

Figure 8. Applicability of Green IT strategy for distributed computing environment (Martinez, Bahloul 2008)

In the last few years, some of research results in Green IT approach to distributed computing deal with:

1. Resource allocation, with metrics such as power consumption and optimization (Khan and Ardil 2009)
2. Resource preserving, i.e. reducing resources waste in distributed environment with virtualization (Torres 2008)
3. Resource management, based on power-aware scheduling in cloud computing (Younge et al, Liu et al 2009) and grid computing (Schott and Emen 2010, Zong et al. 2007)
4. Measuring algorithms efficiency for different development environments and hardware platforms (Johri and Shaikh 2010), as well as evaluation of software services regarding efficiency.

GREEN IT IN DISTRIBUTED SOFTWARE PROJECT MANAGEMENT

Basic project management factors are presented at figure 9 and knowledge areas at figure 10. Distributed software project management deals with collaborative software engineering and project management of geographically distributed software development teams.

According to Laszewski (Laszewski G and Wang L 2009), for the four Green IT impact factors, we propose framework (Figure 11.) for measurement Green IT level for distributed software project management. Measurement of some to these parameters is difficult since distribution of teams often is based on independent heterogeneous computer systems and working environments, as well as risks of communication problems.

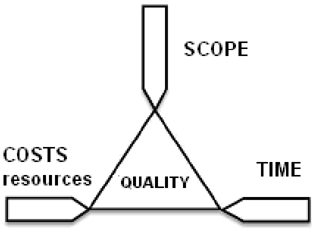

Figure 9. Basic project management factors

Figure 10. Basic project management knowledge areas (PMBOK)

Table 1: Framework for green IT measurement level in distributed software project management

SCOPE	DOMAIN	MEASUREMENT ITEMS
Central team (Project scope) Distributed team (Team task scope) Person (personal scope)	Integration	Number of computer working hours and type of computers, type of other computing devices used, Number and type of material resources used (paper, DVD/CD) etc. Number of people engaged, residency address (for travelling costs), age (for working speed), number of working hours engaged
	Project duration	
	Project costs and resources	
	Project human resources management	
	Project communication	Number of messages, number of phone calls, duration of phone calls
	Project scope	Number of tasks implemented, percentage of tasks quality characteristics achieved
	Project quality	

In the framework we propose (Table 1), there are three categories of measurement items - related to time/costs/resources, communication and tasks. These items should be measured separately and relatively to each other, i.e. costs regarding messaging, costs regarding task qualities etc. It is important to emphasize the role of distributed team leader who is responsible for monitoring all these parameters and reporting progress regarding all project factors during the project implementation. Specially important is development of software tool that could automatically monitor working progress and measure all parameters of time, resources and human resources engagement in software project. One of examples for such a tool development is Microsoft Team Foundation approach for distributed development, which was established in Visual Studio 2008 and onwards.

INDIA EXPERIENCES IN DISTRIBUTED SOFTWARE PROJECT MANAGEMENT

"The IT and ITES (Information Technology Enabled Services) sector in India has continued to perform its role as the most consistent growth driver for India’s economy. Recognizing the importance of IT and its role in the development of India, various Central and state government agencies have given sops for the industry. This impetus has resulted in the emergence of a few important IT hubs in the country. While Bangalore continues to lead the IT sector in India, several other cities are coming up as IT Hubs in their own rights. Some of these cities include Chennai, Hyderabad, Pune, Mumbai, Kolkata and Gurgaon." (OJASWI)

In one the biggest IT hubs in India, Bangalore there could be experienced that some small scaled IT companies have enrolled the developers, but there is not establishment of their cubicles in the base office. Rather they are allotted their work under team foundation and the developers have to remain at their dwelling place and work, also they have to submit the work within given time. In this system the developers are attached to repository of codes using internet or any other medium. This has saved the companies a lot of money, power, and much more. The base office only have few people for validating submitted code and other working artifacts.

CONCLUSION

Last few years brought many results in the field of green IT. Large IT companies established system for measuring sustainability and environmental initiatives for monitoring progress in corporate strategy implementation regarding environment preserving. Powers saving standards regarding computer devices production were established. Large IT companies around the world are creating and implementing green IT strategies and policies. Hardware is moving to more efficient, faster and less material and power required. Software is used for hardware efficiency monitoring, automation of services and automation of task, quality and resources management. People are starting to be aware of impact of IT to environment and practicing activities for environmental protection by reducing material and power consumption.

The research field of implementing green IT approach to distributed computing is not mature. Distribution and heterogeneity of large distributed computing systems combined with green IT requirements brings new challenges to research and practitioners. Software is moving from separate program applications to software as service. Distribution of software services as modules of a software solution open issues such as evaluation of services regarding efficiency, concurrency of services with the same output and choosing services according to efficiency criteria.

In this paper we presented green IT motivators and initiatives. We specially described recent research in the field of distributed computing. We also presented India experience in the field of IT hubs and distributed software project management. We proposed framework for measurement Green IT parameters that enable monitoring green IT level of distributed software development project. These parameters should be monitored by team leader or automatically by a software tool that could acquire necessary data from project artifacts. The need for such a tool is specially emphasized. This presents a future work in this particular area.

REFERENCES

Adamson M, , Hamilton R, Hutchison K, Kazmierowski K, Lau J, Madejski D, and MacDonald N (2005), Environmental Impact of Computer Information Technology in an Institutional Setting: A Case Study at the University of Guelph, University of Guelph, April 2005.

Chakraborty P, Bhattacharyya D, Nargiza Y. S, and Bedajna S (2009), Green computing: Practice of Efficient and Eco-Friendly Computing Resources, International Journal of of Grid and Distributed Computing Vol.2, No.3, September, 2009.

Chow W.S, Chen Y (2009), Intended Belief And Ac Tual Behavior In Green Computing In Hong Kong, Journal Of Computer Information Systems Winter 2009.

De Palma N, Delaval G and Rutten E (2010): QoS and Energy Management Coordination Using Discrete Controller Synthesis, Proceedings of GCM'10, 29-NOV-2010, Bangalore, India.

(greenIT) www.greenit.net

Harmon R. R. and Nora Auseklis N, (2009)Sustainable IT Services: Assessing the Impact of Green Computing Practices, Proceedings of PICMET 2009 Proceedings, August 2-6, Portland, Oregon USA

Johri E and Shaikh S (2010), Improving Performance of Algorithms in Distributed Computing with Perspective of Green Information Technology, International Journal of Computer Applications (0975 - 8887),Volume 1 – No. 18, 2010

Katz R (2010), Good Citizen or Leader: The Case for Green IT, Educause Center for Applied Research, Bulletin 16, 2010.

Khan S.U. and Ardil C. (2009), Energy Efficient Resource Allocation in Distributed Computing Systems, World Academy of Science, Engineering and Technology 56, 2009

Laszewski G, Wang L, Younge A J. and He X (2009). Power-Aware Scheduling of Virtual Machines in DVFS-enabled Clusters. In IEEE Cluster 2009, New Orleans, 31 Aug. - Sep. 4 2009. IEEE.

Laszewski G and Wang L(2009), Greenit Service Level Agreements, Service Level Agreements In Gridsworkshop Colocated With Ieee/Acm Grid 2009 Conference, In Banff Canada, October 13, 2009

Liu L, Wang H, Liu X, Jin X, He W, Wang Q, Chen Y (2009), GreenCloud: A New Architecture for Green Data Center, *ICAC-INDST'09,* June 16, 2009, Barcelona, Spain.

Martinez N and Bahloul K (2008), European Organisations and the Business Imperatives of Deploying a Green and Sustainable IT Strategy, IDC white paper, Dell, September 2008.

(OJASWI) Indian Ojaswi Tech company website, http://www.ojaswitech.com/it-hubs-india.php

(PMBOK) Project Management Body of Knowledge, Project Management Institute, Upper Darby, 1987.

Roy S and Bag M ,Green Computing - New Horizon of Energy Efficiency and E-Waste Minimization –World Perspective vis-à-vis Indian Scenario, http://www.csi-sigegov.org/emerging_pdf/8_64-69.pdf

Schott B and Emmen A (2010): Green Methodologies in Desktop-Grid, Proceedings of the International Multiconference on Computer Science and Information Technology 2010, pp. 671–676

(sing) Software or Hardware: The Future of Green Enterprise Computing, http://sing.stanford.edu/cs303-sp11/papers/green_computers.pdf

Talebi M and Thomas Way T (2009): Methods, Metrics and Motivation for a Green Computer Science Program, SIGCSE'09, March 3–7, 2009, Chattanooga, Tennessee, USA.

Tebbutt D, Atherton M and Lock T (2009), Green IT for Dummies, Hewlett Packard Special Edition, Jon Wiley and Sons, 2009.

Torres J, Carrera D,Hogan K, Gavaldà R, Beltran V, Poggi N (2008), Reducing Wasted Resources to Help Achieve Green Data Centers, IEEE International Symposium on Parallel and Distributed Processing, 2008. IPDPS 2008.

Younge A, Laszewski G, Wang L , Lopez-Alarcon S and Carithers W: Efficient Resource Management for Cloud Computing Environments, http://grids.ucs.indiana.edu/ptliupages/publications/10-ajy-igcc.pdf

Zong Z, Bellam K, Qin X,Yang Y, Ruan X, Manzanares A (2007), A Simulation Framework For Energy Efficient Data Grids, Proceedings Of The 2007 Winter Simulation Conference.

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EDUCATIONAL SOFTWARE FOR SIMULATION OF WIND POWER PLANT

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ABSTRACT

This paper describes software that is developed in the process of higher education of industrial monitoring. It presents a simulation of wind power plant. This software is described from design and implementation perspective.

Key words: Educational software, simulation, wind power plant.

INTRODUCTION

There are many types of educational software. One of them is classified as simulation software. The key concept of simulation software is simplifying presentation of reality, with underlying model that connects core parameters of a process with outcomes of the simulated process. Within simulation software it is enabled to change values of parameters and monitor outcome values of process that depend on parameter values. This enables experiments and learning about core characteristics of processes in software environment that presents safe and much cheaper way to conduct experiments.

In this paper we present a simple software that is developed within higher education process in subject industrial monitoring. This software present setting parameters of wind power plant, visualization of wind power plant production process and computes outcomes, i.e. measurements of electric power produced in the work of wind powerplant. This way we enable students to be introduced to power plant industry and also promote environmental protection approach by presenting technology that could use natural resources for creating electric energy.

EDUCATIONAL SOFTWARE FOR SIMULATION

According to Nadrljanski (Nadrljanski,2000), there are several types of educational software for simulation. Two mayor approaches for simulation software in education:
1. Creating model for simulation building - student has data and need to create model for simulation by identifying parameters and relationships among variables. After creating model, student has to use data to verify the model.
2. Simulation of behaviour - within this approach, students get the model and they can test it with changing parameters.

Within the second approach, there are three types of simulation software:
1. Dynamic simulation - student can change parameters in software based on an internally implemented model that is based on scientific laws that present part of reality or natural laws.
2. Methodology simulation - this software enables comparison of simulation outcome data and real experiments outcome data and verifying simulation model, i.e. verifying theory that is basis for that model

3. Operative simulation - this type of software presents simulation of experiment, tool or process in aim to identify relations between depending variables. This type of simulation software is usually used for smaller educational topics.

Figure 1. presents basic activities in creating a simulation, i.e. creating model, getting testing data and testing simulation model,that verifies the model and theory that is basis for model.

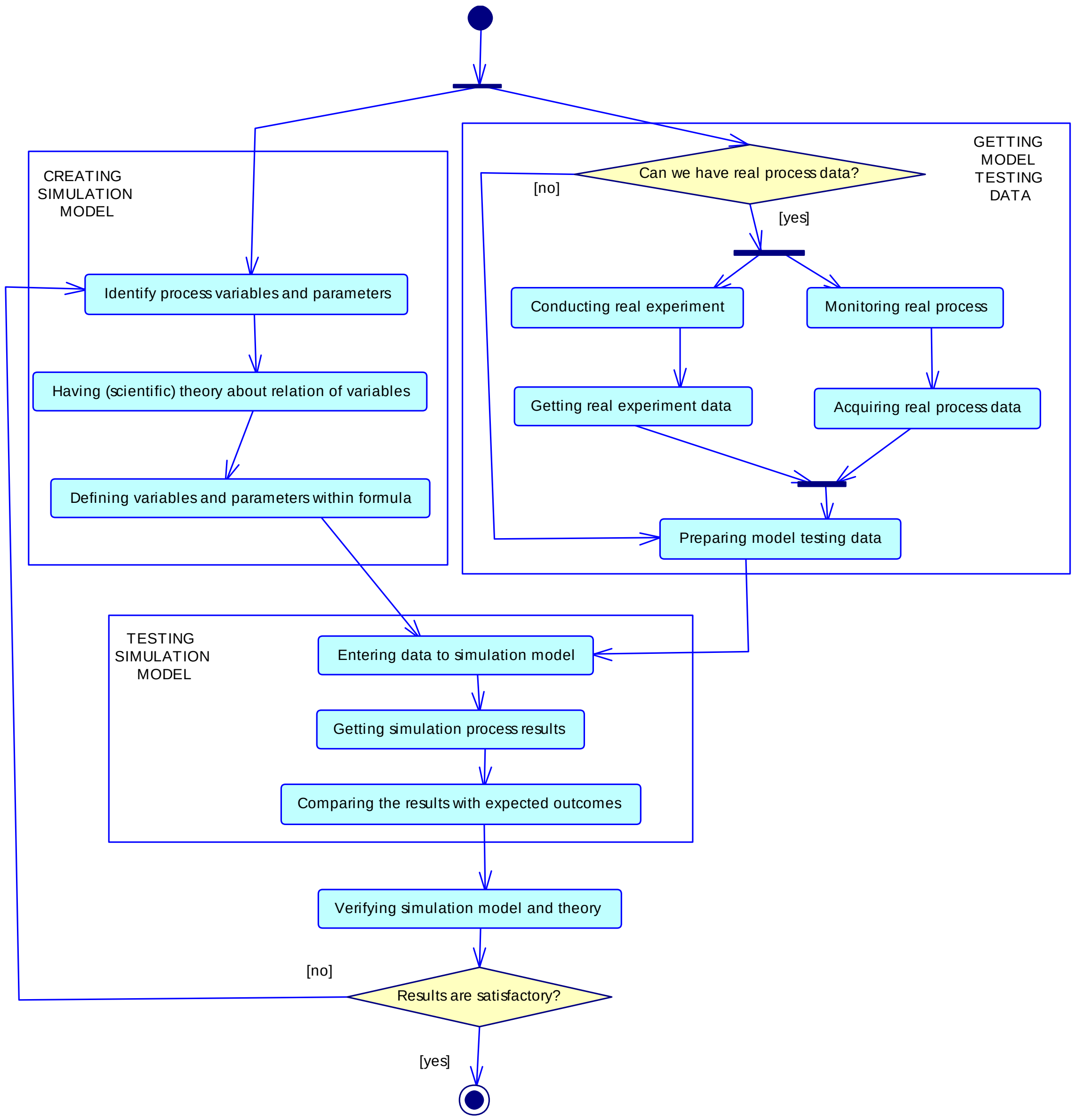

Figure 1. Activities of creating a simulation

WIND POWER PLANTS

"Wind power plants were used as windmills for over 1000 years ago. During 19th century they were used in a great number to enable using mills, water pumps specially in Holland, Denmark and USA. Their main functionality is based on transformation of wind energy to rotational moving that could enable using some working tool. Usage ratio or usefullness percent (ratio of energy created at rotation and energy that wind gives) cant go more than Betz's limit of 16/27 or 59,3%. There are two types of wind power plants, according to position of rotor axis and wind direction:

1. Axial - rotor axis is parallel with foundation, i.e. wind direction is along down the rotor axis
2. Radial - rotor axis is ortogonal to foundation, i.e. wind direction is ortogonal to the rotor axis

Axial wind powerplant are dominant in exploatation and mostly have two or three wings. First treewings axial wind power plant was constructed in mid last century in Denmark, which was the basis for majority of modern wind power plants. During time, many technology improvements are made such as: aerodynamics profiles of wings, technology of rotor and transmission mechanisms, electrogenerator with electronic controllers. Power industry of developed countries have already implemented sets of axial wind power plants in the form of wind farms. They enable very cheap energy - 0.06 euro for kWH.

Better results could be made with power plants that have long wings. Problems with axial power plants occurs with wind speed more than 15m/s when wings could be damaged. This could be solved by using special materials that make them strong and light-weighted, which are often very expensive. Other problems occur with changing direction of wind, which could be solved by flexible position of rotors and wings enabling changing from vertical to horizontal position. This technology is very expensive and is acceptable with power plants of large production capacity. Another problem occur with the need for high tower for rotor installation. Still, high usage ratio (average 45%) gives them advantage in application comparing to other power plants." (WPPB)

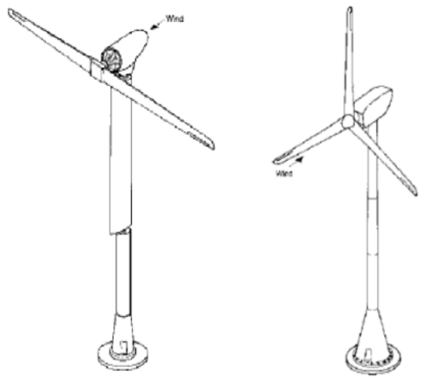

Figure 2. Two types of axial wind power plant (WPPB)

EDUCATIONAL SOFTWARE FOR SIMULATION OF WIND POWER PLANT

Functional concepts of software

In aim to create a simulation software for axial wind power plant, we considered many ideas for functional characteristics of software. Some of these ideas were implemented, but some are left for future improvements. List of those functional concepts is given below:

- animation will present process of wind power plant working, i.e. rotation of wings according to wind power
- setting parameters of the power plant: type of power plant, length of wings, types of wings material, wings position (vertical/horizontal, according to wind direction)
- wind direction and speed senzor - enable having different wind characteristics monitored
- having slider that could enable easier setting wind speed or entering discrete value for wind speed.
- enabling random speed of wind
- enabling automatic adjustment (adaptation) of wings position according to wind direction
- enabling different working regime - minimal, optimal and maximal, with setting parameters for each working regime
- automatically stop functioning at wind speed more than 15m/s, with visual alert
- having all functional data recorded in database and enable report from starting to ending date/time of experiment

Functional design of implemented software

Among many functional features that could be implemented, for the first version of software we choose core functions that include:
1. input:
- setting parameters of power plant - usage ratio, power plant capacity, wings length, wings width
- setting parameters of environment - wind speed
- having random paramaters of environment presenting possible situation from nature - unexpected changing wind speed
2. process:
- visualize rotation speed of powerplant
3. outcomes/results:
- calculate values of electric energy produced
- present calculated values of electric energy produced.

After starting software, the initial values of parameters are set.User can change parameters and start the process. During the process results are computed (according to formula that relates power plant parameters, environment parameters and outcomes) and the process is also visually presented. Any time user can stop the process and get a chance to change parameters and start the process again. Additionally, student can include random wind option where wind speed is continuously changing during the process producing different results during time.

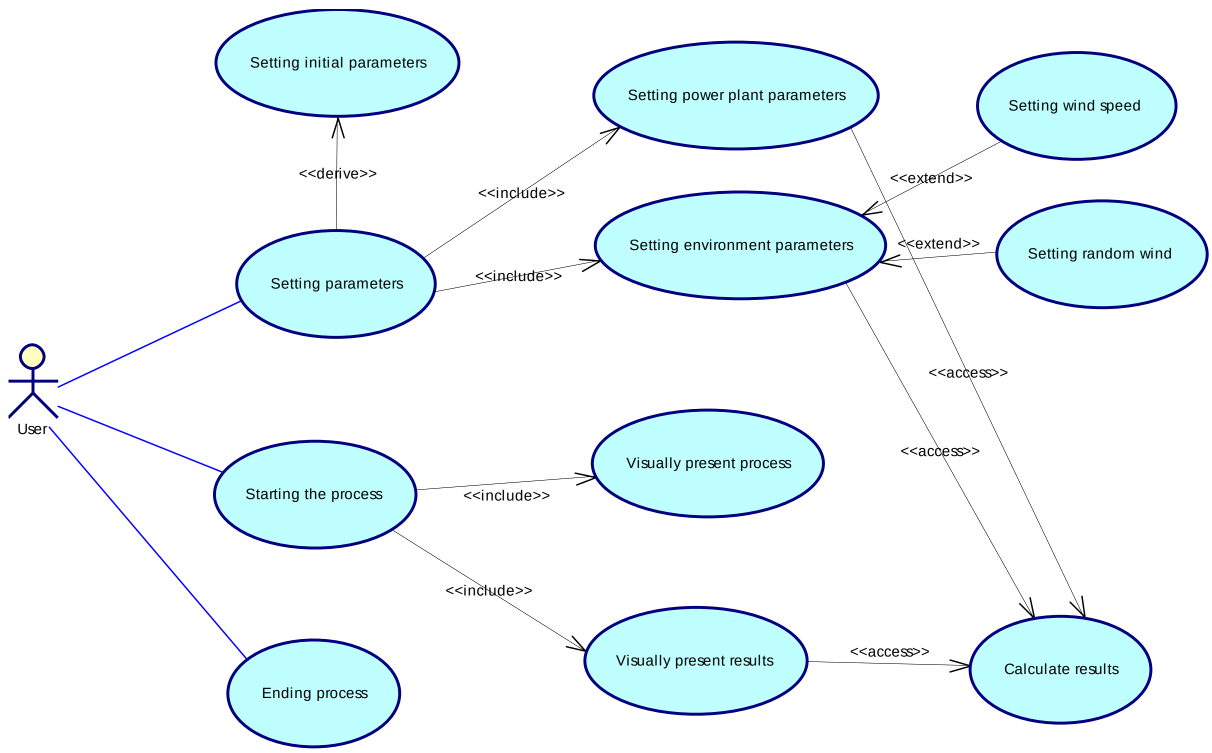

Figure 2. Use case diagram for implemented functional features of software

Software user interface - visual design and functionality

In this section we present visual design of user interface of implemented software and describe functionality from user perspective.

First screen that appears after starting software is presented at Figure 3. Text boxes have initial values of parameters. It is enabled to change these values and also to choose, by using check box, to enable random wind, i.e. constantly changing wind speed. After the parameter setting,user can use start button and start the process.

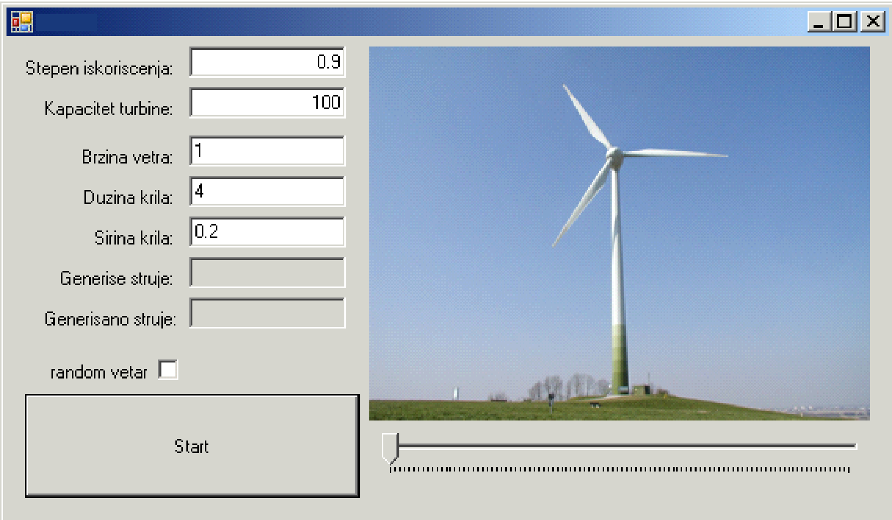

Figure 3. Starting software screen

Figure 4. presents situation where parameters are set and process is started. It is shown that button start changed its caption to stop, so user can stop the process any time. During the process there are three visual presentations that are changing: text boxes with electric energy produced have values, pictures presenting rotation of power plant and horizontal slider - scroll bar at the bottom of pictures, presenting wind speed.

Figure 4. Basic parameters set and process started

When we choose random wind (Figure 5), it has been shown that rotation speed at power plant pictures is changing visually (not constant speed, but random), as well as the position of slider at horizontal slider-scroll bar.

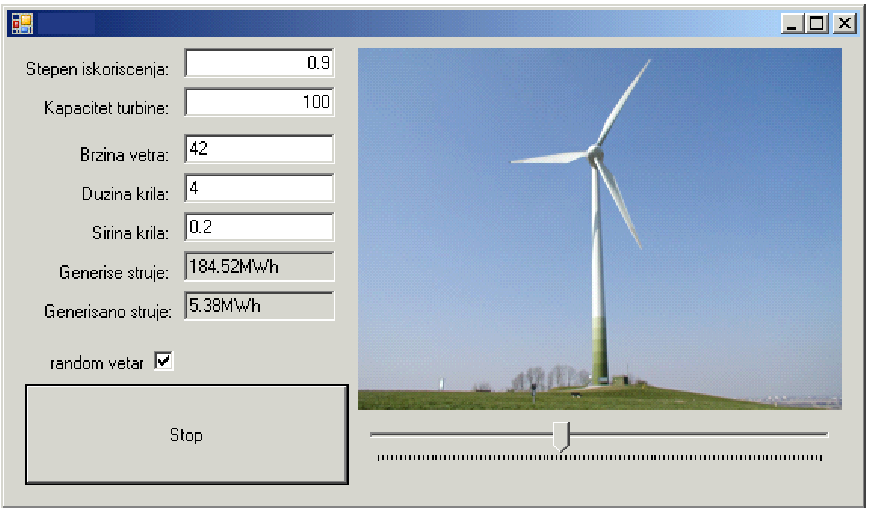

Figure 5. Random wind set as parameter

Figure 6. presents the final state of software, after stop button is pushed by user. All values are preserved and new parameters could be choosen to enable another simulation.

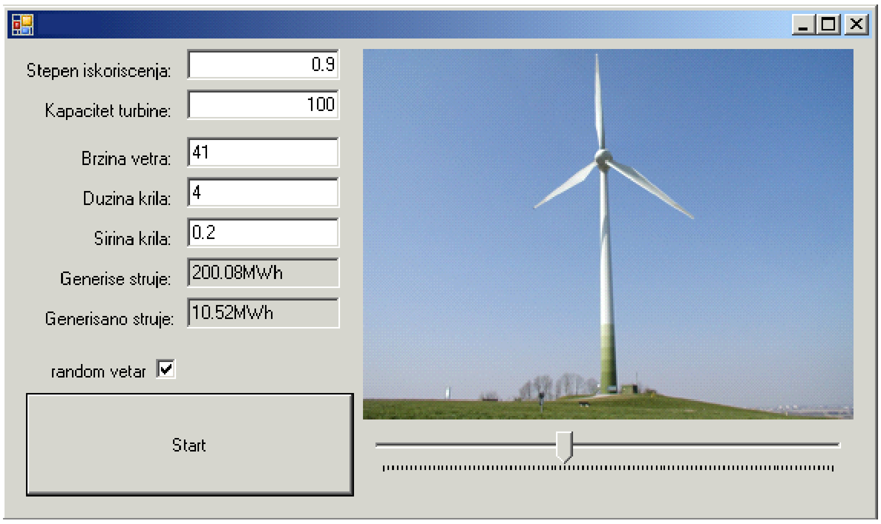

Figure 6. Final screen after process ended

Software implementation

Previously presented software is implemented in Visual Studio 2005 Development Environment, using C# programming language.
Implementation is based on several key programming elements (given with key code part):
1. Using timer control for the process computation
2. Change of pictures for wind power plant process animation
3. Using random functions for wind speed change
4. Having slider change with wind change
5. Having formula for variable relation and output computing

Timer control code - animation and computation:

```
private void timerAnim_Tick(object sender, EventArgs e)
    {
        double v0;
        double p;
        if (checkValidValues())
```

```
        {
            double vv = Convert.ToDouble(txtBrzinaVetra.Text);
            double k = Convert.ToDouble(txtStepenIskoriscenja.Text);
            double ld = Convert.ToDouble(txtDuzinaKrila.Text);
            double ls = Convert.ToDouble(txtSirinaKrila.Text);
            double p0 = Convert.ToDouble(txtKapacitetTurbine.Text);
            if (vv > 15)
            {
                picFrame++;
                pictureBox1.Load("windgen" + Convert.ToString((picFrame % 8) + 1) + ".png");
            }
            v0 = vv * k * ld * ls;
            if (vv > 15)
                p = (v0 * p0) / timerAnim.Interval * 3600 / 1000;
            else
                p = 0;
            if (vv > 15)
                txtGeneriseStruje.Text = p.ToString("#.##") + "MWh";
            else
                txtGeneriseStruje.Text = "0 MWh";
            generisanoStruje += p / timerAnim.Interval / 1000;
            txtGenerisanoStruje.Text = generisanoStruje.ToString("#.##") + "MWh";
        }
    }
```

Timer control code - random wind:

```
private void timerVetar_Tick(object sender, EventArgs e)
    {
        int pomeraj=randPom.Next()%5;
        if (randPredznak.Next() % 2 == 0)
            trackBar1.Value += pomeraj % 5;
        else
            if (trackBar1.Value - pomeraj > 0)
                trackBar1.Value -= pomeraj;
            else
                trackBar1.Value = 1;
    }
```

CONCLUSION

This paper presents first version of educational software for simulation of wind power plant process.This software could be classified as dynamic simulation. It implements core functions needed for simulation, i.e. input parameters, visualization of process, calculation and visual presentation of results. Implemented software could be extended for additional functionality, such as having more parameters, more output variables, having possibility of choosing other types of wind power plants, storing output data in a database and presenting them graphically and in report. The value of this software in educational process is in enabling students to be introduced to simulation software, to get basic knowledge about power plant industry and to promote environmental protection approach by presenting technology that could use natural resources for creating electric energy.

REFERENCES

Nadrljanski Đ (2000), Educational software - hypermedia systems, (in serbian), Technical faculty Mihajlo Pupin, Zrenjanin, 2000.

(WPPB) Wind Power plants basics, http://www.amfiteatar.org/content/view/209/78/lang,en/

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MODELING DATA WAREHOUSE FOR ANALYSIS OF AIR POLLUTION DATA IN URBAN AREAS

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ABSTRACT

This paper presents data warehouse system design for data analyses of air pollution in urban areas. Basic air pollutants in urban regions are described. Relational data model of created database is presented, as well as aggregated data created with data warehouse. Multi-Dimensional On-Line Analytical Processing (MOLAP) cube based on snowflacke schema is implemented. Additional features are used such as exporting analytical data to spreadsheet application, for the purposes of reports in the form of pivot tables and charts to ilustrate air pollutants concentration analyses.

Key words: data warehouse, OLAP cube, air pollution, aggregated data.

INTRODUCTION

Data warehouse is a concept of data integration into a specific storage that is used for conducting analysis and generating various reports. Data from relational databases is extracted, filtered, organized and stored in the storage form which enables complex and multidimensional access to data in aim to compute answers to questions of company management decisions support.

In this paper we ilustrate usage of data warehouse, database system and reporting tools integration to present the organization of data measurement carried out with automatic measuring station in Zrenjanin in urban zone. This proccess allows projecting and generating aggregated analytical and synthetic form of data considered to air pollutants concentrations.

DATA WAREHOUSE AND OLAP ARCHITECTURES

The term "data warehouse" was first introduced by W.H. Inmon in 1992. who defines “data warehouse is subject-oriented, integrated, non-volatile, time-variant collection of data in support of management’s decisions”(Elmasri et al, 2007). The main goal of data warehousing is data collecting and distribution of information throughout the organisation and use of any information, anywhere, at any time due to the realization of the principle of "always be at the service for information users". One of the main data warehouse building goals is not only to store data, but also to enable managers to conduct data analysis. Decision makers in organizations are often under pressure, because they must make their decisions on the basis of analysis of current facts obtained from various business situations, processes and data sources. These facts are stored mostly in on-line transaction (OLTP) systems as well as some the data sources. Integrated obtaining data for analysis is not very easy to perform.

Purpose of data warehouse system is to transform the data obtained from existing OLTP system into a form suitable for processing which enables performing analysis with tools for business decision making support. End user of data warehouse system needs are met by enabling functionality such as using large amount of data from the company business processes for analysis, setting questions and getting answers about different business issues and diverse reporting. Data warehouse systems are based on online analytical processing (OLAP), which is intended for interactive analysis and reporting, as opposed to the production system designed for data update and transaction processing – OLTP systems. OLAP systems like data warehouses are using multidimensionality principle of denormalized data. Basic elements of OLAP systems are: Database - provides data for analysis, OLAP server – process and manipulate data, Interface system – for interaction with a user and other applications and administrative tools.

OLAP architectures are:

- Multidimensional MOLAP architecture is a concept that requires data from a relational database to be transferred to multidimensional structure called a cube. Data extracting and transferring into the cube, creating aggregations, dimensions, calculated fields and other elements of the cube is a time consuming process whose duration depends on server performance. User can start an analysis only after completion of the whole process. It is difficult to add new dimension to the cube after creating a cube. It is necessary to start a completely new process of creating a cube that is defined upon all required elements. These systems have limited size of data sets that can handle with, because they require large disks and high system performance. Therefore, MOLAP system is suitable for use in cases when it is possible to divide large data sets into several smaller data sets, also called data mart. Advantage of MOLAP architecture is excellent performance of aggregated data presentation for analysis, since aggregated data are already available – they are created in the process of creating a cube.
- Relational ROLAP architecture is a concept of direct access to data in relational databases from data warehouse. These systems can work with large amounts of data, because it does not transfer data to the warehouse. Once you determine the source of data, the user can immediately begin the analysis. Because of the direct work with relational database, users always have current data available, and it is easy to add new dimensions. After defining the model of data warehouse, aggregated data from the transactional system can be load to the warehouse. Multidimensional analysis is transformed into a series of SQL statements that are transmitted to the relational database. Each ROLAP report represent one or more queries which execution can last a long time, because a large number of operations that must be executed over data during the process.
- Hybrid HOLAP architecture is a combination of MOLAP and ROLAP architecture. It is based on the multidimensional and relational databases. It aims to support good features of multidimensional analysis, i.e. short response time with analytical capabilities, as well as support to dynamic approach of relational systems. HOLAP data warehouse can perform very complex SQL statements in acceptable time period.
- Development of Desktop DOLAP architecture systems started with the idea that analysts do their work on regular desktop computers. DOLAP systems enable better performance of analysis with segmented and de-centralized data. Cube data sets, data marts and other data sources are stored at desktop computers. Data extraction and analysis are performed at a desktop computer that is temporary disconnected from complex OLTP queries, which enables better analytical processing performance. This approach allows inconsistency of results because under these conditions the analysis can be done on multiple computers and at different time periods. Data that are stored at desktop computers could not be up-to-date with their origins, i.e. transactional data that are processed in relational OLTP systems. Results from different cubes may differ.

AIR POLLUTION

A substance in the air that can cause harm to humans and the environment is known as an air pollutant. Pollutants can be in the form of solid particles, liquid droplets, or gases. Air pollutants include ozone (O_3), oxides of nitrogen (NO, NO_2, NO_x), ammonia (NH_3), sulphur dioxide (SO_2), carbon monoxide (CO) and particulate matter (PM 10 and PM 2,5). Sources of air pollution are:

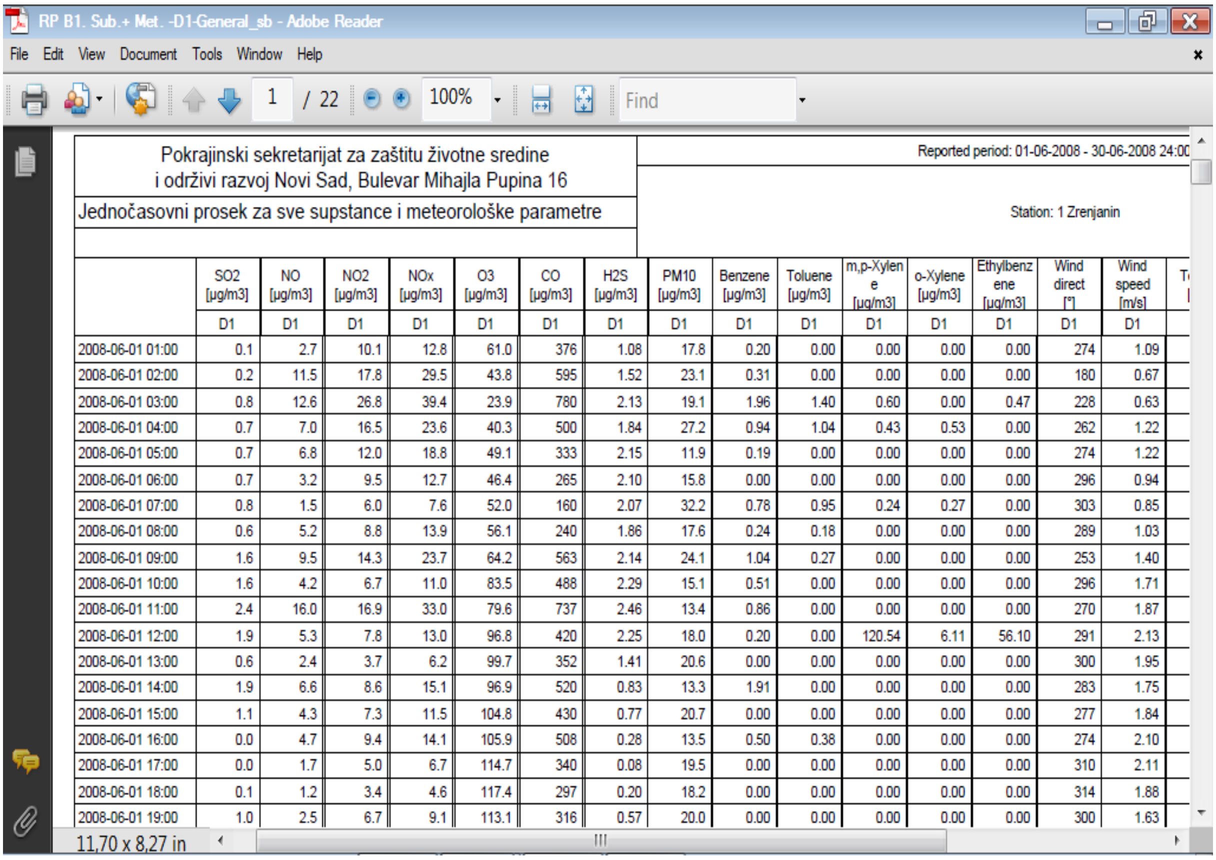
a) Natural – like volcanoes eruption, natural decomposition of organic substances or fire (naturally occurred).

b) Anthropogenic – maid from human activity in industrial processed, residential heating systems, transportation (terrestrial, naval and aerial) and agricultural systems.

The anthropogenic air pollution is of major concern as their sources are increase in number and concentration with the increase of global human population and our continuously increase of energy demand. The anthropogenic air pollution has no borders and no metter where the pollutants are released in atmosphere will have an impact over global environment. The consequences of high value of air pollutants has affected on health and wellbeing of people. Air pollution can also cause acidification of lakes and soils and impacts on crop productivity, forest growth, and biodiversity. Also, pollutions in the atmosphere leading to climate change. Concentrations of most air pollutants are higher in urban areas than in the surrounding rural regions. So, the need to reduce air pollution is very important. In Europe there has been successful reduction in the levels of sulphur dioxide (SO_2) and carbon monoxide (CO) in ambient air, as well as marked reduction in NO_x. Also, exposure to particulate matter (PM) and ozone (O_3) remain of major environment –related health concern, linked to a loss of life expectancy, acute and chronic respiratory and cardiovascular effects. (Ionel, 2007)

AIR POLLUTION MONITORING DATA

Air pollution monitoring is carried in order to obtain reliable and good quality data on environment. Air monitoring provides raw measurements of air pollutant concentrations and with appropriate analysis and interpretation these measurements can be transformed into useful information about air quality. The data measurement is carried out by monitoring with automatic measuring station in Zrenjanin’s urban zone (data source: Provincial Secretariat Internet site). Automatic station is designed to monitor pollution levels in residential and commercial zone that comes primarily from traffic and other sources.



Pokrajinski sekretarijat za zaštitu životne sredine
i održivi razvoj Novi Sad, Bulevar Mihajla Pupina 16

Jednočasovni prosek za sve supstance i meteorološke parametre

Reported period: 01-06-2008 - 30-06-2008 24:00

Station: 1 Zrenjanin

	SO2 [µg/m3]	NO [µg/m3]	NO2 [µg/m3]	NOx [µg/m3]	O3 [µg/m3]	CO [µg/m3]	H2S [µg/m3]	PM10 [µg/m3]	Benzene [µg/m3]	Toluene [µg/m3]	m,p-Xylene [µg/m3]	o-Xylene [µg/m3]	Ethylbenzene [µg/m3]	Wind direct [°]	Wind speed [m/s]
	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1	D1
2008-06-01 01:00	0.1	2.7	10.1	12.8	61.0	376	1.08	17.8	0.20	0.00	0.00	0.00	0.00	274	1.09
2008-06-01 02:00	0.2	11.5	17.8	29.5	43.8	595	1.52	23.1	0.31	0.00	0.00	0.00	0.00	180	0.67
2008-06-01 03:00	0.8	12.6	26.8	39.4	23.9	780	2.13	19.1	1.96	1.40	0.60	0.00	0.47	228	0.63
2008-06-01 04:00	0.7	7.0	16.5	23.6	40.3	500	1.84	27.2	0.94	1.04	0.43	0.53	0.00	262	1.22
2008-06-01 05:00	0.7	6.8	12.0	18.8	49.1	333	2.15	11.9	0.19	0.00	0.00	0.00	0.00	274	1.22
2008-06-01 06:00	0.7	3.2	9.5	12.7	46.4	265	2.10	15.8	0.00	0.00	0.00	0.00	0.00	296	0.94
2008-06-01 07:00	0.8	1.5	6.0	7.6	52.0	160	2.07	32.2	0.78	0.95	0.24	0.27	0.00	303	0.85
2008-06-01 08:00	0.6	5.2	8.8	13.9	56.1	240	1.86	17.6	0.24	0.18	0.00	0.00	0.00	289	1.03
2008-06-01 09:00	1.6	9.5	14.3	23.7	64.2	563	2.14	24.1	1.04	0.27	0.00	0.00	0.00	253	1.40
2008-06-01 10:00	1.6	4.2	6.7	11.0	83.5	488	2.29	15.1	0.51	0.00	0.00	0.00	0.00	296	1.71
2008-06-01 11:00	2.4	16.0	16.9	33.0	79.6	737	2.46	13.4	0.86	0.00	0.00	0.00	0.00	270	1.87
2008-06-01 12:00	1.9	5.3	7.8	13.0	96.8	420	2.25	18.0	0.20	0.00	120.54	6.11	56.10	291	2.13
2008-06-01 13:00	0.6	2.4	3.7	6.2	99.7	352	1.41	20.6	0.00	0.00	0.00	0.00	0.00	300	1.95
2008-06-01 14:00	1.9	6.6	8.6	15.1	96.9	520	0.83	13.3	1.91	0.00	0.00	0.00	0.00	283	1.75
2008-06-01 15:00	1.1	4.3	7.3	11.5	104.8	430	0.77	20.7	0.00	0.00	0.00	0.00	0.00	277	1.84
2008-06-01 16:00	0.0	4.7	9.4	14.1	105.9	508	0.28	13.5	0.50	0.38	0.00	0.00	0.00	274	2.10
2008-06-01 17:00	0.0	1.7	5.0	6.7	114.7	340	0.08	19.5	0.00	0.00	0.00	0.00	0.00	310	2.11
2008-06-01 18:00	0.1	1.2	3.4	4.6	117.4	297	0.20	18.2	0.00	0.00	0.00	0.00	0.00	314	1.88
2008-06-01 19:00	1.0	2.5	6.7	9.1	113.1	316	0.57	20.0	0.00	0.00	0.00	0.00	0.00	300	1.63

Figure 1. Data measurement carried out with automatic measuring station in Zrenjanin

DATA WAREHOUSE DESIGN FOR AIR POLLUTION DATABASE ANALYSES

The OLTP database created in Microsoft Access database management system contains data about air pollutants concentrations that are measured in 2008 year in Zrenjanin (Vojvodina region, Serbia) urban traffic street with other relevant data as are: air temperature, atmospheric pressure, wind speed and wind direction. This raw measured data are downloaded from Provincial Secretariat for Protection of Environment and Sustainable Development site. Then we transformed Adobe Acrobat Reader data into Microsoft Excel table form suitable for entering into realational database software. The database (see Figure 2) is projected upon a data used from XML source files from European air quality database. AirBase is the air quality information system maintained by the EEA through the European topic centre on Air and Climate Change (European air quality database).

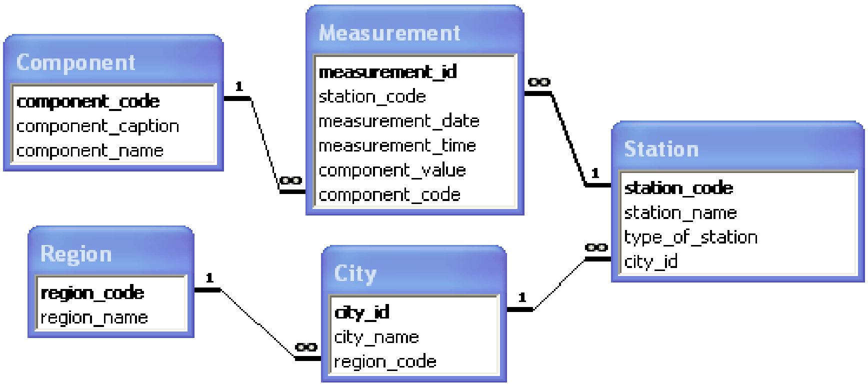


Figure 2. Relational schema of air pollutants concentrations database

Analytical requirements for creating data warehouse of air pollution measurements are defined according to answering following questions:

- How air pollution appears by months in one year?
- How air pollution appears quarterly in one year?
- How air pollution appears by hours in one day during the year?
- What are the concentrations of air pollutants?
- How looks like the comparision of air pollutants averrage values by years, quarters, months, days or hours?
- How many measurements have made stations?
- How small/great are minimum and maximum values of measurements?

OLAP cubes are organized by dimensions and measures. Dimensions are taken from the dimensional tables and measures from the fact table. Table dimensions contain hierarchically arranged data which are the subject of various calculations. Dimension is a category for analyzing data. It can be, for example: standard, time, temporal, geographical and others. Fact table is used for application of mathematical functions such as summarizing, counting, average, maximum and minimum values of some columns, which are then appointed in accordance with the convention and are specified as derivative, i.e. aggregated data.

In our case OLAP cube measures and used functions for counting analytical data:

- Nubmer of measurements: COUNT(measurement_id).
- Summary for air pollutant concentration: SUM(component _value).
- Maximum values of air pollutant concentration: MAX(component_value).
- Minimum values of air pollutant concentration: MIN(component _value).
- Calculated field - Average of air pollutant concentration:
  SUM(component_value)/ COUNT(measurement_id).

There are three cube dimensions, which are specified according to analyses requirements:

- Measurement time -> Global hour (standard dimension).
- Measurement date -> Date (time dimension with levels: quarter, month and day).
- Component for measurement -> Component name, text data type (standard dimension).

Table of facts and dimension tables are related, i.e. connected in data model. Organization of these tables is presented by schemas (see Figure 2). The most frequently used methods of designing a scheme are snowflake schema and star schema. Star schema of data warehouse design is more often used, especially because of the structure that support fact tables to be associated with dimensions tables at only one level. This cube will enable analyzing air pollutant component values in a certain period of time, through measurement time and date, dimensions based on star schema.

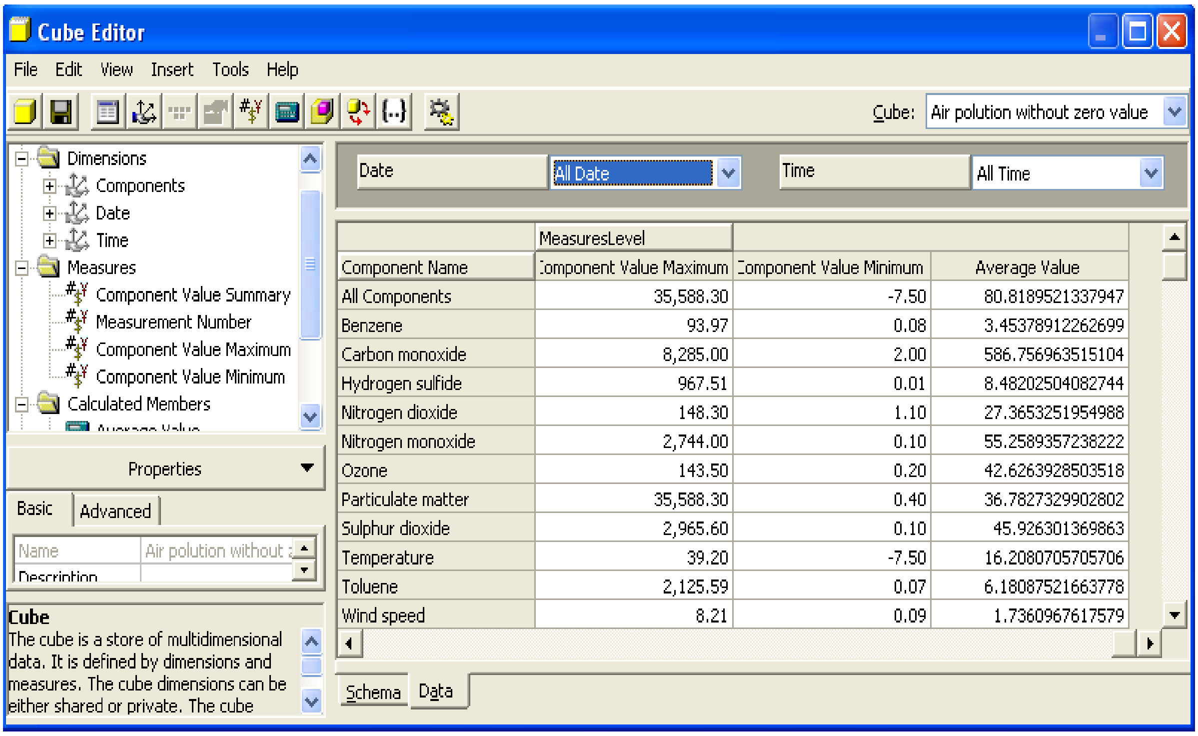


Figure 3. Data warehouse OLAP cube editor

Snowflake schema has more complicated structure where fact table is connected to dimensional tables that are at level two or higher. Snowflake schema requires more joins between the tables and therefore is more resource intensive. Snowflake scheme examples of air polution database at level two could be city where is station placed or city region at level three.

OLAP cubes in our example were designed and created in OLAP cube editor (see Figure 3) of Microsoft SQL Server Analysis Services tool, which is an upgrade to SQL Server database management system. Following steps of using this tool are needed for creating an OLAP cube: creating a database at server, determination of data sources, the path to a relational database and DBMS drivers (DB providers), creating new OLAP cube, selection of fact table and creating measures, specifying dimensions, setting data storage options, by choosing types of storage: MOLAP, ROLAP or HOLAP type of storage, determination of the options for grouping and aggregating data, relating to the limitations of disk space that cube will occupy, processing the cube with the choice of processing methods (new cube, changing existing cube and refresh data in existing cube).

After the cube is created, initial analysis of aggregated data can be accessed (see Figure 3), by using cube reader within the cube editor. Cube reader enables aggregated data and dimensions to be flexibly shown and hidden, depending on required analysis to be performed.

REPORTING ANALYTICAL DATA

In this section we present integration of all previously presented methods and strategies (see Table 1). Additional analysis and graphical display of data, which are organized into OLAP cubes, can be done by using pivot tables and charts. These could be created by connecting OLAP cube as a data source to a spreadsheet application.

In this example, the analytical data are exported to Microsoft Excel from OLAP cube to create pivot tables. Microsoft Excel has efficient mechanisms for connecting to the OLAP source and excellent tools for various forms of diagrams and charts.

Table 1: Pivot table created from OLAP cube data

Time	All Time				
Average Value	Year	Quarter			
	2008			2008 Total	Grand Total
Component Name	Quarter 2	Quarter 3	Quarter 4		
Benzene	2.09	2.61	4.17	3.45	3.45
Carbon monoxide	680.38	552.42	584.19	586.76	586.76
Hydrogen sulfide	2.82	20.73	2.45	8.48	8.48
Nitrogen dioxide	19.51	25.62	32.25	27.37	27.37
Nitrogen monoxide	17.92	56.81	68.21	55.26	55.26
Ozone	63.75	53.15	23.61	42.63	42.63
Particulate matter	35.03	23.79	50.55	36.78	36.78
Sulphur dioxide	7.43	49.45	55.76	45.93	45.93
Temperature	23.26	21.39	8.15	16.21	16.21
Toluene	2.46	4.85	7.27	6.18	6.18
Wind speed	1.61	1.53	2.01	1.74	1.74
Grand Total	93.37	81.09	76.46	80.82	80.82

Figures 4., 5., and 6. shows various diagrams created upon filtered values from the previously created pivot table (see Table 1), which contains the average concetrations of air pollutants measured in Zrenjanin, in 2008. Data for period from january to april (1st quarter) is not given on Internet, so it is not shown in our analyses.

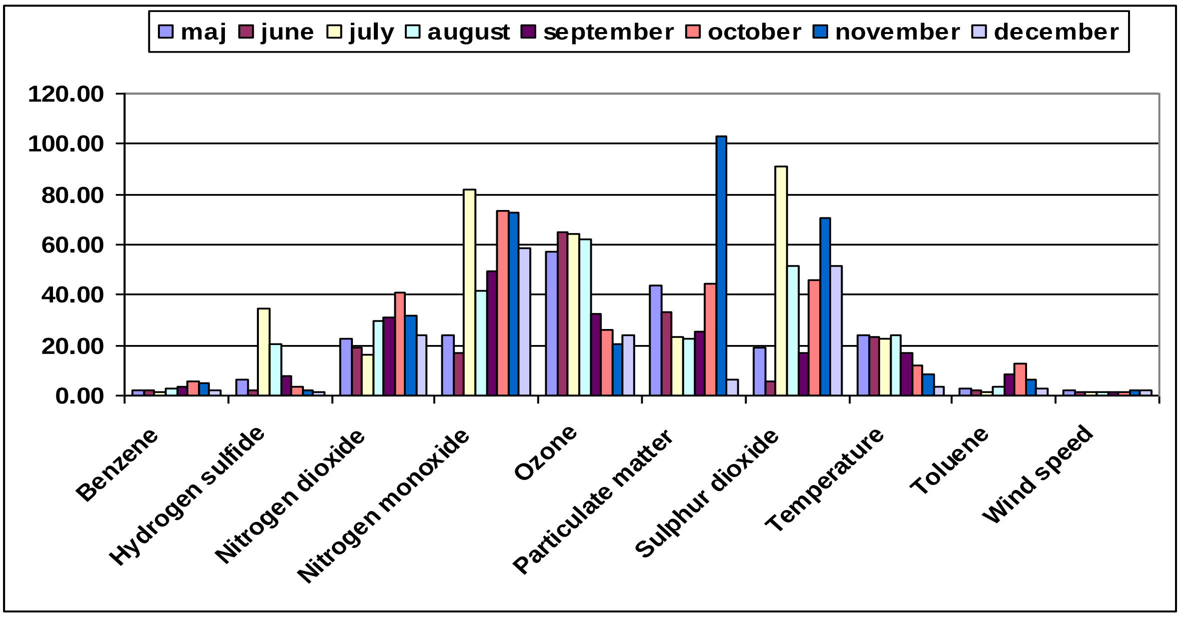


Figure 4. Average concentrations of air pollutants shown monthly

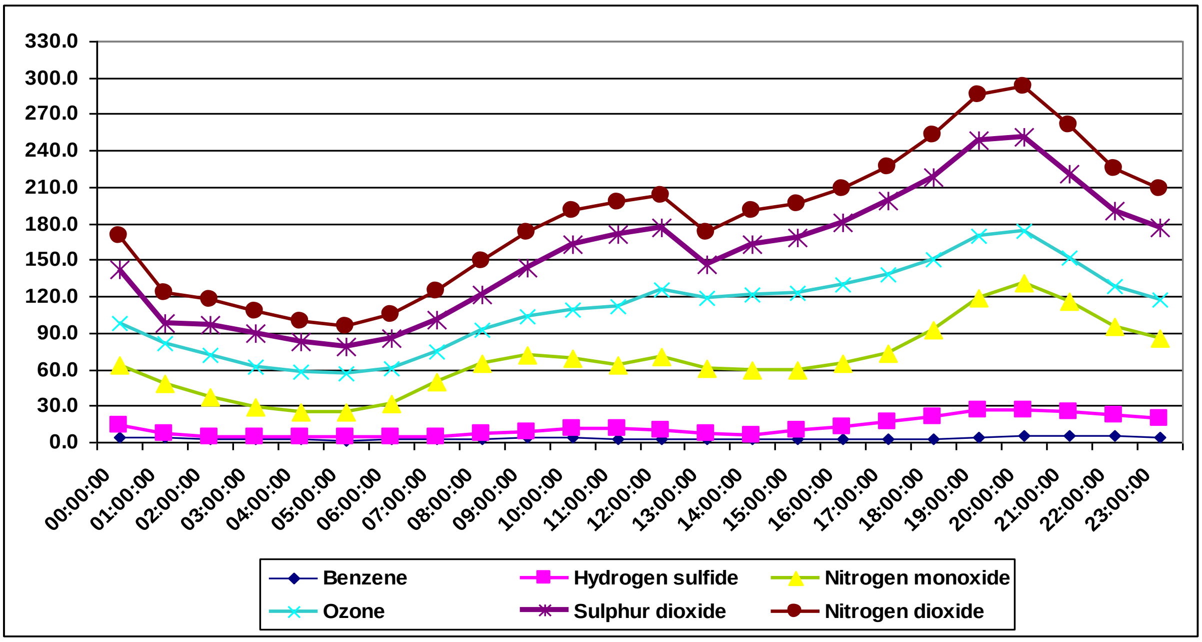
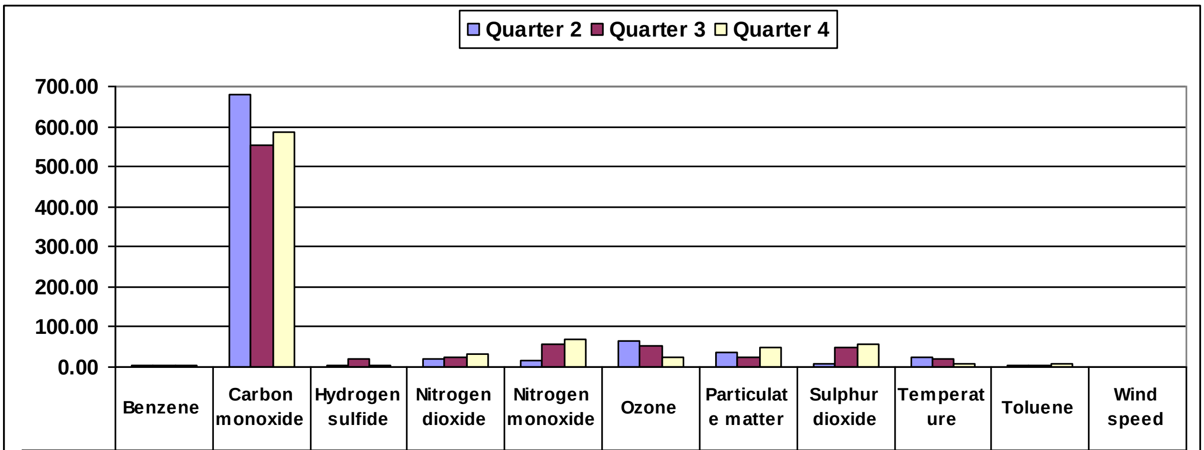


Figure 5. Daily average concentrations of air pollutants



	Benzene	Carbon monoxide	Hydrogen sulfide	Nitrogen dioxide	Nitrogen monoxide	Ozone	Particulat e matter	Sulphur dioxide	Temperat ure	Toluene	Wind speed
Quarter 2	2.09	680.38	2.82	19.51	17.92	63.75	35.03	7.43	23.26	2.46	1.61
Quarter 3	2.61	552.42	20.73	25.62	56.81	53.15	23.79	49.45	21.39	4.85	1.53
Quarter 4	4.17	584.19	2.45	32.25	68.21	23.61	50.55	55.76	8.15	7.27	2.01

Figure 6. Average concentrations of air pollutants shown quarterly with data values table

All the measurement units presented in charts on figure 4, figure 5. and figure 6. are [µg/m3] except for wind speed [m/s] and air temperature [°C].

CONCLUSION

Projecting and using data warehouse for air pollution monitoring with exporting data for graphical reports shows that the data warehouse system may affect to the quality of analysing to improve environment protection. It can significantly improve operations by providing data to enhance quality of services to users, by analysis of data from the database in a specific dimensions.

This system can provide answers to many questions in different areas and can serve as a support for making strategic decisions. Managers, researchers or other employes can make their own analysis, since using software tools, methods, models and hardware support that do not require specific and expert knowledge from areas such as programming, database design, transaction processing data, working with complex report generators and similar tools.

REFERENCES

Elmasri, R. & Navathe, S. B. (2007). Fundamentals of Database Systems, *Addison Wesley*.

European air quality database, http://www.eea.europa.eu/data-and-maps/data/airbase-the-european-air-quality-database-3irBase.

Gunderloy, M., & Jorden, J. L. (2001). SQL Server 2000, *Mikro knjiga, Belgrade, Serbia.*

Ionel, I. (2011) Air quality monitoring for the Banat region by means of education and scientific research & development, *Workshop "Banat Air Quality 2011" Zrenjanin, Serbia.*

Kazi, Z., Radulovic, B., Radovanovic, M., & Kazi, Lj. (2010). MOLAP Data Warehouse of a Software Products Servicing Call Center, *MIPRO XXXIII International Symposium Computers in Education, IEEE Region, May 2010, Opatija, Croatia, Proceedings MiproBIS.*

Mogin, P. , Luković I., & Govedarica, M. (2000). Principi projektovanja baza podataka, *Univerzitet u Novom Sadu, Stylos, Novi Sad, Serbia.*

Pearson, W. MDX at First Glance: Introduction to SQL Server MDX Essentials, http://www.databasejournal.com/article.php/1459531.

Provincial Secretariat for Protection of Environment and Sustainable Development http://www.eko.vojvodina.gov.rs/?q=node/264.

Radulovic, B., Kazi, Lj., & Kazi, Z. (2006). Informacioni sistemi - odabrana poglavlja, *Tehnicki fakultet Mihajlo Pupin, Zrenjanin, Serbia.*

Veljovic, A. (2002). Menadzment informacioni sistemi u praksi, *Kompjuter biblioteka Cacak, Serbia.*

Wikipedia, http://www.en.wikipedia.org/wiki/airpollutant.

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INFORMATION AND COMMUNICATION TECHNOLOGIES IN THE DEVELOPMENT OF NATIONAL AND LOCAL ENVIRONMENTAL ACTION PLAN IN THE REPUBLIC OF SERBIA

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ABSTRACT

Contemporary competitiveness requires new approaches to all aspects of business. One of them is minimizing the negative impact of every activity undertaken to the environment. In this light, a series of standardized actions should be taken so as to ease the process and quicken the result achieving. A good, two-way communication channel, providing the accurate and 'fresh' data is one of the essential requirements. Unfortunately, like in many other aspects of contemporary business, a certain lag can be noticed in domestic business practice regarding environmental protection. The aim of this paper is to provide the theoretical background of the national and local ecologic action plan, an insight into the implementation of IT support in the world and the review of the national strategy regarding monitoring and information system.

Key words: information system, communication technologies, environmental action plan, reform.

INTRODUCTION

Facing the imperative of protecting the environment as one of basic preconditions of business excellence in today's business world, the organisations which aim to survive and prosper on market have to develop detailed environmental plans. This regards not only the commercial companies, but also national institutions like municipalities and local communities. Domestic experience in this field is still poor, but the international one can be used as a basis for developing successful and efficient monitoring and information environmental systems. This paper provides the theoretical basis of national and local environmental action plans, an insight into current national monitoring and IT system strategy, as well as the experience of IT support implementation in the world.

NATIONAL AND LOCAL ENVIRONMENTAL ACTION PLAN

A series of conferences regarding environmental issues have been held in the period from the early '90s until today, raising the awareness of the ever-growing need to minimise the negative impact at every possible level. One of the most prominent one was the UN Conference on Environment and Development (also known as Earth Summit) and Environment for Europe, held in Lucerne in 1993. The first one had the 'Agenda 21' as a result, maintaining a global consensus and a high degree of political consensus on the inseparability of development and environment and raising the globally most important ecological issues faced by the modern civilisation.

The second one saw the signing of the Environmental Action Program for Central and Eastern Europe (abbreviated to EAP), which basic principle was to merge the issue of environmental protection with the economic reconstruction with the objective of assisting the Central and Eastern Europe countries to reach Western standards in preserving and improving the environment. One of the basic tasks of the

EAP is to enforce the local environment protection planning, which is currently taking place in the most of the Central and Eastern European countries under the name of NEAP (National Environmental Action Program).

Development of national and local environmental action plans is in fact translation of world tendencies onto the local level. Having more or less obstacles as the result of ecological problems and current economic state of the countries, the initiative to form the adequate local community program has not yet been completely successful. However, local communities approached the elaboration of their own plans for environmental protection and improvement, based primarily on these communities' priorities and EAP methodology. The fact was proved that, on the local level, it is easier to identify and apply the recommendations and methodology for developing plans and programs of environmental actions.

PUBLIC PARTICIPATION IN PROCESSES OF IMPORTANCE FOR THE ENVIRONMENT

EU Standards in the Field of Public Participation in Processes of Importance for the Environment

The leading European standard in the field of public participation in processes of importance for the environment is the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Matters Concerning the Environment. The convention is also known as the Aarhus Convention, obliging the member states to provide the access to information important for the environment, participation in decision-making and an adequate legal protection in the case of the disregard of its rights. (LEAP Vrnjacka Banja, 2010, p. 45)

Serbia - Public Participation in Processes of Importance for the Environment

The Legal Framework of the Republic of Serbia for Citizen Participation

The following section will represent a part of Serbian legislature regarding the matter of interest for this paper.

- The Serbian Constitution (Official Gazette of RS, vol. 83/06) emphasises the right for true, complete and timely notice on matters of public importance and the obligation of media to respect that right (Article 51). Furthermore, this document stresses the right to obtain information on the environmental state: *'Everyone is entitled to healthy environment and timely and complete notification about its state. Everyone is obliged to protect and improve the environment* (Article 74).
- Law on Local Self-Government (Official Gazette of SCG, vol. 9/02 33/02, 33/04) describes the forms of citizen participation such as referendum, citizen initiatives and citizen assemblies, but does not address the other ways of exercising the citizen right exercising by their own action.
- Law on Free Access to Information of Public Importance (Official Gazette of SCG, vol. 120/04). Citation: *'An information of public importance, in this law's sense, is an information held by a public authority, created in work or in relation to the work of public authorities, contained in a document and applied to all that the public has the legitimate interest to know'* (Official Gazette of SCG, vol. 120/04, Article 2).

The Laws of the Republic of Serbia on Protecting the Environment Relevant to Public Participation

A significant effort to streamline the regulations for environmental protection and their compliance with the European regulations was made by the adoption of four laws in 2004. By transposing the EU directives into its legal system through these four laws, the Republic of Serbia has managed to provide implementation of Aarhus Convention, although not the Convention Party.
These four laws are, as follows:

- I The Law on Environmental Protection (Official Gazette of SCG, vol. 135/2004), presenting the process of public participation as the process of displaying projects, plans or programs to the public and public debate.
- II Impact Assessment Act on Environment (Official Gazette of SCG, vol. 135/2004). Assessing the environmental impact is based on feasibility study, consulting with the publicity and measure analysis, with the aim to predict the adverse effects of certain projects on life and health of the society, flora and fauna, soil, water, air, climate etc. Public participation is present in all the three phases of the process.
- III Law on Strategic Environmental Impact Assessment (Official Gazette of SCG, vol. 135/2004). All interested agencies and organisations are involved in the procedure of strategic assessment of certain plans and programs' impact on the environment.
- IV Law on Integrated Prevention and Control of Environmental Pollution (Official Gazette of SCG, vol. 135/2004). Public participation begins in the early phase of application for issuance of integrated permit, when the publicity gets the right to express an opinion on the application, as well as in the permit drafting stage. The procedure is followed by the obligation of informing the publicity about the stages of the proceedings and the final decision of the competent authority.

Relevant Local Regulations

Exercising the right of the publicity to participate and be informed is arranged by the local regulations, which of the most important are the Statute of the municipality, Decision on Municipal Administration and Rules of Work of the Municipal Assembly.
These acts are fairly often at the same generality level as the Law itself, with no detailed elaboration of the citizens' right to participate in the local management. In fact, this is one of the basic faults in the legal framework for exercising the citizens' participation at the local level.

The term 'public' in the environment protection system

The Law on Environment Protection defines the following terms:

- Publicity, as one or more physical or legal entities, their associations, organisations or groups.
- Interested publicity, as the publicity influenced or influencing the plan or program, i.e. the one that has its interest in making decisions regarding environmental protection, including non-government organisations addressing the environment protection and recorded by the local authority.
- Principle of information and public participation, according to which everyone is entitled to be informed about the environment state and participate in the process of decision making, which implementation could influence the environment. (LEAP Vrnjacka Banja, 2010, pp. 98-99)

INFORMATION AND COMMUNICATION TECHNOLOGIES IN THE DEVELOPMENT OF NEAP IN SERBIA

Unfortunately, the domestic experience in this field is still modest in comparison to the European and worldwide one. The efforts are sporadic and decentralised, thus it is not possible to make a unique information system and consequently integrated decision-making strategy. Some initiatives are present, however, but they all have the local character.

For instance, the municipality of Vrnjacka Banja (like most of the other Serbian municipalities) has no organised and efficient environmental information system at the moment. Likewise, development of polluters' cadastre is slow due to economy and agricultural transitional restructuring. This process should be coordinated with the EU regulations on the national, but also on the local level. (LEAP Vrnjacka Banja, 2010, p. 37)

The majority of data was obtained from the estimates, since there is no operational information system which could systematically follow the generation of certain waste types. (LEAP Vrnjacka Banja, 2010, p. 65)

National Environmental Action Plan – NEAP

The positive legislature and commitments made by ratification of a number of international conventions and protocols lead to making the network of measuring stations for continuous and systematic monitoring of certain environmental factors' quality. However, the present resources are inadequate and insufficient.

One of the most significant programs is the limited number of acredited laboratories, insufficiency of standard operational procedures for sampling and analysis, reference laboratories, interlaboratory calibration and comparison etc. (Serbian Government, National Environmental Action Plan) Thus, the quality of the collected data is in certain cases unsatisfactory.

The problem in our country is the fragmentation of information system, i.e. lack of the integral environment information system. The activities are sporadic and mutually incompatible, databases are local and as the result, it is not possible to make appropriate decisions at the state level.
Serbian monitoring is focused on the quality of ambient environment, which does not cover all the priority areas, which leads to the monitoring system's financial dependence on the limited state funding.

Air quality monitoring is done in the network of multi-level measuring stations established by the authorities, like Institutes of Public Health, Republic Hydrometheorogical Service and such. The data quality depends on the institutions' measuring equipment, and is limited by financial possibilities.
The local network of urban stations cover the monitoring of primary pollutants (char, SO_2, NO_x, CO, ozone, suspended particles and sediment matter), including heavy metals as well. The program adopted by the Government in the two-year period introduces positioning of the stations in 40 settlements, 76 measuring points. Local area network for the control of specific pollutants covers 19 settlements and 44 measuring points, regarding the industrial facilities' proximity. For instance, acrolein, phenol, NH_3, benzene, etc. are measured in such places.

The polluters themselves convey specific monitoring at times. Systematic measuring of primary and specific pollutant imission is conveyed in reduced scope compared to the one provided in the program, due to the limited finances. Actual primary pollutant measuring is conveyed in 28 settlements and 60 measuring points, while specific pollutant measuring takes place in only 5 settlements and 11 measuring points. Monthly reports (which the yearly ones are based on) are submitted to the Department for Environmental protection.

Since the data on emission sources are unavailable, it is not possible to use the spatial dispersion mode so as to make the pollution maps and effective reduction measures plan.

When it comes to *water quality monitoring*, which the Republic Hydrometheorogical Service is amenable for, the Program of Systematic control was introduced on two-year period as well. The measuring station network comprises 143 stations for quality control of surface waters, 66 stations for control of groundwater (piesometers), 35 stations for well control and 360 stations for accumulation control. (Official Gazette of SFRY, vol. 50/90 and 54/90).

The sampling frequency and analysed parameters are defined according to the measuring location and vary from daily sampling, over semi-month up to once monthly (the most common practice). The samples are analysed for the presence of 36-63 physical and chemical parametres and the results have to be sent to the Republic Hydrometheorogical Service once monthly, and in cases of accident, the very same day. It is important to notice that the river sediment quality analysis begun in 2002 and is conveyed once yearly in 33 places. The drinking water quality is also measured regularly.

However, the previous decade has seen significantly little investments into modernisation of the existing equipment for sampling and laboratory analyses. The obsolete Regulation on Classification of Surface Waters, dating from 1978, cannot follow modern trends in the field. Apart from that, it is necessary to establish the reference national laboratory, automatic stations for continuous monitoring of certain parameters of water quality, as well as the development of modern biological monitoring.

There is a worrying fact is that the Republic of Serbia does not have the systematic wastewater monitoring, the register of wastewater discharges, as well as the available current data on these discharges. However, there are certain lists of river polluters, which are obliged to measure the quantity of their pollution and monitor the water treatment plants. Since the standard for wastewaters is not implemented, the supervision over regulation compliance is not possible.

Waste monitoring is highly insufficient. There is no reliable mass balance of deposited waste, thus the waste statistics is approximate; statistics on other types of waste (hazardous, biodegradable or construction waste) does not even exist. Nevertheless, the positive regulation demands the classification, characterisation (conveyed by the authorised laboratory) and categorisation of industrial waste (conveyed by the Agency for recycling).

Ionising radiation is monitored by the Institute of Occupational and Radiological Health ‘Dr Dragomir Krajovic’ of the Clinical Centre of Serbia. It has been conveyed for the previous 40 years, being coordinated with the Decision on the systematic analysis of the radionuclides in the environment (‘Official Gazette of FRY’, vol. 45/97)

The Proposed Reform of the Monitoring and Information System

A large number of specific goals, regarding the environment mediums or economic sectors, can be conveyed only within a better monitoring, self-monitoring of pollutants and establishing the integral information system and reporting (Table 1).

Table 1: The list of proposed reforms of monitoring system and information system

Areas for which the goals have been set	**The proposed reforms of monitoring system and information system**
Water quality and water resources	Further monitoring development for surface and groundwater in compliance with the Outline Water Directive. Accreditation of existing laboratories and establishing of reference laboratories. Making polluter cadastre. Establishing an unique information system and informing system. Increasing the number of places, frequency and expansion of the list of parameters for monitoring the drinking water quality. Expansion of monitoring nitrates and nutrients in nitrate-sensitive zones.
Waste management	Improving waste generators self-reporting. Monitoring quantity, composition and physic-chemical characteristics of waste. Creation of waste databases.
Chemicals management	Establishing a register of chemicals.

	Establishing the systematic monitoring of traffic and use of chemicals as well as their metabolites and chemical pathways in the environment and living organisms for placing chemicals on the list of controlled substances. Monitoring and control of laboratories with good laboratory practice certificate.
Air quality and climate changes	Improving the monitoring program of ambient air and air quality assessment Modernisation of the monitoring network in cities and on endangered location for monitoring the ambient concentrations. Accreditation of laboratories and establishing the reference laboratory. Creation of the polluters and emission balance cadastre. Defining the zones with the pollution level which exceeds the legally permitted values. Modelling the effects of stationary and large point sources. Implementation of the polluters self-monitoring. Determining the list of greenhouse gas emissions.
Nature conservation and biodiversity	Improving the monitoring of biodiversity components, endangered species, ecosystems and protected areas. Establishing bio-monitoring of certain water ecosystems. Determination of national information system and databases in protected areas.
Soil and forest protection	Improving the monitoring of heavy metals, PAHs and pesticides in soil. The introduction of monitoring of sludge quality. Monitoring nitrates in surface and groundwater. Improvement of forest health monitoring in accordance with the International Cooperative Program of the Forest (ICPF). Establishing of the soil erosion monitoring.
Noise	Improving the monitoring of ambient noise, particularly at endangered locations. Making noise maps. Accreditation of organisations involved in noise measuring and establishing the reference organisation.
Ionising and non-ionising radiation	Improving the monitoring of radioactivity, including the indoor radon. Improving the monitoring of border radioactivity control of goods for import, export and transit. Introduction of environmental radioactivity monitoring at sites contaminated by depleted uranium. Introduction of UV radiation monitoring.

	Creation of ionising and non-ionising source database. Creation of radioactive waste database.
Industry	Introduction of the polluters self-monitoring (air, water) and improving the emission monitoring. Monitoring of the contaminated soil. Establishing the polluters' cadastre and database management. Collecting the statistical data about waste.
Mining	Introduction of the polluters self-monitoring (air, water) and improving the emission monitoring. Monitoring of the contaminated soil. Establishing the polluters' cadastre and database management. Collecting the statistical data about waste.
Energy	Introduction of the polluters self-monitoring (air, water) and improving the emission monitoring. Monitoring of the contaminated soil. Establishing the polluters' cadastre and database management. Collecting the statistical data about waste.
Agriculture	Monitoring the impact of large livestock farms and processing plants. Monitoring the use of hazardous chemicals in agriculture. Monitoring nitrates.
Transport	The establishment and improvement of monitoring (air quality) on vulnerable roads. The establishment of mandatory surveys of emissions from motor vehicles.

Short-term Reforms of Monitoring and Information System (2005 - 2009)

Reform of the monitoring system and reporting on the environment on the short term should be focused on the gaps influencing the law enforcement and decision making in the environmental field. Many monitoring reforms and reports will be initiated on the short term, but their implementation will take place in the entire following decade. The following reforms are necessary:

- Laboratories should be accredited in accordance with international standard ISO/IEC 17025, i.e. certified in accordance with good laboratory practice. Reference and calibration laboratories should be established, and unique analysis and sampling procedures applied.
- Monitoring activities should be the polluters' obligation, in the form of self-monitoring, with record keeping and the obligation of reporting to the authorities. The polluters have to be completely responsible for emission self-monitoring, but the authorities need to have sufficient laboratory capacities for performing tests on a random sample, reference analyses and field measurements (sampling devices and mobile measuring devices). Reliability and validity of polluters' self-monitoring represents the basic precondition for the proper use of other policy instruments and inspection.
- Monitoring program adopted by the Government of the Republic of Serbia (National monitoring – state network for monitoring the quality of air, water etc.) is financed from the

state budget. This monitoring should be improved by establishing automatic measuring stations.
- Self-monitoring should be performed and funded by the polluters. Control of such a monitoring is occasionally conducted by the authorities through monitoring the regulation implementations.
- The monitoring station network should be optimised, and automatic monitoring of ambient air implemented in the biggest cities and vulnerable locations (like the radioactivity monitoring of the sites contaminated with depleted uranium).
- Monitoring of surface and ground waters should be aligned with the recommendations of European directives on water, according to the schedule of activities in the Danube basin countries.
- Establishing the monitoring network for wastewater emissions.
- A central and integrated database of all the environmental factors in Serbia should be formed with environmental information provided to the publicity. This database should be linked with a network of European Environment Agency. (EIONET)
- Establishment of monitoring and processing of data on waste generation, waste composition and physical-chemical characteristics.

Mid-term Reforms of Monitoring and Information System (2010 - 2014)

The following reforms are seen as mid-term:
- Improving the quality assurance and control of authorised organisations and laboratories.
- Further expansion of polluters self-monitoring and emission monitoring.
- Expansion of network for continuous monitoring of ambient air and noise to smaller settlements.
- Expansion of the monitoring network for wastewater emission.
- Introduction of regular monitoring of heavy metal in sewage sludge and the concentration of heavy metals and pesticides in soil.
- Expansion of the monitoring network and processing data on waste generation, composition and physical-chemical characteristics.
- Monitoring of POPs emission reductions.
- Regular nitrate and nitrite monitoring in zones vulnerable to nitrites.
- Expansion of monitoring factors of nature and forest health.
- Further development of noise maps based on monitoring.
- Updating and expansion of polluters. The formation of greenhouse gas emission inventories.
- Further distribution of environmental data and further improving public access to environmental information.

Following the suggested actions, our country should achieve an integrated feedback system, through which decision making is made more efficient and appropriate. It is clear that the organisational and economic effects will be positive and business performance improved on a large scale. The reform should be conveyed in compliance to the international regulations, gradually, but perpetually.

CONCLUSION AND IMPLICATIONS

Being an important, but still inadequately understood tool for environmental protection, information and communication systems are only just to bring the benefits in future business. The initiative to use information and communication systems throughout the world is evident, but on national level, the current state is still insufficient.

Therefore, a string of reforms should be undertaken according to the international regulations, so as to achieve an efficient feedback system. Individual local initiatives for protecting the environment should be encouraged and expanded, but also standardised so as to comply mutually, in order to develop a unique information system based on which integrated decisions could be made efficiently on the national level. Hence, decentralised and sporadic information system should be converted into the standardised and systematic one, with the final goal to support the effective decision making on national level.

REFERENCES

Local Environmental Action Plan Vrnjacka Banja (2010), Regional Environmental Centre for Central and Eastern Europe, Office in Serbia, Vrnjacka Banja/Belgrade

Melville, N., (2010). Information Systems Innovation for Environmental Sustainability, *Mis Quarterly, vol. 34 (1)*, 1-21.

Mungai, W., (2005). The 'M-vironment' Approach, *A Developing Connection: Bridging the Policy Gap between the Information Society and Sustainable Development*, International Institute for Sustainable Development, 43-85.

National Environmental Action Plan (scheme), European Agency for Reconstruction and Ministry of Science and Environmental Protection of Serbia – Department of Environmental Protection, Belgrade

Official Gazette of FRY, vol. 45/97

Official Gazette of RS, vol. 83/06

Official Gazette of SCG, vol. 120/04

Official Gazette of SCG, vol. 135/2004

Official Gazette of SCG, vol. 9/02 33/02, 33/04

Official Gazette of SFRY, vol. 50/90 and 54/90

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URBAN EARLY WARNING TO THE THREAT OF FLOODS FOR THE CITIZENS OF NOVI SAD

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ABSTRACT

Natural characteristics of Vojvodina and more and more frequent meteorological phenomena and extremes make flood a constant threat to our survival every year. Based on that, the Public Water Management Company "Vode Vojvodine" published the competition for elaboration of conceptual solution for early warning in cases of threats of flood on the Danube at Novi Sad. The significance of this competition is in evoking and rising of awareness on the relevance of flood defence on one of the largest and most important rivers not only in our country but also in the world – the Danube River, all aimed at educating and warning the citizens of Novi Sad. The paper explains in details the significance of the conceptual solution that won the first prize at the competition via historical data on floods in Novi Sad.

Key words: floods, the Danube, warning, Novi Sad

INTRODUCTION

Novi Sad was established in 1694. Today, it has more than 400,000 inhabitants and it is the largest city and the centre of public administration bodies of the Autonomous Province of Vojvodina, the northern province of Serbia, and administrative centre of the South Backa District with a long history and tradition, and a large number of monuments of culture that make Novi Sad unique and special. Novi Sad is located on the banks of the river Danube (between 1,252th and 1,262th kilometre of the river flow). On the left bank of the river, there is a flatland part – Backa, and from the right the hilly part on the foothill of Fruska Gora Mountain – Srem.

The Danube springs in the foothill of the Schwarzwald Mountain in Germany and it flows with its delta into the Black Sea. The flow length makes the Danube the second largest river in Europe, and it flows through Germany, Austria, Slovakia, Hungary, Croatia, Serbia, Romania, Bulgaria, Moldova, and Ukraine. The Danube is a powerful and large river, not only in Europe but also in the world. It is the main recipient and regulator of surface and ground waters in the territory of Vojvodina, primarily of Novi Sad.

Considering that Novi Sad arose on the banks of the Danube, its development has been oriented to that river and it has largely depended on it. Looking from that aspect, the Danube is very important for providing of economic development (industry, agriculture, water transport, drinking water supply, etc.), development of water sports, river tourism, etc. However, it can also show its negative side, which means floods and drought. Numerous floods have been recorded in a long history of Novi Sad.

MATERIAL AND METHODS APPLIED IN THE PAPER

The data of the Hydro-meteorological Institute of the Republic of Serbia on water levels on the Danube at Novi Sad were used for the needs of this paper. The systematisation of water levels determined the maximum water levels and singled out two absolute water levels (from 1965 – 778 cm, and from 2006 – 745 cm). Those two water levels were used for fulfilment of the objectives.

The research methods that were used in the paper include:

- Methods of analytical study of all the factors that are relevant for early warning
- Researches on the site of the future “Urban hydrological benchmark display“
- The conclusion on significance of potential setting of the “Urban hydrological benchmark display“ was reached via synthesis based reasoning.

HISTORY OF FLOODING IN THE CITY

Floods are the most frequent in our sector of the Danube by the end of winter, during spring, and beginning of summer. The construction of defence dikes protected significant surfaces against flooding from water courses. However, although the dikes resolved the issue of protection against direct flooding with water from the water course, the flooding occurs on defended surfaces, namely on wider inland territory of Vojvodina. That was the basis for the following division: flooding from external waters (dike over spilling and breach) and flooding from inland waters (large precipitation quantities).

When it comes to historical phenomena of high waters in our sector, there are no available reliable-registered hydrological data, except for the date and year of emerging. The years of application of certain elements of measuring and monitoring at Hydrological Station Novi Sad are presented in Table 1.

Table 1: Elements of water level measuring and monitoring

Method of water level registering:	Years
1. The bar since	1919
2. The liminigraph since	-
3. Digital registering since	2006
4. Water level measuring since	1945
5. Water temperature measuring since	1948
6. Suspended deposit flow since	-
7. Occurrence of ice since	1900
8. Water quality testing since	1965
9. Reporting method	Telephone

The years with floods in the City of Novi Sad are presented in Table 2, together with characteristics of those floods.

Table 2: Years with floods in the City of Novi Sad and characteristics of those floods

Years	Water level of the Danube (cm)	Characteristics
1770	+620	The first recorded flood. A larger part of the city, city centre and its direct vicinity were surrounded with water from all sides and became an island during the flood period (30 days). The disappearance of the fishermen’s settlement (in the vicinity of the former railroad bridge) is connected with this flood.
1876	+650	Despite the measures that were undertaken and huge efforts, the city was not defended against high waters of the Danube and it was flooded again, just as it was 100 years before that.
1926	+659	The Report of the Water Directorate that was compiled on the occasion of those catastrophic floods stated: “In resolving of a number of problems that arise from the analysis of causes of the

		flood, it would be of great significance to establish co-operation between the hydro-metric service of Hungary and the one in our country that would be aimed at exchange of necessary data."
1940	+706	The existence of the telephone line and facilitated communication with dike watch towers. Based on the information on the water level the forecasts were made related to certain water metering stations on the flood wave migration, namely better organisation of flood defence (the defence lasted for 14 days). The elevation and strengthening of the existing dike. The breach at Sombor railroad, flooded Adamovic's settlement. More than 3,000 inhabitants of Telep were left homeless. The construction of the dike in the length of 2.3 km implied the use of 40.000m³ of soil.
1965	+778	Novi Sad was under direct threat and intervention demolition of certain upstream dikes was undertaken in order to discharge surplus water into arable land in order to save the city. Flood defence lasted for 128 days (the longest until then). If the dike had been breached 80% of the City of Novi Sad would have been flooded. After those floods, the threat from the Danube was largely diminished due to the construction of the dike system.
2006	+745	Once again, we witnessed a long and tiring flood defence struggle. Around 225,000 ha of arable land were under water, residential and industrial facilities were flooded, some residential premises were destroyed, and a large material damage was caused. After those large scale floods it was decided to reconstruct the quay wall. The existing defence line at the Belgrade Quay was elevated for 60 to 80 cm on the average.

Due to the fact that floods have become more and more frequent, the need has arisen to establish an urban early warning system based on the benchmark that would show how floods are destructive and how important is the timely knowledge on their arrival for protection of the population, as well as significant institutions and structures.

URBAN BENCHMARK DISPLAY USED TO WARN THE CITIZENS OF NOVI SAD ON THE THREAT OF FLOODS

The objective of the "Urban hydrological benchmark display" is to provoke and strengthen the awareness on the significance of flood defence and to serve for education and warning purposes. The facility consists of two parts: the "benchmark" that is set vertically, and a chess field that is set horizontally.

Figure 1. The "benchmark" and the chess field

The “benchmark“ (which represents and new symbol and urban detail in the City) was designed to read different water levels of the Danube and in the case of elevated level it warns to the threat of floods. Water level reading from the water metering bar on the “benchmark“ is enabled via the electronic “reader“, which was designed to connect with the electronic device in the Public Water Management Company “Vode Vojvodine“ and send data on a daily basis. In addition to water level reading and warning of floods, the “benchmark“ also contains three static frames. Within the frames, there are photographs, namely presentations of the City of Novi Sad during floods from the past, the current situation, as well as the display of potential scenario of flooded significant institutions in the City of Novi Sad in the case of future high flood wave on the Danube.

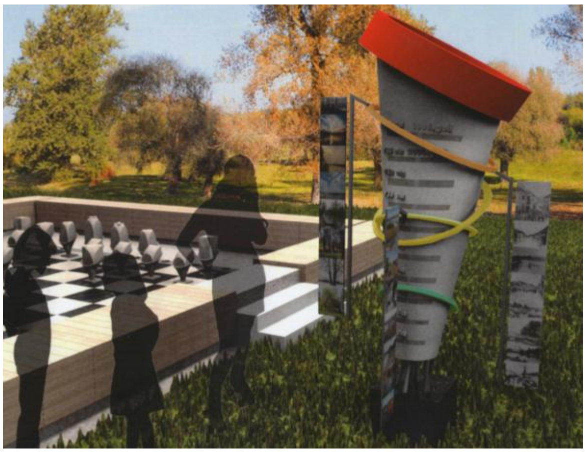

Figure 2. The “benchmark“

The “benchmark“ is of a conical shape. It also consists of three elliptical rings that are connected with the water level and that are of different colours, each with a different meaning. For example, the green colour represents a normal water level of the Danube, yellow represents the introduction of measures of regular flood defence (e.g. the criterion for regular flood defence at Bezdan is 500 cm, and at Novi Sad it is 450 cm), orange represents extraordinary flood defence (e.g. the criterion for extraordinary flood defence at Bezdan is 700 cm and at Novi Sad it is also 700 cm) and on the top a large red elliptical ring that represents the arrival of a flood wave. It is planned for each ring to glow so that the information on the current water level on the Danube would be available to everyone and at all timers. The light would be seen both on land and on the Danube. The dimensions and material that the “benchmark“ would be made of depend primarily on its location, but it certainly should not disturb the concept of the surroundings and surrounding structures.

The chess field: (presented in Figure 1) its purpose is to provide a form of entertainment and recreation. It would be located directly beside the vertically set “benchmark“ so that the largest number of people possible (players, passers by and tourists) could see the vertically set “benchmark“. The chess field is dug in so that it can provide space for sitting and watching the game. In addition, during rainfalls, the field is filled with water and the game terminates, which suggests that floods interrupt functioning of people and the surroundings. Since the field is dug in, the problem of precipitation, discharge would be resolved via drainage.

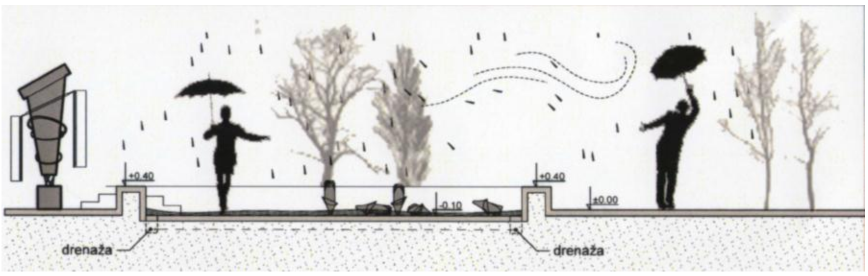

Figure 3. The “benchmark“ during rain

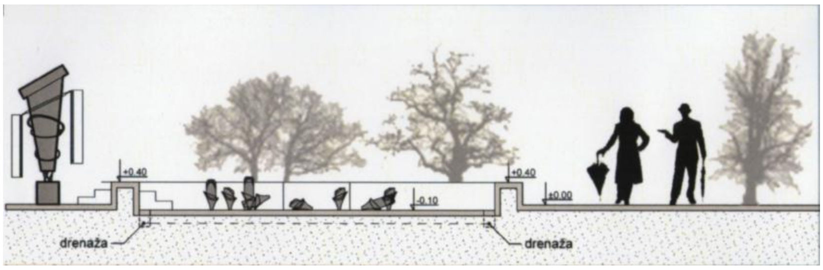

Figure 4. The “benchmark“ after water has been discharged

The figures in the chess field follow the concept of vertically set “benchmark“, namely they are of the conical shape, each figure being typical in its own way without disturbing the concept of the structure as a whole. The dimensions and material that the chess field would be made of depend primarily on its location, but it certainly should not disturb the concept of the surroundings and surrounding structures.

CONCLUSION

Despite a relatively high level of protection against floods, nature can often surprise us unpleasantly, which, in extreme cases, leads to over spilling of rivers from their beds. In such case, only a fast and efficient intervention can prevent large scale damages on economic and residential structures. That is the main purpose of the “benchmark“ that serves to warns on floods. The result of the overall project should show and contribute to better information of people on floods, warn them on potential consequences and serve for recreation and enrich visually the selected site.

However, the problem with floods cannot be resolved by such an “urban benchmark“. If such type of benchmark would be used in all the countries, namely cities and villages through which the Danube flows, and if those benchmarks would be connected, much higher efficiency and speed in resolving of problems that we are faced with today would be achieved. The possibility to accomplish the connection of the “urban warning benchmark for the citizens of Novi Sad on threat of floods“ would contribute to better informing of people and eliminate in such a way or minimise potential consequences of floods in the future. This benchmark can also have a wider application, in particular in places with smaller rivers and places where floods have already occurred previously or places where there is the possibility of their occurrence. This type of benchmark used to warn on the threat against flood is a novelty and there is nothing similar to it in practice.

REFERENCES

INTERNET: http://www.turizamns.rs/istorija-2/
INTERNET: http://www.vodacom.co.me/mne/marketing/rekli-su-o-vodi
INTERNET: Wikipedia, Dunav, http://sr.wikipedia.org/sr/Dunav
INTERNET: Wikipedia, Novi Sad, http://sr.wikipedia.org/sr/Novi_Sad
Milošev Žarko: Poplave u Novom Sadu tokom prostornog razvoja grada 1770 - 1965

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INFRASTRUCTURAL VULNERABILITY OF BUILDINGS TO EARTHQUAKES IN KRALJEVO MUNICIPALITY

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ABSTRACT

Abstract - Task of this paper is vizualization of infrastructural voulnerability on earthquaqes in the area of Kraljevo municipality and also description of Quantum GIS software which is used in this process. Concept of earthquake and seismic activity of Southeast Europe is defined, and the special attention is given to the statistics of earthquakes and protection to earthquakes in Serbia. Further on, SWOT analysis is defined, and the example of SWOT analysis applied on Kraljevo earthquake. The final section of the paper gives description of Quantum GIS program and gives data visualization refering to damage and infrastructural vulnerability after Kraljevo earthquake by using this program.

Key words: Disaster, Risk, Earthquake, Quantum GIS, SWOT Analysis.

INTRODUCTION

Vulnerability may be defined as “The extent to which a community, structure, services or geographic area is likely to be damaged or disrupted by the impact of particular hazard, on account of their nature, construction and proximity to hazardous terrains or a disaster prone area”, according to Khan et al. (2006). Vulnerabilities can be categorized into physical and socio-economic vulnerability.

Exposure to natural hazards has been increased over the years as a result of climate changes and destruction of mangroves which protect coasts of high tie waves. Risks are also being increased as a result of continued concentration of people in highly exposed areas. In the last 20 years, over 1.5 billion of lives have been taken, and over 200 billion of people has been affected. Over 90% people exposed to disaster lives in developing countries, and over half of deaths caused by disasters have happened in countries of low HDI (human development index). Possibility of adaption is being violated by decreasing social protection, safety nets, poorly built infrastructure, chronicle diseases and conflicts.

CONCEPT OF VULNERABILITY

There is a strong connection between the state of environment, human welfare and vulnerability. Understanding of influence of changes related to environment and changes which are not related to environment on human welfare and vulnerability is crucial for addressing challenges and opportunities for improving human welfare, and protecting the environment at the same time. Vulnerabilities are often led by actions taken at long distance, emphasizing mutual connections over the world. This can provide strategic guidelines for making regulations for decreasing vulnerability and improvement of human welfare.

The concept of vulnerability is an important addition to traditional risk analysis, which was primary based on natural hazards. Vulnerability has become the center of studying of food insecurity, poverty and climate changes. While the earlier researches gravitated towards opinion that vulnerable people and communities are victims of environmental and socio-economic risks, more recent works emphasize capacities of affected groups to anticipate and fight the risks, and capacities of institutions to improve resilience and adaptation to changes.

VULNERABILITY ASPECTS

Although vulnerability is specific to location, usual elements could be observed trough several regions, ranges and explanations. Certain problems of vulnerability such as equality, import and export of vulnerability from one to another location, or generation, and causal connection with conflict, hazards and environment need special attention, because they represent strategic entrance points for effective vulnerability and regulations reduction.

Inequality, justice and vulnerable groups

Vulnerability has variety of categories, between man and woman, rich and poor, very young and old, women and children are the most vulnerable groups to multiple pressures.

Import and export of vulnerability

In many cases vulnerability is created or increased with distance, trough causal relations which survive long distances in space and time. Many archetypes of vulnerability displaying phenomenon of "vulnerability export". Vulnerability reduction, for example, through providing shelters, increase vulnerability for others who are far away, for example, trough country degradation and contamination around mining areas, according to Martinez – Alier (2002).

Vulnerability, environment and conflict

Many vulnerability patterns represent potential for conflict. Connection between environmental problems and international and civilian conflict was the main subject for many academic researches after the Cold War, according to Diehl and Gleditsch (2001). Lack and large number of resources could deteriorate existent tensions and they could contribute to conflict between groups, especially in societies with lack of capacity for effective and fair resources management, according to Homer – Dixon (1999) and Kahl (2006).

Vulnerability, welfare and natural hazards

In the last 20 years, natural disasters took more than 1.5 million lives and they affected more than 200 million people annually, according to Munich Re (2004). One of the main triggers of increased vulnerability to hazards is global environmental changing. Natural hazards, such as earthquakes, floods, droughts, storms, tropical cyclone and hurricanes, wild fires, tsunamis, volcanic eruptions and landslides affecting everyone. The most of all they affect poor people. Global data for extreme events suggest that the number of natural hazards is rising, according to EM-DAT (The International Disaster Database). Two thirds of all disasters are hydro-meteorological events, such as floods, storm winds and extreme temperatures.

EARTHQUAKES

Seismic activity, earthquake, is a result of sudden energy release in the crust where seismic waves are created. Earthquakes are recorded with seismometer, also called seismograph. Earthquakes arise because of movement of tectonic plates, Earth movement or appearance of impact with consequences such as tremble of crust as a result of large energy release. Earthquakes have variety of consequences such as geological change, damage of environment and property made by human and they have great influence on human life. They could cause dramatic geo-morphological changes, including horizontal and vertical Earth movement. Consequences of earthquakes are: landslides, avalanches, fires, floods, volcanic eruptions and tsunamis.

SEISMIC CHARACTERISTICS OF SOUTH-EAST EUROPE

Term Southeast Europe refers to the whole area of Balkan Peninsula, a part of Panonian plane, Vlach depression and parts of Carpathian Mountains, and some include Asia Minor to this region. The most active seismic areas were placed on Adriatic area, west and north Macedonia, and south Serbia, especially area around mountain Rudnik and river Morava. The least active area was Carpathian-Balkan area with only minor impacts.

Seismic areas in Serbia

Serbia does not lie in the area of high seismic activity, but earthquakes which can take place there have magnitude up to 5.8 degrees of Richter's scale. By its force, this kind of earthquake can be devastating. According to experts, earthquakes in Serbia can reach maximum of 6.3 degrees of Richter's scale, because of its location.

Data in The International Disaster Database (EM-DAT) about Serbia are listed only from 1989. and are used for understanding vulnerability and hazards. Number of events which occurred during the years since 1989. to 2006. show that the most frequent hazards were related to technological hazards and hazards related to floods. According to EM-DAT, other hazards which occurred in this period and their frequency shown in the percents are presented in Figure 1:

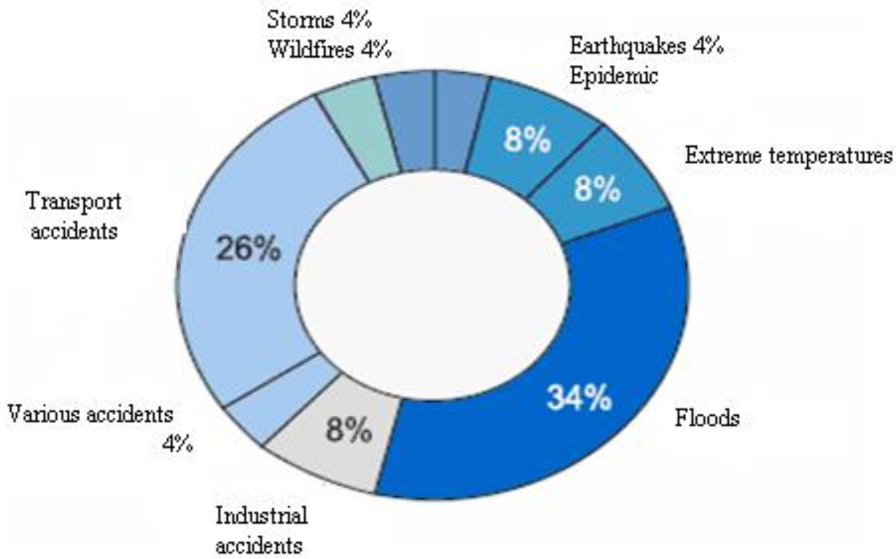

Figure 1. Distribution of various hazards in Serbia (1989.-2006.)

OBJECT STANDARDIZATION IN KRALJEVO MUNICIPALITY

Macro-seismic intensity scale used to evaluate the severity of ground shaking on the basis of observed effects in area of the earthquake occurrence is called the Medvedev – Sponheuer – Karnik scale (MSK-64). This scale includes only three types of constructions such as:

A: Buildings made of rough stone, rural buildings, buildings made of adobe brick, houses made of clay.

B: Basic buildings made of bricks, buildings made of large blocks and buildings made of prefabricated materials.

C: Buildings made of reinforced concrete and solid built wooden buildings.

SWOT ANALYSIS

One of useful tools used to estimate ability of community or organization is called SWOT analysis. The name SWOT analysis was made of first letters of words Strengths, Weaknesses, Opportunities and Threats.

Strengths and weaknesses are usually considered as “internal affairs” of community, while opportunities and threats are “external”. It is important to consider “internal” strengths and weaknesses of the community as well as outside strengths which can affect it. Strengths are unique abilities on which you can build your success, while weaknesses are areas on which you must work on and where you must strengthen your community. Opportunities are “external” strengths which can help you to achieve your goals, while threats are those strengths which can work against you and you must try to avoid or reduce their influence.

SWOT analysis example of Kraljevo earthquake

Strengths

- Serbia doesn't have high seismic activity, but earthquakes which take place in this area can reach magnitude up to 5.8 degrees on the Richter scale.
- After the earthquake people of Kraljevo were very united and showed great will to help out each other and provide help for the victims.
- Seismological survey of Serbia monitors seismic activities in Serbia on daily basis, which represents one of early warning systems.

Weaknesses

- Community, people, nor State was not prepared to cope with earthquake of this kind of force.
- There is not appropriate governmental Disaster Agency on community level, made of experts in field of disaster risk management.
- In emergency situations coordinator in all actions is Ministry of Interior of Serbia, which does not have many experts in this area.
- People do not have proper education about disasters and how to behave when a disaster strikes.
- Even though it is well known that Kraljevo lies in area of high seismic activity, the constructions were not built with enough resilience.

Opportunities

- To demand budget for creating governmental Disaster Agency made of experts in this field, which could cooperate with Seismological survey of Serbia in order to make public states and orders in case of emergency situations. Governmental Disaster Agency would also be responsible for monitoring of all natural hazards, as well as for analyzing risk and vulnerability in order to decrease damage due to natural hazards.
- Also, governmental Disaster Agency should organize public seminars in order to raise public awareness to a higher level, and train people how to react in case of a disaster.
- Adopt law regulations which make the governmental Disaster Agency in charge of all actions in case of emergency.
- Adopt a budget for catastrophe damage reparation and thus shorten the time for providing necessary help for population.
- It is necessary to pay more attention on construction and object strengthening during housing development to reduce possible earthquake damage.

Threats

- In Serbia, catastrophe preparedness is on a low level, whether it is natural or anthropologicaly provoked (political, economical etc.). Most recent examples are world economic crisis and

Kraljevo earthquake – people are receiving financial help after one year and construction material is for now only part of the promise.
- Previous shows that it is very hard to get budget funds for creation of governmental Disaster Agency for environmental protection. Even if formed, question is would actual experts would be part of this team, or people with most financial influence.
- In most cases, investor for construction of infrastructure is not chosen according to solid building plans but usually political influence.

VISUALIZATION OF DATA ABOUT DAMAGE AND INFRASTRUCTURAL VULNERABILITY AFTER EARTHQUAKE IN KRALJEVO MUNICIPALITY USING QUANTUM GIS APPLICATION

Geographic Information System (GIS) is a software tool used to manage geo-spatial data and their attributes. Most simply put, it is a computer application used to integrate, store, arrange and display information. GIS is a tool which uses “smart geography cards” and gives possibility of making inquiries about data that comes from a research of users by analyzing spatial data and arranging it.
GIS is made of four interactive components: system for data import, which converts maps and other spatial data into digital form; system for storage and connecting data; system for data analyzing; system for exporting maps, tables and answers to inquiries made earlier.
Programmes of GIS:
- Global Mapper
- ESRI Arc View
- MapInfo Professional
- Quantum GIS

Quantum GIS enables integration with other open source GIS tools including PostGIS, GRASS GIS and MapServer to achieve wider usability.

Spatial distribution of infrastructural vulnerability of objects affected by earthquakes in Kraljevo municipality is presented using Quantum GIS application. The visualization is performed based on the data collected in table of attributes which shows information about earthquake epicentre, class of object on the given location, damage degree and damage amount.

Software Quantum GIS was used with purpose of visualisation of infrastructural vulnerability based on different degree of damage in different municipalities by presenting each degree with different colour on map. And because of that we first classified damage degrees in table of attributes and than we assigned different colour to each degree of damage, as shown in Table 1.

Table 1: Degrees of damage and their colour on map

Degree of damage:	**Colour on map:**
0	Green
1	Blue
1,2	Blue
2	Yellow
2,3	Yellow
3	Purple
3,4	Purple
4	Red

As the final result of this work, a map with all damage degree presented with different colours is generated, as shown in Figure 2. Purpose of this map is easier identification and classification of infrastructural vulnerability in order to decrease it, as well as human vulnerability.

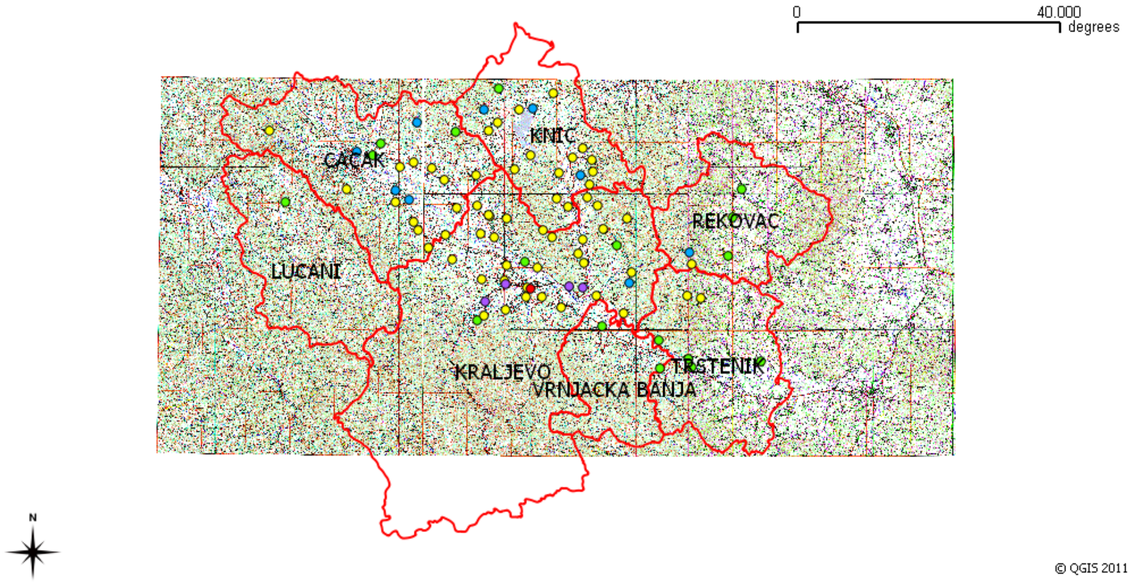

Figure 2. Visualization of data by degree of damage in municipalities affected by earthquake

CONCLUSION

This paper describes one of the possibilities of practical use of Quantum GIS application for earthquake analysis with the purpose of presenting spatial distribution of infrastructural vulnerability of objects in area affected with earthquakes, with accent on Kraljevo municipality. Main goal of this usage is to decrease infrastructural vulnerability, therefore also human vulnerability. Results of practical Quantum GIS application contribute to actual catastrophe risk decrease and efficient accidental risk management.

REFERENCES

Blaikie, P., Cannon T., Davis, I. & Wisner, B. (1994). At Risk: Natural Hazards, People’s Vulnerability and Disasters. *London, Routledge*.

Kingston J., & Lambert D. (1982). Catastrophe and crisis. *Narodna knjiga*, Beograd.

Villagran De Leon, H.C. (2006). Source 4-Vulnerability, conceptual and methodology review. *UNU-EHS Publications, No.4*

United Nations Environment Programme (2007). Global Environment Outlook GEO 4 environment for development. *Chapter 7 Vulnerability of People and the Environment: Challenges and Opportunities*

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ELECTRICAL INSTALLATIONS AND LIGHTNING PROTECTION SYSTEMS EXAMINATION AS A PRECAUTIONARY MEASURE TO ACCIDENTAL SITUATIONS IN URBAN AREAS

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ABSTRACT

In this paper the importance of electrical energy is presented as one of main causes of accidental situations in urban areas wich are manifested as fires and explosions. Electrical meausurement is also pointed out as an component of precautionary engineering whose aim is to minimise the risk of emerging such situotions. Specific data on the condition of electrical and lighting installations in public and industrial buildings on the Zrenjanin municipality territory are presented, as well as the need for their constant monitoring coming from the existing regualtions, but also from the real need to make exploitation of electrical installations in this respect maximally safe.

Key words: Electrical measuring, preventive engineering, fires, explosions, electrical energy

INTRODUCTION

Fires and explosions are categorized as accidental situations deserving growing attention in urban areas recently. On the one hand that refers to the consequences of such accdidental situations, reflecting not only in a high level of destruction of material goods and the pollution of environment, but in great number of cases, in resulting in human casualites as well; on the other hand, increasing attention is paid to preventive actions during projecting, construction and exploitation of buildings and installations, in order to prevent such accidents in the future.

FIRES AND EXPLOSIONS

Fires

The fire is generally defined as an uncontrolled combustion causing material damage or endangering human lives. The combustion is a complex physical-chemical process in which chemically tied heat is released as a result of oxygen tying to the combustible ingredients of the material.

To start the combustion process there must be:

- combustible material
- air (oxygen)
- source of heat (energy)

If any of these conditions is eliminated, the combustion process is stopped.

Explosions

The explosion is a chemical or physical process taking place as a rapid increase in the volume and energy release, which is as a rule folllowed by generation of a high temperature and gas releasing, which results in fires in most cases.

All explosions can be divided into two basic groups:
- mechanical explosions
- chemical explosions

Mechanical explosions are a clearly physical phenomenon, a consequence of decomposition of vessels under pressure. They are followed by devastation effects and shock waves and so on. In mechanical explosions there is no heat release as a consequence of the chemical reaction, but a fire can occur as a consequence of firebox devastation, as a result of the damage to electrical installations capable of combustible material igniting.

Chemical explosions are processes of a rapid combustion of certain substances during which a great quantity of heat is released and large overpressure is created. These explosions are followed by a supersonic shock wave causing sound effects.

ELECTRICAL ENERGY AS THE CAUSE OF FIRES AND EXPLOSIONS

Statistical data

Electrical energy is a frequent cause of fires and explosions in practice. There are many statistics showing that 10-25% of all fires and explosions are a result of the termical action of the electrical energy.

Statistical data of the state autorities on such accidental situations on the territory of Serbia are given (table 1 and 2). According to these data in can be seen that one quarter of total number of fires and explosions in Serbia are caused by electrical energy. More than two thirds of these are caused by short circuit in electrical installation. [1]

Table 1: Total number of fires and explosions in Serbia during the preiod 2004.-2009. [1]

Year	*2004.*	*2005.*	*2006.*	*2007.*	*2008.*	*2009.*
Total number of fires and explosions	*5147*	*5256*	*5709*	*6948*	*6573*	*6168*
Total number of fires and explosions during the preiod 2004.-2009.					***35801***	

Table 2: Total number of fires and explosions during the period 2004-2009. caused by electrical energy by years [1]

Year	*Electrical device and appliances*	*Short circuit*	*Overloaded conductors*	*Lightning*
2004.	*422*	*914*	*49*	*23*
2005.	*411*	*1067*	*45*	*36*
2006.	*252*	*1188*	*37*	*51*
2007.	*164*	*638*	*34*	*34*
2008.	*205*	*754*	*52*	*56*
2009.	*314*	*685*	*45*	*63*
Total	***1768 (23,5%)***	***5246 (69,6%)***	***262 (3,4%)***	***263 (3,5%)***
Total number of fires and explosions during the period 2004-2009. caused by electrical energy				***7539***
Percentage of fires and explosions caused by electrical energy in the relation to total number fires and explosions during the period 2004-2009. in Serbia				***25,8%***

The following review of the caueses of fires is based on an analysis of more than 25000 recorded fires during the period of ten years in a highly developed industry. This analysis is made credible by the number of the fires recorded and the period of time, with a remark that most fires took place in industry.

The causes, given in percentage, are sorted by their frequency in industry: electrical energy 24%. This is the leading cause of industrial fires. The greatest number of fires occurs in installations, conductors, engines, transformers and distribution systems.

Other causes are given in the table:

Table 3: Percentage of various causes in fires and explosions

smoking	*friction*	*overheated metals*	*overheated surfaces*	*open flame*	*infammable sparks*	*selfingnition*
18%	*10%*	*8%*	*7%*	*7%*	*5%*	*4%*
cutting and welding	*exposure to fire*	*intentional ingnition*	*mechanical particles*	*boiling materials*	*chemical processes*	*other causes*
4%	*3%*	*3%*	*2%*	*2%*	*1%*	*1%*

In European countries with the fires causes statistics, it has been stated that electrical installation failures in residential buildings are the cause of about 15-20% of the total number of fires. During the period of 1988-1998, the number of fires caused by electrical installation failures increased by 25% and there is tendency of its further increase [2].

This indicates that, due to the constant increase in the number of electrical consumers and the „aging“ of electrical installation in residential, business and public buildings, there is a tendency of increase in number of fires and explosions caused by electrical energy.

The latest statistics of the National Fire Protection Association [3], available for 1993-1997 in the USA are that 41,200 home structure fires per year are attributed to electrical distribution. Fires are caused by electrical failures accounted for 9,7% of the total number of fires occured in the period viewed in the USA, due to which they are ranked fifth in the total of 12 most frequent types of fires (sorted by their cause).[4]

Table 4: Causes of US residential fires due to electrical distribution [4]

Cause of fire	*Percent*
fixed wiring	*34,7*
cords and plugs	*17,2*
light fixtures	*12,4*
switches, receptacles, and outlets	*11,4*
lamps and light bulbs	*8,3*
fuses, circuit breakers	*5,6*
meters and meter boxes	*2,2*
transformers	*1,0*
unclassified or unknown electrical distribution equipment	*7,3*

Annually, in the USA an estimated 28,300 residential building electrical fires cause 360 deaths, 1,000 injuries, and $995 million in direct loss. [5]

THERMICAL EFFECT OF ELETRICAL CURRENT

Going through conductors, coils and other devices, a part of the electrical current turns into heat. the quantity of the heat developed in this way, according to joule's laws:

$$Q = I^2 \cdot R \cdot t \ [J]$$

where *Q [J]* is the heat generated by a constant current *I [A]* flowing through a conductor of electrical resistance *R [Ω]*, for a time *t[s]*.

All electrical circuits in electrical installations have to be sized and performed to make the insulation and wire size capable of enduring this heat release (Joule`s losses) occuring while electric current flows in the normal mode of the electrical instagllation.

If there is conductor overheating, there can be damage to the insualtion and igniting of an easily flammable substance nearby.

FAILURES ON ELECTRICAL INSTALLATIONS AS CAUSES OF FIRES AND EXPLOSIONS

The most frequent damages and failures on electrical installations with can be causes of fires are:
- short circuit
- overloading
- high contacts ressistance
- mechanical and thermical damage
- overvoltage

Short circuits are most often a result of a damage or breakdown od the insulation, conductor cut under voltage etc. The short circuit is a phenomenon in electrical installation where is mutual joint of wires at different potentials with small resistance. The total resistance of the electrical circuit at the moment of the short circuit suddenly decreases, which results in a sudden increase in current in relation to normal mode.

In the place of short circuit there are resistances consisting of the generated electric arc resistance and the resistances of the other parts of the electric circuit. In most cases the short circuit resistances are low so they can be neglected.

In the place of short circuit there are characteristics tracks manifested as melted conductors and other parts of the installation and device, due to the electric arc generated, whose temeprature can be 1500-4000°C.

The main causes of short circuit generation are damages to the electric conductors insulation. The possible causes of damages to the electric conductors insulation in a concrete case are multiple:
- „weak“ contact on the electric system which are high transitional resistance which can cause overheating or sparking near a flammable substance,
- mechanical damage to the cinductor,
- damage to the conductor due to animals (rodents),
- „aging“ of the insulation due to overloading or increased temepratures of the conductors over an extended period, resulting in losing of the normed performances, defined by standards and technical regulatives concerning insulation.

All the facts mentioned above reffers to the short circiuts resulting from various failures existing before the fire breaks out, but short circiuts resulting as a consequence of the damage to the insulation from the heat of the fire must also be taken into account. Thus short circiuts can be divided into:
- primary short circiuts which are the cause of the fire
- secondary short circiuts which are the consequence of the fire

In order to estabilsh which of those types we deal with, it is necessary to subject samples of the conductors from the centre of the fire to the metal-graphic and X-ray examination. (The structure of melted conductors is different because secondary short circiuts conductors are melted without the presence of oxygen).

Overloads (temporary or permanent exceding the allowed values) of the conductors occur due to an incorect selection of the wire size of the cables and conductors. Overloading leads to overheating of the conductors which causes accelerated insualation “aging”, damage to the insualation and finally breakthrough (short circiut).

This is prevented by the correct sizing of the equipment and correct selection and setting of overloading protection devices.

High contact ressistance occurs due to incorrectly performed contacts („weak“ connection) or contacts occuring due to the contact site oxydation. High contact ressistance causes the increase in temperature at those sites which results in accelerated „aging“ and damage to the insulation.

Mechanical damage can cause failure either immediately (conductor breakage or short circiut) or lead to the failure due to partial damage after some time because of moisture.

This is prevented by correct selection and setting of the equipment (providing protection from mechanical influence, if necessary). A part from mechanical damage, the insulation can also be damaged due to „aging“, moisture and aggressive surroundings.

Overvoltage causes accelerated insulation „aging“, breakages and damage. This is prevented by correct selection of the equipment, that is, the equipment has to be conected at the regular voltage.

The above mentioned failures can be caused by:

- error in manufacture
- thermical action of electric devices
- disobeying the installation and usage instruction etc.

EXAMINATION OF ELECTRICAL INSTALLATIONS AND LIGHTNING PROTECTION SYSTEMS

Examination of electrical installations and lightning protection systems has been growing in importance in the last 20 years in terms of preventive engineering both in industry and other buildings. There are a number of reasons for that, but it is predominatly a growing attention paid to the system of prevention of accidental situations like fires and electric shocks on one hand growing affordability of measuring devices which used to be very rare and expensive.

Examination of electrical and lighting installations has become a component of the obligatory regulations in most countries in the last 20 years, within the occupational safety and health system and electric power distribution companies practice.

It is in that period that the standards of electrical energy quality examination have been organised (standard EN50160) and of electrical installation examination (standard EN61557) while the lighting installation is performed according to the standard IEC 1024-1, in accordance with the procedure from the SRPS N.B4.802 national standard.

Table 5: Types of examination of electrical installations defined by standard

Types of examination	Standard
AC voltage testers	EN 61557/1
Insulation resistance ohmmeters	EN 61557/2
Earth fault loop impedance testers	EN 61557/3
Low-resistance ohmmeters	EN 61557/4
Earth electrode resistance testers	EN 61557/5
RCD testers	EN 61557/6
Phase sequence	EN 61557/7

AN EXAMPLE OF EXAMINATION

Within its regular activities Technical faculty „Mihajlo Pupin“ performed examination of electrical installations and lightning protections systems in 43 public and industrial buildings (schools, health institutions, workshops, warehouses etc.) in the period 2008-2010.

Over 90% buildings examined were older than 20 years, so the results can well be used as quality monitoring of electrical installations maintenance. Over 80% of the installations examined were performed in earthing systemTN-C-S, while the remaining ones were of TT earthing system**.**

The complete sample of the examination was considered as the first electrical installation examination since the beginning of the exploitation.

More than 95% of the lightning protections system had been examined before periodically according to the existing regulation.

The number of measurement places on the given sample of electrical installations examination is 2576.

The number of measurement places on the given sample of lightning protection systems examination is 387.

Table 6: Percentage of malfunction found by examination of electric installation on a sample of 43 buildings during the period 2008-2010

	Types of malfunction				
	breakage PE conductor	faulty protection devices	faulty insulation	faulty equal potential safety	unmarked electric circuits
The number of measurement places: 2567	206	129	103	232	2215
Percentage of malfunction	8%	5%	4%	9%	86%

Table 7: Percentage of malfunction found by examination of lightning protection system on a sample of 43 buildings during the period 2008-2010

	Types of malfunction		
	breakage down conductor	high earthing ressistance	inaccessible measurement places
The number of measurement places: 387	48	17	27
Percentage of malfunction	12,4%	4,4%	7%

It is also interesting that there was no regualtion before 2008. which would make compulsory periodical examination of electrical installation in buildings which were not considered to be industrial production facilities.

PE conductor breakage is not as relevant from the fire danger point of view as it is for the basic protection electric shock. Every electric socket without PE conductor represents potential danger for human lives.

Faulty protection devices are one of the greatest dangers because they cannot timely break malfunction place loading, which results in further development of the malfunction. This is especially important with impovised fuses, which use their original purpose which is the protection of installations from short circuit and overload.

As it has already been mentioned, a faulty installation is the basic fire risk with electrical installations. Malfunction of equal potential safety especially in boiler rooms, is a great explosion risk, and in rooms with water installations it is represents a risk of electric shock.

A surprisingly percentage of unmarked electric circuits disables quick operation of turning off individual consumers, which is crucial for making this operation efficient.

All these kinds of malfunction which are found by electrical examination require urgent repair, both from the fire safety point of view and electric shock safety.

It can be noticed that the condition of lightning protection system on the sample processed, despite the legal obligation of periodical examination, is generally worse than that with eletrical installations, which can be explained by these installations permanently being exposed to elements, which causes weakening or breaking contacts on the air-termination and down-conductor system.

In recent years it has become more frequent to install air-termination rod with device for early streamt emission, which have only two down-conductor, thus reducing the number of connections, apt to damage and breakage.

CONCLUSION

In this paper the importance of electrical energy is presented as one of main causes of accidental situations in urban areas wich are manifested as fires and explosions. It points out the trend of permanent growth in number of electrical consumers and „aging“ of electrical installation in residential, bussines and public buildings, the trend growth in number of fires and explosions caused by electrical energy. Electrical meausurement is also pointed out as an component of precautionary engineering whose aim is to minimise the risk of emerging such situotions. Concrete data of the condition of electrical installations and lightning protection systems in public and industry buildings on territory of Zrenjanin munipicality, shows that level of risk of fires and explosions caused by failures of electrical isntallations and lightning protections systems is not negligible. This shows that precautionary engineering has to be a permanent action of consumers of electrical intallations. It is also pointed out that this kind of periodic monitoring enables quality emergency maintenance of electrical installations and lightning protection systems, because it shows the exact place, number and nature of failure.

REFERENCES

Statistical data of Ministry of Interior, Sector for emergency menagment, Republica of Serbia

European Copper Institute,“Overview of electrical safety in 11 countries“, Barcelona, 2002.

Rohr, K. D., The U.S. Home Product Report (Appliances and Equipment Involved in Fires), Fire Analysis & Research Div., *National Fire Protection Assn., Quincy MA (2000)*.

Babrauskas, V., How Do Electrical Wiring Faults Lead to Structure Ignitions? pp. 39-51 in *Proc. Fire and Materials 2001 Conf.,* Interscience Communications Ltd., London (2001).

Topical fire report series „Residential building electrical fires“, Vol. 8, Issue 2, March 2008.

Measurements on electric Installations in theory and practice Instruction manual, *Code: 20 750 664,* Metrel.

ENVIRONMENTAL ASPECTS OF TRAFFIC IN URBAN AREAS

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THE TOWNSCAPE AND THE IMPACT OF TRAFFIC TO THE CITY AS ECOSYSTEM

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ABSTRACT

The process of urbanization leads to rapid expansion of cities. Fast migration processes from village to city have created major problems in the new urban environment. Urban areas are characterized by high density of development and population, as well as dysfunctional transport and infrastructure. In addition to being the single largest cause of air pollution and noise in the city, traffic occupies a large part of the urban area, and thus significantly influences the image of the city. City landscape areas are mostly made of artificial materials, and to a much smaller part consist of green spaces, which are of great importance for the urban man. Apart from fulfilling a biological requirement, greenery in cities is also a visual and aesthetic element. The battle for space between built-up and green areas has always resulted in favor of the first. One solution is to implement the underground transport - subway and parking spaces located beneath the surface of the city, which has long been applied in the metropolises around the world. Planning of traffic must be done parallel with the planning of all elements of the urban environment in order to reduce the negative impact of transport on the environment as much as possible.

Key words: traffic, urban environment, townscape.

THE TOWNSCAPE

The urbanization process, caused by the process of industrialization and development of the tertiary sector, as well as the population explosion and many other factors, determines the forms of the town.
Standardization of large serial building elements is basically the monotony of the village and the physical structures intended for housing. In social terms, the lack of identity space, mono functionality, uniformity and impersonality of urban environments are one of the causes of alienation of the urban population. (Radović, 2003.)

To meet the growing demands and needs of a growing population in towns, it was necessary to increase the scope of exploitation of natural resources. This way natural landscape is greatly changed, but the change is also influenced by pollution emanating from the treatment process of raw materials, increasing number of transport links and plenty of waste that occurs as a result of modern living. The principles and criteria of sustainable development are based on urban ecology and have significant impact on urban planning.

The visual character, the image of a city, to a large extent is formed not only by relief, hydrological and architectural peculiarities, but also the character, distribution, status and the attention paid to ornamental plants embedded in city streets, squares and other green areas. Architectural aesthetic role of vegetation is such that emphasizes the beauty of objects, and if necessary, mask the ugly facades and auxiliary facilities. While planning, it must be taken into account that the plants are *living material* which changes color and shape during its growth.

Coloristic characteristics of ornamental plants of the city, though often treated as an endless repetition of different shades of green, complement and complete the aesthetic characteristics of plants as urban elements which make life of the urban population easier and more beautiful. Almost every color of plant species used in the urban environment is a treasure in it self, and even more when it is confronted with the gray concrete urban areas. All of this leads to striving towards unity and the humanization of the city as a human environment, and achieving harmony.

Mass as an expression of the spatial character of ornamental plants represents an element that comes in a variety of artifacts relating to the masses of urban landscapes in which the irregular, natural shapes are clearly opposed to regular stereometric forms of buildings. Relations of symmetry and contrast, which can be achieved by deliberate use of repetition of the same or different plant elements (type, age of the individual, looks of the foliage, etc..), will make a monotonous landscape of the city center streets quite different, more aesthetic and psychologically more worthy.

Large green ranges, green blocks, representing the lungs of the city significantly affect the health of residents. Broken by thick foliage, monotony of the blocks is a lot more pleasant. Green blocks expand and grow into the urban tissue and satisfy man's need for coexistence with nature.

Forest parks are often converted to urban parks due to the increase in urban construction. The expansion of cities, raising the settlements (industrial, rural, tourism, holiday resort) on the edge of the town, often disrupts the silhouette of the city and rarely fits into the landscape. These settlements bring major changes in landscape values. Their construction and their further expansion, increases the volume of pollution and more disrupts the natural harmony in the area.

TRAFFIC

The impact of traffic on urban ecosystem

Since the beginning of the twentieth century, even the world's largest cities did not feel the burden of the traffic problem. A real transport revolution occurs with the appearance and larger use of motor vehicles, especially passenger cars. The development of public transport and increase of the motorization leveled to such a spatial expansion of cities so that today many cities are facing the real traffic collapse. A large number of cities today is characterized by traffic congestion, an increasing number of traffic accidents, the growing losses of public transport organizations and a high degree of environmental pollution. Traffic in the suburbs, as well as in the city centre, is one of the most important components which along with housing, utilities, industry and green areas makes an integral part of the city's system. Looking from the protective and ecological point of view, we can note that traffic significantly affects the environment by polluting the air in cities, making noise and taking up urban areas. In addition, it is a significant consumer of energy. Its functioning and existence as a function of economic and social relations in the city and region, in addition to pollution, irreversibly undermines the natural balance of ecosystems.

Motor vehicles produce a third of all toxic substances on earth emitting more than 90% of carbon monoxide, 80% of hydro carbons and 50% of nitrogen oxides. Other factors such as: weather, traffic regulation, speed, flow and traffic density, width, rise and fall of the streets and the state of vegetation influence on the level of pollution. The low level of the transport system in cities is represented by the poor condition of the street network and inappropriate street profile, inadequate organization of public passenger transport, unsatisfactory traffic management and poor conditions of stationary traffic (parking spaces). This state of the transport system in cities indirectly impacts on increasing level of air pollution, which is actually a direct consequence of the increased volume of motor traffic and mobility.

Public transport is a major source of noise and creates more than 80% of noise in cities. In addition to motor vehicles, traffic noise problem gets more complex with traffic conditions in cities, in which significantly greater number of vehicles than the number of vehicles for what the streets were planned and designed ranges in already established urban units, and the facades of buildings, arranged in a continuous row on both sides of pavement allow multiple reflection noise.

The impact of traffic on townscape

In addition to air pollution and noise, urban transport affect the environment by taking a large part of the urban area. Cars are the biggest consumers of the urban area from all forms of public transport. For normal traffic of motor vehicles, except the street network, large areas of urban land are required for parking spaces.

Parallel and simultaneous planning of the transport system, with the land-use plan and other elements of the urban system would certainly contribute to better organization of cities and reducing environmental pollution. Equal distribution of activities and functions in the land-use plan and the urban space leads to a decrease of long journeys, and short trips can be done so that they don't have any negative impact on the environment (pedestrian and bicycle traffic). This concept of the transport system would not only be partly based on a passenger car as the dominant form of transportation, it would be more directed to public mass transit (subway, trams, trolleys, buses...) and non-motorized modes of transport. Metro planning is the best environmental solution. A pedestrian environment and communication system should be planned for all developments in cities that can be done on foot, that pedestrians do not mix with the motor vehicle traffic. The implementation of the principle of cohesion through a system of continuity of green vegetation in the residential areas, protective greenery, between big business and traffic zones and vegetation in large recreational areas, can contribute to reducing pollution.

Underground urban planning

In tight urban spaces, buildings with high floors and high traffic, the underground urban planning is applied for a long time. It is particularly useful in solving some traffic problems in overcrowded cities for the subway, their stations, underground crossings and the opportunity for opening various trade and tourist facilities. In some European cities, the entire city's underground pedestrian streets are being made with a great number of shops, restaurants and more. The spaces are beautiful architecturally designed and luxuriously furnished. However, seen from the ecological point of view, those spaces have many shortcomings. First of all, the functioning of these extensions needs equipment for artificial air conditioning. That means that regular consumption of large amounts of energy is unfavorable for the people who work in the constant artificial conditions. The negative effects on health, the vision, respiratory system and psyche are difficult to predict in advance, but they are undisputed as the evolution of the human body has not adapted to them. In addition, poverty and isolation environment deprived of any landscape, stifle all human creative capabilities.

CONCLUSION

The impact of traffic on the ecosystem, as well as on townscape is enormous.World metropolis can not be imagined without a major network of roads, where all the transport of goods and people takes place. Cars represent a permanent factor in air pollution, especially in urban areas. Therefore, it is necessary to plan and implement the ecological aspects of traffic (pedestrian and bicyclepaths, underground). The green areas are the largest assistant to combat air pollution, therefore traffic should be placed next to green corridors, which will contribute to the convenience of traffic, especially pedestrian separation from motor traffic. Thus, the townscape next to the areas intended for traffic, will be enhanced with greenery.

REFERENCES

Anastasijević, N., & Vratuša, V., (1999). „Analiza estetske vrednosti biljaka u formiranju slike velikog grada“, *Zbornik radova Ekološkog pokreta grada Novog Sada, I tom,* Novi Sad, 445 – 450.

Vujković, LJ., (2003). „Pejzažna Arhitektura – planiranje i projektovanje“, Univerzitet u Beogradu, Šumarski fakultet, Beograd, 201.

Dunčić, D., & Protić – Eremić, Lj.,(1995). „Saobraćaj i životna sredina u gradovima“, *Zbornik radova Ekološkog pokreta grada Novog Sada, II tom,* Novi Sad, 45-52.

Đukanović, M., (1991). „Ekološki izazovi“, Beograd

Đukanović, M., (1996). „Životna sredina i održivi razvoj“, Beograd

Piperski, J., & Belić, S., (2001). „Urbana ekologija i deep ecology – povratak prirodi na novi način“, *Zbornik radova Ekološkog pokreta grada Novog Sada, II tom,* Novi Sad, 239 – 244.

Radović, R., (2003). „Forma grada“, Orion art, Beograd, 27-28.

IMPACT OF AGRICULTURAL ACTIVITIES TO URBAN AREA

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ORGANOCHLORINE PESTICIDES IN WHEAT AS A RESULT OF ENVIRONMENTAL POLLUTION

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ABSTRACT

The main sources of pollutant organic compounds in environment are a result of human activities such as: traffic, industrial production, energy production, application of agrotechnical measures, and others. Organochlorine pesticides (OCP) are considered to be the most present of all pollutants in natural environment, which reach the consumers through plants i.e. trough food consumption.

According to the recommendations of nutritionists, wheat products should be the most present in daily meal structure so their hygiene and safety are particularly important.

The paper shows basic characteristics and sources of wheat pollution caused by organochlorine and organophosphorus pesticides.

The samples taken from localities in Srednja Bačka i Srednji Banat were tested for the presence of 19 organochlorine pesticides. The samples used for determination of OCP and OPP presence were prepared by extraction using the modified method E 13400 with internal standard and were identified by gas and mass detector. The obtained results of determination of organochlorine pesticides content on the surface of wheat grain account for the need to provide a thorough procedure of grain processing during wheat cleaning in mills with the aim to remove harmful substances from the grain surface and to ensure food safety.

Key words: wheat, grain, environment, organochlorine pesticides.

INTRODUCTION

Pesticides are synthetic compounds used in the natural environment for the purpose of crops protection from diseases and pests and for increase of yield of agricultural production.

Soil is an environment where pesticides are accumulated, but it is also a reservoir of particularly persistent pesticides until they are translocated in plants via root system, get into the air or water from where they enter plants again.

Pesticides enter the soil directly and indirectly. Directly, as a result of controlled use to repel rodents, soil insects, weed, while indirectly pesticides occur in soil with water contaminated with these substances used for watering and irrigation or via surface and underground waters and during plant treatments.

Pesticides may enter the soil by wash-off from the treated plants, settling down from the atmosphere, through plant and animal residues (Nešković, 1988).

Organochlorine pesticides were much more used in the past, but due to their consistency and influence on the environment, their use in developed countries was generally prohibited during 1970s and 1980s of the 20th century (Fatoki, Awofolu, 2003). Numerous researches have proven the presence of these compounds in all parts of natural environment. The most analyzed pesticides are: isomers hexachlorocyclohexane (α-, β-, γ-, δ-HCH), dichlorodiphenyltrichloroethane (DDT) and the compounds developed by its decomposition (dichlorodiphenyldichloroethylene-DDE, dichlorodiphenyldichloroethylene-DDD), hexachlorobenzene (HCB) and the pesticides of cyclodiene group (endrin, aldrin, dieldrin, chlordane, heptachlor, endosulfan) (Fatoki, Awofolu, 2003).

ORGANOCHLORINE PESTICIDES IN WHEAT

Organochlorine pesticides are mainly connected with the organic matter of soil. Due to wash-off caused by atmospheric precipitation and underground waters they enter into other environments such as water systems and sediments (Škrbić et al., 2004). Pesticides reach people mainly via plants, i.e. by food consumption. Raw material for food production taken from areas which are far away from urban and industrial zones usually do not contain large quantities of pollutants, while the contents of contaminant found in it are a result of their atmospheric transfer from long distance sources (Škrbić et al., 2004). Their use is restricted and/or prohibited in many European countries and the USA, but they are still used and produced in many developing countries (http://wa.water.usgs.gov/ccpt/pubs/fs-170-96.html.).

Seed coat is easily polluted by many sources of pollution, above all by microorganism and their metabolites, pesticides, toxic elements residues and other, so special attention must be paid to safety of the raw material meant for whole grain products (Filipović et al., 1998).

Lindane (γ-HCH), an organochlorine pesticide, is very intensively taken up by plants through leaves and root. Wheat sprouts can take up 100mg/kg of lindane from water solution in seven days (Kastori, Petrović, 1993). When found in prescribed concentrations lindane does not cause any harmful effects with plants. When its use exceeds the prescribed quantity the result is reduced seed germination, growth and yield.

Plants may also be surface contaminated by retaining tiny soil particles of several dozens of mm which are mostly retained on lower leaves and lower part of the stem. After harvesting wheat grain contains 120 mg of soil per kg of grain (Pinder, McLeod, 1999). Regardless of the way the pesticides appeared in soil, they are partly adsorbed on soil particles or chemically bonded to other compounds and thus enter the food chain via contaminated soil particles.

MATERIAL AND METHODS

The wheat samples were collected from localities in Srednja Bačka and Srednji Banat. Five different wheat cultivars from each Srednja Bačka and Srednji Banat localities were tested for the presence of OCP.

The samples used for determination of OCP presence were prepared by extraction using the modified method (AOAC 970.52/ 1993). The presence of OCP, β –HCH, γ-HCH, aldrin, dieldrin, endrinketone and endrinaldehyde were tested.

10g of sample was measured and then 1μl of internal standard PCB-189 for OCP was added. Extraction was made using Dionex extractor.

Working conditions of Dionex extractor:
- temperature 90^{o} C
- pressure 6900 kPa
- extraction solvent – acetonitrile

After extraction the content was vaporized under nitrogen atmosphere taking care to stop vaporization immediately when the last liquid drop was vaporized.

Reconstruction was done using 1cm^3 hexane mixture: acetone (7:3). The content was put into a vial and closed with a screw cap.

OCP was identified by gas chromatograph with mass detector. Working conditions of Agilent GC 6890 gas chromatograph analysis are shown in Table 1.

Table 1: Gas chromatography working conditions

	OCP
carrier gas	helium
column	DB5-MS 60m, normal diameter 250μm, film thickness 0.10μm
injector	HP 6890
Injection volume	1μl
Injection temperature	285 ^oC
Detector temperature	300 ^oC

Instrument detection limit for organochlorine compounds is 0.005 mg/kg.

RESULTS AND DISCUSSION

The results obtained after testing the wheat samples taken from Srednja Bačka and Srednji Banat localities for the presence of OCP are given in Tables 2 and 3. The content of β-HCH is 1.8-2.2, of aldrin is 2.2-4.7, of dieldrin is 1.45-4.43 times higher than concentrations prescribed in the Regulation (1992).

Endrinketone and endrinaldehyde were also identified in what samples, however the Regulation (1992) does not define the highest quantities of these organochlorine compounds. On the other hand, γ-HCH was within quantities prescribed in the Regulation (1992).

Table 2: Organochlorine pesticides presence in samples of wheat grown in Srednja Bačka County given in ng/g in relation to the dry matter

sample	compound ng/g					
	β-HCH	γ-HCH	Aldrin	Dieldrin	Endrinketone	Endrinaldehyde
Pesma	36	31	35	5	103	<5
	36	30	33	5	100	<5
N. Rana	32	28	18	19	111	23
	32	27	18	19	110	23
Renesansa	38	34	31	5	48	<5
	37	34	30	5	48	<5
Pobeda	38	33	-	20	60	<5
	38	31	-	19	60	<5
Prima	37	33	29	24	19	39
	37	31	27	24	19	37
Mean value	36.1	31.2	22.1	14.5	67.8	12.2
Stan.dev.	2.16	2.27	5.99	7.95	34.04	7.53

Table 3: Organochlorine pesticides presence in samples of wheat grown in Srednji Banat County given in ng/g in relation to the dry matter

sample	compound ng/g					
	β-HCH	γ-HCH	Aldrin	Dieldrin	Endrinketone	Endrinaldehyde
Lasta	44	38	49	73	43	29
	45	37	48	73	43	27
Evropa	47	41	33	6	15	30
	45	41	32	6	16	30
Pesma	41	36	46	5	61	68
	41	37	48	5	61	67
Mina	41	36	46	5	61	68
	44	38	49	6	59	66
Mešavina	47	41	61	132	74	77
	47	39	60	132	75	76
Mean value	44.2	38.4	47.2	44.3	50.8	53.8
Stan.dev.	2.35	1.90	8.93	51.05	20.29	20.55

The paper written by Škrbić et al. (2004) the presence of 16 organochlorine pesticides was tested in durum wheat bran sample. According to this paper there were 4 organochlorine pesticides identified in the bran: p,p'-DDE, endrinaldehyde, endosulfan sulfate and p,p'-DDT, but it should be said that the registered contents of pesticides are only a part of all present quantities regarding the established efficiency of the method.

Comparison between identified quantities of endrinaldehyde in bran (Škrbić et al., 2004) and in tested wheat samples shows a big difference because the values in the bran are lower than 1ng/g, and the endrinaldehyde content in tested wheat samples is 23-70 times higher. Such big differences may be a result of intensive surface treatment of wheat grain in the process of wheat cleaning in mills which precedes grain milling, i.e. separation of flour and bran and the results of this paper are for the wheat which was not cleaned.

Since the maximum allowable concentrations of endrinaldehyde and endrinketone are not established in the Regulation on the quantities of pesticide from 1992 in force, the degree of contamination of tested wheat samples cannot be precisely established, but only the big quantities of tested pollutants. These data point out the necessity of effective cleaning of grain surface and establishment of the pollutants content in wheat after a thorough wheat grain cleaning process as well as the necessity to amend the Regulation on the quantities of pesticide (1992).

Quantities of organochlorine pesticides in relation to the daily bread consumption

Consumption of wholemeal bread enriches nutrition with valuable ingredients found in germs and seed coat, but it should be borne in mind that the safety of a product depends on the presence of pollutants. In our country many production plants are equipped with stone mills used for wheat grain milling immediately before it is used for production of wholemeal products, while at the same time not much attention is paid to hygiene and safety of grain because very often the manufacturers are not familiar with the effect of impurities, foreign matter and damaged grains on the quality of the final product.

The average daily bread consumption is 300 g, and 70-75 g of wheat is needed for 100g of wholemeal bread. Analysis of daily bread and wheat products consumption in human nutrition provides data about daily intake of analyzed OCP shown in Table 4 if the products made from this type of wheat were consumed.

Table 4: Quantities of organochlorine pesticides in relation to the daily bread consumption

	Compound (μg/day)					
	β-HCH	γ-HCH	Aldrin	Dieldrin	Endrinketone	Endrinaldehyde
Srednja Bačka	7.5	6.55	4.64	3.04	14.2	2.56
Srednji Banat	9.28	8.06	9.74	9.3	10.66	11.29
Allowable quantities(μg/day)	4.20	21	2.10	2.10	-	-

Wholemeal bread and pastry can be made only from safe wheat. The obtained results show that an intensive wheat grain treatment including scrubbing is necessary, i.e. wholemeal products can be produced only of the grain whose surface is regularly treated by modern equipment with high efficiency in surface treatment. In other words, it is necessary to remove 3-6% of seed coat and thus reduce the quantity of pollutants whose concentration is the highest on the grain surface. Thus a quality and safe product is obtained, which is beneficial and not harmful for consumers' health (Filipović et al., 2000).

The obtained results (fig. 1) show that the quantity of pollutants retained on the seed coat may be such that it can damage the health of people and livestock, so OCP analysis of wheat grain also after an intensive surface treatment of grain is suggested.

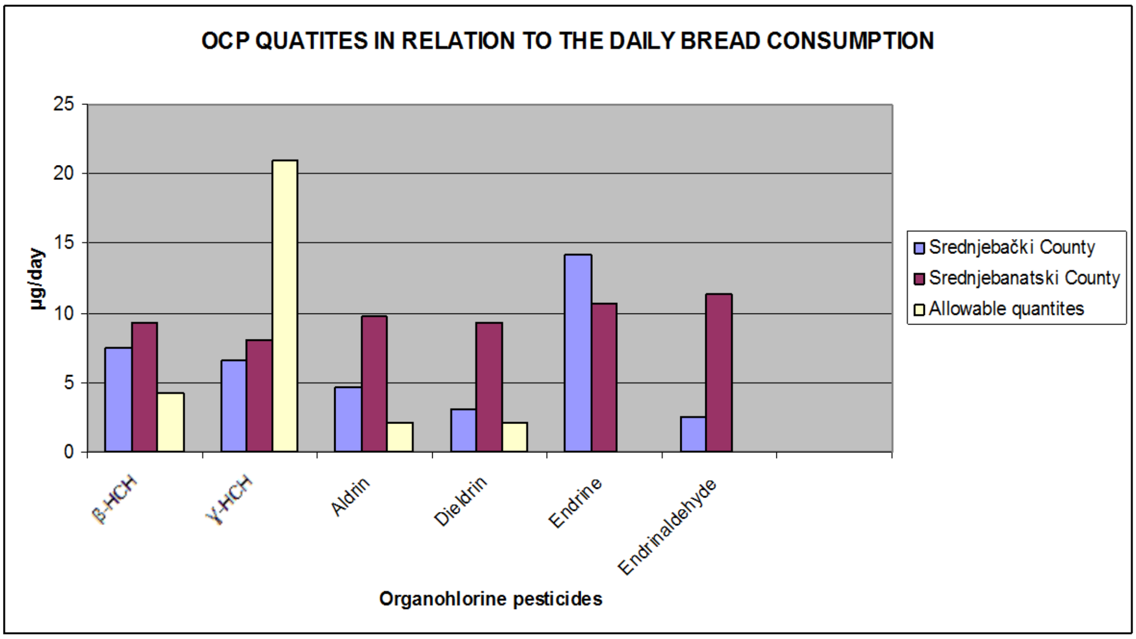

Figure 1. Comparison between daily intake of OCP by consuming products made from analyzed wheat with allowable quantities

CONCLUSION

Based on the results obtained by testing wheat grain grown in Srednjebački and Srednjebanatski counties for the presence of OCP, the following conclusions may be drawn:

- in the tested samples taken from Srednjebački and Srednjebanatski counties higher quantities of OCP were noticed. The content of β –HCH was 1.8-2.8 times higher than the maximum allowable values, the content of aldrin 2.2-4.8, and of dieldrin 1.45-4.43;
- the presence of endrinketone and endrinaldehyde was identified in samples, but although the Regulation on the quantities of pesticide does not establish maximum allowable concentrations, the pesticides were found in the analyzed wheat, so the Regulation in force should be amended;

- the measured values of OCP content point out the necessity of thorough grain treatment process in wheat grain cleaning in order to remove harmful matter from the surface of the grain meant for wholemeal product to ensure safe food;
- intensive surface treatment of the grain ensures removal of harmful matter and dead parts of seed coat which has a positive effect on quality and safety of raw material;
- To produce safe wholemeal food it is necessary to analyze the content of toxic substances in stored wheat grain and the use of adequate procedures of mixing and cleaning may ensure their content reduction within limits prescribed in the Regulation on the quantities of pesticide.

REFERENCES

AOAC 970.52/ 1993.

Camoli I., Fabbrini R., Attias L, Di Musccio A., Cecere E., Consolino A., Roberti F.: Estimation of dietery intake of pesticide residues by the Italian population during 1997, *Food Additives and Contaminants*, 18 (2001) 10, 932-936.

Fatoki, O., Awofolu, R. (2003). Methods for selective determination of persistent organochlorine pesticide residues in water and sediments by capillary gas chromatography and electron-capture detection, *J. Chromatogr. A.* 983, 225.

Filipović, N., Kaluđerski, G., Šarić, M. (2000). Priprema pšenice za proizvodnju hleba od celog zrna, Faculty of Tehnology, Novi Sad, *Acta Periodica Tehnologica* 31, pp. 273-280.

Filipović, N., Kaluđerski, G., Šarić, M. (1998). Primese u pšenici i kvalitet hleba od celog zrna, *Žito-hleb*, 25, 5-6, 149-155.

http://wa.water.usgs.gov/ccpt/pubs/fs-170-96.html.

Kastori, R., Petrović, N., (1993). *Toksični elementi i pesticidi u zemljištu*, Poljoprivredni fakultet, Institut za ratarstvo i povrtarstvo, Novi Sad, str. 55-72.

Levy, S., Griffin, R., Krizner, S. (1999): *Chlorpyrifos: Revised Acuteand Chronic Dietary Exposure Analyses*, october 28,. United States Enviromental Protection Agency.

Nešković, N.(1988). Uticaj pesticida na životne procese biljaka, *Zbornik radova Jug.simp.Pesticidi i njihovo delovanje na zdravlje ljudi i okolinu*, Bečej, 95-100.

Pinder, J.E., McLeod, K.W. (1999). Effect of pesticides on vital processes in plants. *J. Environ. Qual*, 17, 207- 213.

Pravilnik o količinama pesticida, metala i metaloida i drugih otrovnih supstancija, hemioterapeutika, anabolika i drugih supstancija koje se mogu nalaziti u namirnicama, (1992), Službeni list SRJ, 5, 67-85.

Škrbić,B., Đurišić-Mladenović, N.,Cvejanov, J. (2004). Prisustvo postojanih organskih zagađujućih jedinjenja u proizvodima od pšenice, *Žito-hleb* 31, 1-2, 9-16.

Škrbić, B., Filipčev, B., Đurišić-Mladenović, N. (2004): Mogući putevi i tehničke mere koje utiču na sadržaj perzistentnih organskih polutanata u žitu iproizvodima od žita, *Žito-hleb*, 31, 1-2, 1-7.

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ASSESSMENT OF TOLERANCE AND NICKEL ACCUMULATION OF WHITE POPLAR CLONES' AND ITS USE IN ENVIRONMENTAL PROTECTION

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ABSTRACT

Nowadays, we are witnesses of environment degradation, which caused disturbation of the ecological balance. Heavy metals are present in small amounts in environment, and because of that we are classify it as a microelements. The soil pollution with heavy metals is not easy to estimate and it varies in different soil types (Bogdanović, 2007). The most dangerous pollutants are: Cadmium (Cd), Lead (Pb), Mercury (Hg), Chromium (Cr), Copper (Cu), Zinc (Zn), Arsenic (As), Selenium (Se), Boron (B), Fluoride (F), and Nickel (Ni). Nickel has a special place among heavy metals. This metal is essential, biogenic element which is necessary for plant life. Because heavy metals can not decompose, the best solutions is to remove them from polluted areas. Fitoremediation is a set of techniques and technologies which using plants for the aim of purification contaminated areas. In this paper is presented the influence of nickel presence of shoots of three poplar clones from section *Leuce* cultivated in tissue culture. Shoots of clones L – 12, L – 80, and LBM, were multiplicated by micropropagation on ACM (Aspen Culture Medium). Terminal shoots, about 1,5 – 2 cm long, were cultuivated for period of five weeks on the ACM medium with addition of different nickel concentrations (0 M, 10^{-4} M , 10^{-5} M, 10^{-6} M). Parameters examinated in shoot cultures included: lenght of the main shoot, shoot multiplication (number of axillary shoots per explant), and accumulation of nickel in fresh biomass. Highest lenght and number of shoots had control plants, what showed that nickel in medium with higher concentration had inhibitory effect. Clones LBM and L-12, had highest accumulation of nickel. On the other side, only medium with concentration 10^{-4} M were gained higher accumulation of nickel compared to control. Clone L-12 characterized by rapid growth in culture, tolerance on higher concentration of nickel and significant accumulation, and we can recommended this clone for greening contaminated soils with nickel. Clones LBM and L-80 can be recommended for projects phytoextraction, phytostabilisation and for greening problematic soils.

Key words: environment protection, white poplars, phytoremediation, nickel, clone

INTRODUCTION

Nowadays, we are witnesses of environment degradation, which caused disturbation of the ecological balance. Millenniums ago, biosphere was powerful enough to neutralize negative consequences of all human activities. But, from the beginning of industrial revolution until now, offensive technological development, uncontrolled growth of population and insufficient development of environmental awareness led to the rapid exhaustion of natural resources and environmental degradation.

In environment heavy metals are present in small amounts, and because of that we are classify it as a microelements. In small quantities micronutrients are necessary for the normal functioning of the metabolism of living organisms, but, in larger amounts can be harmful and dangerous (Ubavić and Bogdanović, 2001). The soil pollution with heavy metals is not easy to estimate and it varies in different soil types (Bogdanović, 2007). Nowadays, these elements are present in agricultural soils much more than in other types, although the main supstrate on which the soil was formed has not consisted of such material. This is caused by increasing emmisions within the products of combustion in industrial facilities, metal smelters, thermal power stations and transports. Heavy metals most often comes to the soils by rainfalls causing environment pollution and destroying vegetation. The sources of importation of heavy metals into the soils can be some mineral fertilizers and pesticides. A lot of heavy metals are imported by means of plants protection, although the city garbage (waste) is increasingly mentioned as a potential source of these elements, too. Until now, in plant tissues has been established the presence of around 70 elements, but all the elements does not have the same significance. Some of them are necessary, because without them the plants can not completed normally theirs life cycle, others may act stimulating, while one group of elements, especially heavy metals, has a toxic effects on plants in higher concentrations. The most dangerous pollutants are: Cadmium (Cd), Lead (Pb), Mercury (Hg), Chromium (Cr), Copper (Cu), Zinc (Zn), Arsenic (As), Selenium (Se), Boron (B), Fluoride (F), and Nickel (Ni).

Nickel has a special place among heavy metals. Since its concentration is in plant dry mass around 0,001 μmol/g it is clasiffied as a microelement (Epstein, 1972). Nickel is among the essential elements primarily because of its function – it is necessary for the enzyme urease which is responsible for the hydrolysis of urea, and for many hydrogenases required for sulfate reduction, photosynthesis (Gerandas et al., 1999). Higher concentrations of Ni^{2+} in cultivation medium can become toxic for plants, and visual symptoms of toxicity are chlorosis and necrosis of leaves. Overbalance of Ni^{2+} affects on mineral nutrition, as well as photosynthesis and respiration (Carlson R.W., Bazzazet F.A., Rolfe G.L., 1975).

Heavy metals can not be decomposed and the best solution is to remove them from polluted areas. During the 80’s of 20th century in the United States has been started with researches of the plant impact at the soils which are contaminated by heavy metals. Most of phytoremediation studies are related to field conditions which examines the reduction of pollutant concentrations in the substrate and groundwater, reducing groundwater levels, and the impact of contaminants on growth and development of plants (Licht and Schnoor, 1993). Studies have shown that plants affected on the reduction of the presence of contaminants in soil and groundwater, and it has created the idea of the possibilities of the treatment of plants growing in contaminated soils (Pilipović et al., 2002).

According to the Agency for Environmental Protection of the United States – EPA (Pilipovic et al., 2002), fitoremediation is a set of techniques and technologies which using plants for the aim of purification contaminated areas. Toward to the classification (EPA 2000), there are following phytoremediation mechanisms: Phyto - extraction, Phyto - stabilization, Rhizosphere biodegradation, Phyto – degradation (Phyto – transformation), Phyto – volatilization, Hydraulic Contol, Hydroponic Systems for Treating Water Streams (Rhizofiltration), Plant vegetation. From a diverse range of plant species used for phytoremediation, poplars are the most commonly used, because of their abilities to grow rapidly, to tolerate low soil fertility, have well - developed root system that can reach up to the groundwater, large transpiration, and can grow well in tissue culture (Aitchison et al., 2000). They are able to perform phytoremediation in several ways by: Phyto – extraction, Phyto – degradation, Phyto – volatilization and Rhizosphere biodegradation.

The aim of this research was to investigate the effect of different nickel concentrations on the growth of shoots, as well as to assess the possibility level of accumulation and toleration of nickel in three white poplar clones grown in vitro. According to the results we could recommended which poplar clones can be used for phytoremediation and landscaping projects at areas which are contaminated with nickel.

MATERIAL AND METHOD

Research was conducted on white poplars clones grown in the laboratory for micropropagation under controlled conditions. The axial buds of different ages trees have been taken in inactive period of vegetation, and placed into tissue culture experiments. Experiment were carried out in two separate phases. In first phase, to approach the multiplication of plant material the first 30 days plants were grown on the substrate that did not contain nickel. After 30 days plants were placed in 4 different

treatment, depending on the concentration of nickel in the medium: control (without nickel in the medium), medium with nickel concentration 10^{-6} μM, 10^{-5} μM and 10^{-4} μM.
Nickel was added to the medium in form of $NiSO4 \cdot 6H2O$, and the plants were grown on it 5 weeks. In all phases of the research was used medium ACM (Aspen Culture Medium) by Ahuja (1983). The experiment were set as a block design, and consisted of three replications (blocks) where was all clones in four treatmans. For experiment were chosen clones of white poplars (*Populus alba*, section *Leuce*) because of theirs characteristic to grow well in tissue culture (Kovačević et al., 2005). Selection of clones was performed according to the principle of taxonomic and genetic diversity, and the choice was reduced to the following three clones:

Clones L – 12 and L – 80 are selections of the Institute of Lowland Forestry and Environment in Novi Sad, and they are still in testing phase for the aim as a recognition as a new cultivars. Clone L – 12 has luxuriant growth, rightness of trunk, and big adaptability. Clones L – 12 and L – 80 are characterized by good rooting and tolerance to pests and pathogens. LBM – this clone has pyramidal shape of treetop, fast growth and tolerance to pathogens and pests. It is intended for growing in urban environment because of the decorative characteristics.

In order to examine the effects of different nickel concentrations on the morphological and physiological parameters, measurements of following parameters were made after 5 weeks:
Morphological parameters – the parameters of growth – the length of shoots (mm) – when the experiment was set plant materials was uniform in length (15 – 20 mm), and it was measured the length of the highest shoot of explants after 5 weeks of cultivation. Number of new shoots (multiplication rate) **-** the number of axillary shoots per explants, grown in the period when plants were set at the medium of different concentrations of nickel.

Parameters of nickel accumulation in fresh biomass were determined by Atomic Absorption Spectrophotometer. Atomic Absorption Spectrophotometry (AAS) is based on the appearance that atoms of one element absorb radiation of certain wavelengths.

THE RESULTS OF THE RESEARCH

The results of this research are consistent with previous researches, where it was determined that higher concentrations of nickel causing chlorosis which resembling as a iron deficiency induced chlorosis, which is accompanied by necrosis, withering of young leaves, apical buds, and reduction in the adoption of certain nutrients (Rabie, et al. 1984; Hewitt, 1953).

The influence of investigated nickel concentrations at the morphological parameters

The influence of nickel in concentrations 10^{-6} M, 10^{-5} M, 10^{-4} M on the height and number of new shoots of white poplar clones is shown in Table 1.

LSD test confirmed the week influence of nickel concentration on variation of the height of shoots. However, although all treatments (except the concentration of 10^{-6} M) were not significantly different from the control of the height of shoots, we can see that the height of shoots at all concentrations tended to be lower than the control ones. From the other side, clone LBM was significantly lower than other tested clones. The most inhibitory effect of the nickel presence in medium was observed in clone L – 80.

Table 1: The influence of different nickel concentration for the morphological characteristics of white poplar clones on medium with nickel (LSD-test)

Clone	**(Ni^{2+}) (M)**	**Height of shoots after 5 weeks (mm)**		**Number of new shoots after 5 weeks**	
L-12	0	33,750	ab*	2,777	abcde
	10^{-6}	24,805	cdefgh	2,111	bcde
	10^{-5}	32,055	abcd	1,213	fg
	10^{-4}	30,916	bcde	1,806	cdefg
LBM	0	24,722	cdefgh	3,028	abc
	10^{-6}	21,578	fgh	2,889	abcd
	10^{-5}	20,933	fgh	1,567	defg
	10^{-4}	22,833	efgh	0,444	g
L-80	0	40,464	a	2,060	bcdef
	10^{-6}	30,279	bcde	2,232	abcdef
	10^{-5}	26,250	bcdefgh	1,472	efg
	10^{-4}	34,767	ab	2,878	abcd
C(Ni^{2+})	0	29,582	a	2,711	a
	10^{-6}	24,970	b	2,587	ab
	10^{-5}	26,207	ab	2,052	bc
	10^{-4}	28,401	ab	1,836	c

* The difference between the values marked with the same letter not statistically significant for α=0.05

Depending of the applied concentrations of nickel, a statistically significant differences were achieved in the multiplication compared with control. A significant inhibitory effect was achieved only with the medium 10^{-4} M (Ni^{2+}). For clones L-12 and LBM statistically significant differences were between control and medium with a 10^{-5} M nickel concentration.

Based on these results we can conclude that the greatest height and the number of new shoots had control shoots, which is indicating that nickel in higher concentrations has inhibitory effect to the height and number of new shoots in the examined clones.

These research are consistent with the results of Servilia et al. (2005) who found that the heavy metals had an inhibitory effect (Hg, Zn, Cd, Ni) on growth and height of tomato plants, which resulting to damage of structures, and decreasing of physiological and biochemical activities.

The influence of investigated nickel concentrations at its accumulation in fresh biomass

Based on the LSD test (Table 2), the largest accumulation of nickel had clones LBM and L-12. From the other side, only the medium with 10^{-4} M achieved significantly higher accumulation of nickel comparing with the control. In that case, concentrations of 10^{-5} M or less do not have so big influence for the nickel accumulation but it is important for the growth and increasing of biomass.

Table 2: The influence of different nickel concentration at fresh biomass of white poplar clones on medium with nickel (LSD-test)

Clone	$c(Ni^{2+})$ (M)	The nickel content in fresh biomass (mg/kg)	
L-12	0	4,67	cdef*
	10^{-6}	6,13	cde
	10^{-5}	7,33	def
	10^{-4}	11,88	ab
LBM	0	3,87	def
	10^{-6}	4,15	cdef
	10^{-5}	6,27	cde
	10^{-4}	14,91	a
L-80	0	0,61	f
	10^{-6}	3,18	def
	10^{-5}	3,75	def
	10^{-4}	9,21	bc
$C(Ni^{2+})$	0	2,39	b
	10^{-6}	3,45	b
	10^{-5}	3,32	b
	10^{-4}	10,54	a

* The difference between the values marked with the same letter not statistically significant for α=0.05

Considering that nowadays the pollution of water, air and soil is one the most serious problems, numerous researches have been conducted dealing with this issue. Mizuno (1968), has found that level of nickel toxicity is influenced by soil type and plant species.

It was found that in some plant species nickel at low concentrations has stimulatory effect but as the concentration of nickel increases and approaches the critical limit, which varies from species to species, the favorable effects of this metal becomes extremely adverse and even toxic to plants (Abdel Latif et al.1988). The positive effect of lower concentrations of nickel in the examined white poplar clones coincided with the results obtained in previous researches. Even though, in lower concentrations (10^{-6} M), nickel has stimulating effect but in higher concentrations (10^{-5} M, 10^{-4} M) has an inhibitory effect on the height and number of new shoots. Nickel has a big adversely impact on mobility, translocation of iron, but also to its adsorbation (Servilia O. Et al. 2005; Vysloužilová M. et al. 2003).

One of the aims of this research was to examined the possibility of using the parameters obtained from the shoots grown *in vitro* for estimation of potential use of white poplar clones in phytoremediation projects. This estimation was made in both directions – from the aspects of investigated nickel concentrations of tolerance and accumulation. We can assume that the investigated clones will be tolerated on enhancement of presence of nickel in the soil, because in that case it will be lower accessibility of nickel.

Clone L – 12 is characterized by luxuriant growth in culture and multiplication. Clones L – 12 and LBM had high accumulation of nickel. In that case, clone L – 12 can be recommended for greening soils contaminated with nickel, and for projects Phyto – extraction, Phyto – stabilization.

CONCLUSION

According to this research it was found that:

Height of the shoots - in all concentrations were lower than control ones. Clone LBM was significantly lower than other tested clones. The most inhibitory effect of the nickel presence in medium was observed in clone L – 80.

Multiplication - The control explants generally had a higher multiplication compared to all three treatments with nickel. A significant inhibitory effect in all clones was achieved only in the medium containing 10^{-4} M (Ni^{2+}). Clones L-12 and LBM had also a statistically significant reduction of new shoots number, in medium containing 10^{-5} M nickel concentration.

Based on these results we can conclude that the greatest height and the number of new shoots had control shoots, which is indicating that nickel in higher concentrations has inhibitory effect to the height and number of new shoots in the examined clones.

The content of nickel in biomass - was significantly influenced by the concentration of nickel in the medium and differences among the clones. The largest accumulation of nickel were accomplished by clones LBM and L – 12.

Clone L – 12 is characterized by luxuriant growth in culture, tolerance of higher concentrations and significant accumulation of nickel, and can be recommended for greening soils contaminated with nickel. Clones LBM and L-80 can be recommended for projects Phyto – extraction, Phyto – stabilization and for greening problematic soils.

BIBLIOGRAPHY

Abdel Latif E.A., Rabie M.H., Aboshelbaya, M.A.A. and Nofal, M.A., The effect of nickel on plants (I) Effect of seed soaking in nickel sulphate solution on the growth and chemical composition of sorghum, Minia J. Agric. Res.Dev. 10, 7: 33 – 46 (1988)

Aitchison E.W.; Kelley S.L.; Alvarez P.J.J.; Schnoor J.L.(2000): Phytoremediation of 1,4 – dioxane by hybrid poplar trees. Water Environ. Res., 72, 313 – 321.

Bogdanović D. (2007): Letopis naučnih radova vol. 31, br. 1, str. 21 – 28, Poljoprivredni fakultet, Univerzitet u Novom Sadu

Vysloužilová M., Tlustoš P., Száková J.:Cadmium and zinc phytoextraction potential of seven clones of *Salix* spp. planted on heavy metal contaminated soils.*Czech University of Agriculture in Prague, Czech Republic*, plant soil environment, 49, 2003 (12): 542 – 547

Gerandas J.; Polacco J.C.; Freyermuth S.K.; Sattelmacher B. (1999): Significance of nickel for planth growth and metabolism. J. Plant Nutr. Soil Sci. 162, 241 – 256.

EPA/600/R-99/107. (2000): Introduction to Phytoremediation, U.S. Environmental Protection Agency, National Risk Management Research Laboratory Office of Research and Development Cincinnati, Ohio 45268. February 2000.

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CONTENT PLANT-AVAILABLE POTASSIUM AND PHOSPHORUS IN THE SOIL AND ITS NEGATIVE IMPACT

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ABSTRACT

The main parameters of the agricultural chemical soil testing are easily available phosphorus (P_2O_5) and potassium (K_2O). These elements are very important for plant nutrition. The high content of these elements is harmful, i.e. negative and can be considered as soil pollution.

Determination of phosphorus and potassium on farms PKB Corporation, Dijamant Agrar and the private sectore were found significant differences in their content. The content of both of these elements ranged from 0.5 mg/100g and up to 400 mg/100g. In the parcels where the content of both parameters is determined by more than 50 mg/100g are expected to be negative consequences.

The content of phosphorus and potassium in the soil up than 50 mg/100g has harmful effects on agricultural crops. The excess phosphorus and potassium can lead to reduced content of some nutrients in plants, reducing yield and deterioration of their quality. The high content of phosphorus may reduced the content of Fe, Mn, Zn, Cu i B, and high content of potassium can reduced the content of Ca, Mg, Mn, Cu i B in the plant.

Erosion of soil phosphorus due to surface waters where causes eutrophication.

Key words: soil, plant-available phosphorus and potassium, plant, surface waters.

INTRODUCTION

Agricultural producers in Serbia, their crops mostly rubbish by heart, without control of soil fertility. The consequence of this way of working was a reduction in yield and reduction in quality of crops, the lower cost of production and declining soil fertility.

Wrong fertilization can lead either to a lack or the excess of plant nutrients in soil and plants. Both effects are harmful, but the lack of nutrients is given greater importance than the excess, although in many cases are determined a high content of available phosphorus and potassium in the soil.

In this paper, were determinated the results from 1150 samples of individual sectors in the Middle Banat, 200 samples from farms Dijamant Agrar and 1550 samples from farms PKB Corporation (determined in 2010 year).

This paper is intended to indicate the problems that can arise in crop production because of appearance of excess phosphorus and potassium in the soil and to determine what is the representation of such land with us.

THEORY

According Kastori (1983,1986), excess of phosphorus and potassium in the soil to the plants can act directly and indirectly. Immediate harmful effects rarely occur because the phosphorus and potassium in the soil are connectivity rapidly. In the plants, excess of this nutrients occurs only in case of extremely high content in the soil. Indirectly harmful effect occurs much more frequently.

In the case of excess phosphorus in the plant, which is direct consequence of the impact of excess phosphorus in the soil, comes to reduced growth of plants, reducing leaves, shortening of the tree, appearance of black spots on leaves, and their early death. Vegetation period was shorten besause of earlier flowering and fruiting times.

Immediate harmful effects of excess potassium can result to the appearance of intercostal (between the funeral of the courts) necrosis of the leaves, their premature decline and the extension of the vegetation.

Indirect harmful action of excess phosphorus and potassium per Kastori (1983,1986), is reflected in reduced adoption and transport of some plant nutrients, especially in the soil who is slightly ensured by accessible nutrients.

The high content of phosphorus may reduced the content of Fe, Mn, Zn, Cu i B in the plant.

The high content of potassium can reduced the content of Ca, Mg, Mn, Cu i B in the plant.

Symptoms of an indirect action of phosphorus and potassium are not unique because it depends on which element is failing. At the same time it can happen to express a symptoms of deficiency two or more elements. The lack of these elements is due to the existence of antagonism or competition during the adoption, between phosphorus and potassium on the one hand, and the iron, manganese, zinc, copper, boron, calcium and magnesium on the other side. Another mechanism to explain reduced adoption of these elements is the creation of inaccessible phosphorus compounds such as iron phosphate.

As a final result of excess phosphorus and potassium, there is decrease in yields and reduced quality of cultivated plants.

Important issue associated with a high content of phosphorus in the soil is the influence of nutrient pollution in the soil and surface water.

When phosphatic fertilizers are applied in large quantities than is necessary from the aspect of plant nutrition, there is a risk of soil pollution by radioactive uranium and potassium, as well as the havy metal cadmium because these elements are regular followers of phosphate phosphorus in the sediment which is obtained phosphatic fertilizers. Vukadinović and Lončarić (1997) reported that for now there is no danger of pollution in the soil, because these elements are on small amount in fertilizers.

Too much phosphorus in the soil is associated with eutrophication of lakes, ponds and artificial reservoirs. Eutrophication is enrichment of water by organic and mineral substances, primarily biogenic elements nitrogen and phosphorus, which results in a turbulent growth of all aquatic plants, mostly blue-green algae. After the die of algae, all the oxygen in the water is consumes for their decomposition, which resulting to the die of the entire flora and fauna in the lake. The question is what is the source of nitrogen and phosphorus that are accumulated in large amounts in the water. Studying the causes of extinction Palić Lake, Seleši (1977) found that the main cause of the accumulation of nitrogen and phosphorus in the lake water was discharge of industrial and municipal water in the lake.

Vukadinović and Lončarić (1997) show how much crop production takes part in the eutrophication of lake. Eutrophication is contributed most to the polyphosphate detergents (67%) and industry (13%) and soil erosion (10%) of which the erosion of cultivated land only accounts 3%.
According to Popović (1989) phosphates are not due to the water of lakes and rivers rinse out from the soil but by irrigation of fertilizer over surface of the soil. The reason is the low mobility of phosphorus in the soil profile as a result of his strong binding to the soil.

Small share of phosphorus pollution from fertilizer in soil, groundwater and surface water does not relieve our obligation to rationally fertilized plants grown and to continuously monitoring the impact of fertilizers on soil and water pollution.

METHODS

Determination of plant-available phosphorus content:

Plant-available form of phosphorus from the soil is extracted with ammonium-lactate solution (0,1 mol/l ammonium-lactate and 0,4mol/l CH_3COOH, pH=3,7). The sample (5g) was extracted with 100ml of extraction solution. After 2 hours of shaking and filtering, the extract was determined by phosphorus content, using the calibration curve, in concentration range of 0-5mg P_2O_5/25ml. The spectrophotometer absorbance measurement was performed with phosphate molybdate at λ=690nm or λ=580nm.

Determination of plant-available potassium content:

Plant-available potassium content was determined in the same extract which is used for determination of phosphorus. The concentration of potassium was determined by plamenofotometer measuring the intensity on λ=768nm, using calibration curve in the interval from 0-4mg K/100ml

FINDINGS

In our country there is no uniform regulation on what is optimal and what is very high and harmful content plant-available phosphorus and potassium. For the chernozem soil and similiar, Marinković et al. (2005), report that the optimal content of phosphorus and potassium are 16-25mg/100g of soil P_2O_5 or K_2O , and very high content is greater than 40mg/100g. In the case that levels of phosphorus and potassium are greater than 40mg/100g of soil fertilization is proposed for the omission of a certain period. Content of P_2O_5 and K_2O exceeding 50mg/100g is harmful for plants. For the purposes of our work is taken the high content of phosphorus and potassium greater than 40mg/100g of soil.

All results were statistically analyzed. It was calculated the percentage of content plant-available phosphorus and potassium in tested soil samples according to the classification of soil.

The data are given in tables (1-6). Tabels are given for individual sectors and especially for farms because of the different soil types. In the first part of the table is given the percentages of phosphorus and potassium in the soil of 40mg/100g, and in second part of table are given the percentages of plant-available phosphorus and potassium with high content. These data are separated into two parts, with data on the border of toxic values of these elements with values that are twice toxic.

Table1: The content of plant-available phosphorus in the field soil in the individual sectors

Classes	***Content of phosphorus (%)***
Soil containing up 40 mg/100g	85,9
Soil containing up 40-100 mg/100g	8,7
Soil containing higher than 100 mg/100g	5,4

Table2: The content of plant-available potassium in the field soil in the individual sectors

Classes	***Content of potassium* (%)**
Soil containing up 40 mg/100g	70,5
Soil containing up 40-100 mg/100g	28,9
Soil containing higher than 100 mg/100g	0,6

Table3: The content of plant-available phosphorus in the field soil in the Dijamant Agrar

Classes	***Content of phosphorus (%)***
Soil containing up 40 mg/100g	88,1
Soil containing up 40-100 mg/100g	10,4
Soil containing higher than 100 mg/100g	1,5

Table4: The content of plant-available potassium in the field soil in the Dijamant Agrar

Classes	***Content of potassium* (%)**
Soil containing up 40 mg/100g	81,2
Soil containing up 40-100 mg/100g	18,8
Soil containing higher than 100 mg/100g	0

Table5: The content of plant-available phosphorus in the field soil in the PKB Corporation

Classes	***Content of phosphorus (%)***
Soil containing up 40 mg/100g	99,5
Soil containing up 40-100 mg/100g	0,5
Soil containing higher than 100 mg/100g	0

Table6: The content of plant-available potassium in the field soil in the Corporation

Classes	***Content of potassium* (%)**
Soil containing up 40 mg/100g	92,3
Soil containing up 40-100 mg/100g	7,6
Soil containing higher than 100 mg/100g	0,1

DISCUSSION

Processing the obtained data is showed that the soil are well provided by plant-available content of phosphorus and potassium. Content of plant-available phosphorus and potassium is mostly up to 40mg/100g. This percentage ranges from 85,9% to 99,5% for the plant-available content of phosphorus and from 70,5% to 92,3% for the plant-available content of potassium. You can see differences in content of these elements in individual sector and on agricultural holdings.

Comparing the data shows that a greater percentage of soil in the individual sector has values that are considered as a toxic and have harmful effects on agricultural crops. The soil which conteining more than 40mg/100g of plant-available phosphorus on individual sector is 14,1% and the conteining of plant-available potassium 29,6%. The content of these two elements in correlation with content in the soil in the PKB Corporation, who rational use fertilizers, is very high.

CONCLUSIONS AND IMPLICATIONS

Although the percentage of parcels with increased content of plant-available phosphorus and potassium are relatively low it does not mean that should take certain measures to reduce their content. The obtained values over than 40mg/100g of soil are on the border of toxic action (harmful effects) and can be considered as contamination soil. The percentage of the soil with this high value are low. In order to reduce high content of this two elements it is necessary a years of working with appropriate agro-technical measures and growing crops, which can adopt these elements from the soil in greater amounts than other crops.

REFERENCES

R. Kastori, (1983) “Uloga elemenata u ishrani biljaka”, *Matica Srpska – Odeljenje za prirodne nauke*, Novi Sad.

R. Kastori, (1986) “Fiziologija biljaka”, *Poljoprivredni fakultet*, Novi Sad.

V. Vukadinović, Z. Lončarić, (1997) “Ishrana bilja”, *Poljoprivredni fakultet*, Osijek.

Đ. Seleši, (1977)“Jezero ponovo živi”, *Rad*, Beograd, Žaštita čovekove sredine, Ekologija I kolo.

Ž. Popović, (1989) “Agrohemija”, *Poljoprivredni fakultet*, Beograd, *Naučna knjiga*, Beograd

“Priručnik za ispitivanje zemljišta”, (1966) knjiga I, Hemijske metode ispitivanja zemljišta, *Jugoslovensko društvo za proučavanje zemljišta*, Beograd, 105-107.

B. Marinković, S. Janković, M. Malešević, J. Crnobarac, (2005) “Racionalna upotreba đubriva u biljnoj proizvodnji”, Priručnik, *Poljoprivredni fakultet i Naučni institut za ratarstvo i povrtarstvo*, Novi Sad, *Institut za primenu nauke u poljoprivredi*, Beograd.

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THE IMPORTANCE OF ESTABLISHING OF INTEGRATED WASTE MANAGEMENT SYSTEM IN HEALTH INSTITUTIONS

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ABSTRACT

The waste generated in health facilities is a mixture of municipal and hazardous medical waste. Waste management in health facilities is complex, so it is necessary to develop a comprehensive system that includes establishing accountability and ensuring the necessary funds for its implementation. This paper deals, from several aspects, with an integrated waste management system from health facilities with special reference to the possibility of its application in the Republic of Srpska. In addition to financial, technical and legislative aspects neccesary for establishing of an integrated medical waste management it is neccesary to raise awareness of staff in health institutions in Republic of Srpska, as well as the entire population.

Key words: medical waste, management, integrated system.

INTRODUCTION

Under the medical waste includes all waste generated in health facilities, regardless of its composition, properties and origin. Medical waste is a heterogeneous mixture of classical garbage, infectious, pathological, and laboratory waste, organic materials, packaging, pharmaceuticals and other chemical waste. In general, the total amount of medical waste generated on average about 20% is hazardous waste, while the other 80% classic waste.

The health services in their work produce different types of waste that can lead to infection and poisoning. Waste from health facilities is a specific and can be dangerous to the health of staff working in health care facilities, and the environment if not managed with it adequately.

The paper discusses several aspects of the concept of integrated management of waste generated in health facilities.

DISTRIBUTION, PROPERTIES AND QUANTITY OF MEDICAL WASTE

To achieve the simplified management of waste from health facilities is necessary to carry out its division according to their characteristics and place of formation.

Medical waste by type and properties divided into municipal and hazardous waste. According to the classification of the World Health Organization (WHO) medical waste is divided into:

- Biological waste (recognizable anatomical remains);
- Infectious waste;
- Chemicals, toxins or pharmaceuticals (including cytotoxin and easily volatile substances);
- Sharps (needles, scalpels, broken materials, etc..);
- Radioactive waste.

In addition to the previous classification, there is a classification of the World Health Organization concerning the management of medical waste according to which there are five categories for the division of hazardous medical waste.

The legislation of many European countries, medical waste is defined as:

- Waste that is partially or entirely composed of human or animal tissue, blood and body fluids remains, excretions, drugs or other pharmaceutical products, swabs or bandages, syringes, needles and other sharp instruments;
- Waste arising from medical, dental, veterinary, pharmaceutical or similar activities, research, treatment, care or taking a blood transfusion can cause infection of staff with him coming into contact.

As defined by the Agency for Environmental Protection United States (U.S. EPA), the following groups of medical waste is considered infectious or hazardous:

- Accessories for seeding and culturing;
- Blood and blood products;
- Needles, syringes, pipettes, test tubes and laboratory glassware;
- Waste from surgery and the autopsy room;
- Infectious waste and quarantine departments;
- Human tissue, organs and excreta containing pathogenic microorganisms;
- Waste resulting from the dialysis and blood transfusion;
- Waste from the production of vaccines and serums;
- Tissues, organs and laboratory animals used for experiments with pathogenic microorganisms.

According to the World Health Organization waste generated in health facilities has the following composition: traditional 80% of municipal waste, infectious and anatomically waste 15%, sharps (syringes, needles, scalpels and other discarded.) 1%, chemicals (disinfectants and solvents funds) 3% waste and genotoxic (mutagenic, teratogenic or carcinogenic) about 1%.

The creation of waste in health facilities is uneven. The amount and type of waste strongly depends on the size and type of institution, ie. whether the institution has a dispensary and what type of disease treated, whether the checks and perform only minor interventions, and others. Developed countries produce about 6 kg of hazardous medical waste per person per year. In most developing countries and countries in transition which is usually not separated from hazardous non-hazardous waste, this amount ranges from 0.5 to 3 kg per person annually. Table 1 shows the annual production of medical waste, depending on the development of the country.

Table 1: Production of medical waste in depending on the country development (Bera et al., 2008)

The degree of development of the country	The annual production of waste, kg / resident
Highly developed countries	
total medical waste	1,1-12,0
hazardous medical waste	0,4-5,5
Middle income countries	
total medical waste	0,8-6,0
hazardous medical waste	0,3-0,4
underdeveloped countries	
total medical waste	0,5-3,0

In the hospitals of the European Union's daily production of chemical and pharmaceutical waste is about 0.5 kg / bed, sharp objects 0.04 kg / bed and combustible containers about 0.5 kg /bed.

Each day in North America produce between 7 and 10 kg / bed of hazardous medical waste and in Western Europe 3 to 6. In Eastern Europe daily amount of hazardous medical waste ranges from 1.4 to 2 kg / bed. It is estimated that in Serbia a day to create 1.8 kg / bed medical waste, which corresponds to an average which is in Eastern Europe (Bera et al. 2008).

Health institutions in BiH, according to the World Health Organization, 21.5 tons per day incurred medical waste, of which 14 tonnes in the Federation and 7.5 tons in the Republic of Srpska.

According to estimates in Serbia amount of medical waste will be the 2015th the amount to 76 thousand tons, while production will be biohazardous waste over 11 thousand tons. In Belgrade, according to some estimates, each year produces about 10 tons of medical waste.

Table 2 shows how the annual waste arising in Europe in certain areas of medicine.

Table 2: Waste generation depending on the field of medicine (Simic, 2010)

The manufacturer and type of waste		The quantity of waste	Unit
General practitioners	sharps	4	kg/year
	infectious waste	20	
gynecologists	infectious waste	350	
dentists	sharps	11	
	infectious waste	50	
	heavy metals	2,5	
Nephrologists (kidney dialysis)	infectious waste	minimum 30	

Assessment of the World Health Organization that the amount of medical waste in the world is constantly growing and that the 2015th the amount to 8.5 kg per capita.

HAZARDS AND RISKS DUE TO INADEQUATE MEDICAL WASTE MANAGEMENT

Inadequate management of hazardous medical waste handling from within the institutions providing medical or veterinary services to final disposal, is an extremely high risk for both health professionals and patients, and in general for the environment. Medical waste poses a risk to:

- Health workers (doctors, nurses, pharmacists and others.)
- Patients in medical institutions and patients that provides home care;
- Visitor medical institutions;
- Workers in charge of follow-up;
- The general public if an infectious or toxic waste gets into some of the ambient environment.

Contact with infectious medical waste can cause injury or disease in humans and animals, and its inadequate treatment, storage and disposal cause pollution of soil, air and water. Risks that may arise from hazardous medical waste are as follows:

- Infectious diseases (AIDS, hepatitis B and C, intestinal infections, respiratory infections, blood infections, skin infections, etc..);
- The effects of radioactive substances (carcinogenic, mutagenic, teratogenic).

The measures and actions to be taken to avoid risk are:

- Become familiar with the rules for disposal of medical waste;
- Sort the waste at the site of its formation;
- Use protective equipment;
- Closed containers (bags, bottles, containers, etc.). As soon as it becomes full of waste;
- Carefully transported the waste to permanent disposal sites;
- Packaging of the medical waste must be properly marked;
- Respect for personal hygiene after contact with medical waste (washing hands, face, etc.).

Generally, hazardous waste management, in that context, and hazardous medical waste, requires systematic planning. The plan should include clearly defined responsibilities with the appointment of officers of Waste Management to coordinate the work of all persons who have a connection with the generation of waste. Good management of medical waste requires:

- Continuous training of all employees;
- Good organization of work;
- The existence of a professional team of waste management;
- Functional legislature;
- Comprehensive planning;
- Good administration;
- The application of good practice, and others.

INTEGRATED MANAGEMENT CONCEPT AND THE MEDICAL MANAGEMENT IN HEALTH INSTITUTIONS IN THE REPUBLIC OF SRPSKA

Selection of waste at the site of formation is a concern primarily of medical professionals and is the basis for proper management of medical waste. Good selection can significantly reduce the amount of medical waste, which requires specialized treatment. To separate collection possible, hospital staff at all levels should be trained to separate waste products. In all departments of medical waste generated where it is necessary to set the color bags, cans or containers labeled by type of waste being deposited in them. Separation of medical waste means a systematic approach in all health facilities. The importance of proper handling of this type of hazardous waste is rising sharply the last few years due to the appearance of the spread of infectious diseases, as well as the presence of heavy metals and toxic organic compounds that are toxic, mutagenic, teratogenic and carcinogenic. Both internal and external transport of waste should be considered as part of a comprehensive waste management system in all health facilities.

The concept of integrated management of medical waste has been developed and perfected in the previous period. This concept involves a hierarchical approach, which is now internationally accepted in the management of medical waste. An integrated approach to medical waste management including collection, storage, transportation and disposal of waste in a safe manner by a person's life and work environment. The main objective of integrated management of medical waste is a treatment of infectious waste in an environmentally acceptable manner, or prevention of disposing of waste at landfills for municipal waste anticipated. Apart from very few exceptions, medical waste management in health institutions in the Republic of Srpska is not satisfactory. Health institutions should be defined procedures for the management of this waste and clearly marked containers and containers for the disposal. Health care facilities must provide adequate space for storage of hazardous medical waste. In addition, it is necessary to have controlled storage facilities for drugs whose expiry date has passed, as well as radioactive waste originating from medical facilities.

The system for keeping records on the amount of medical waste must be organized in health institutions and companies which carry out waste collection. It is essential that health facilities have signed contracts for hazardous medical waste with companies who are authorized to download and manage this waste. To reduce the amount of drugs that have expired, and that must be disposed of with the allocation of significant funding in the futureto sign contracts with suppliers who are committed to accept the return of any of your medicines with expired. This will slightly increase the purchase price of these drugs, but will still be much less than the cost of their care in an enlarged European Union. To ensure the control of drugs with expired use by own household and to prevent the drugs kept in a container for construction waste, it is necessary to commit the central pharmacy for their temporary storage, and the Ministry of Health and Welfare for permanent disposal. Such action was in 2010. was conducted in the Republic of Srpska, but due to lack of promotion of the public did not give any significant results.

Since BiH has a strategic goal to join the European Union should be in the long term plan for the construction of regional plants for the treatment of hazardous medical waste. The plant is to consist of units for the incineration of body parts, the autoclave for the treatment of infectious wastes and sterilizers for the treatment of infectious waste less.

Regional facilities will serve a number of municipalities. In order for medical waste management system could operate in an environmentally acceptable manner, in addition to facilities for treatment, it is necessary to provide for its collection and transport provided by law.

BEST AVAILABLE TECHNIQUES FOR THE TREATMENT OF MEDICAL WASTE

Depending on the origin and characteristics of medical waste isthe selection of appropriate technologies for its treatment.

Incineration of medical waste in incinerators of different design is environmentally acceptable process for final disposal of hazardous waste. This method of removal of medical waste has several positive effects, such as the destruction of pathogenic microorganisms and reducing the volume of waste by 90%. The resulting energy can be used for heating. The biggest problems that occur during the incineration of medical waste incinerator in increased emissions of harmful components in the air and waste ash that has the properties of hazardous waste. To reduce emissions of harmful components in the air during incineration is necessary adequate treatment and quality control of flue gases.The temperature in the incineration process of moving over $1200^{O}C$. One of the most modern procedures for the thermal treatment of hazardous waste is a plasma process. This procedure is based on the principle of bringing into contact with the waste gas contained in a plasma state as a result of electrical discharge. In the process of plasma temperatures can reach a value of approximately $5000^{O}C$. Since the pyrolytic process, the size of the equipment is small compared to the capacity of the plant. Therefore, the plasma process plants are often designed as a mobile unit. Incineration of medical waste are often used for multi-chamber incinerator. These plants are designed and used for pathological waste with high moisture content and waste containing a large amount of liquid. In addition, incineration of medical waste incinerators are used as a rotary kiln and a single-chamber incinerator with a stationary grid.

Waste materials that can not be burned because of explosion phenomena in the incinerator or toxic emissions into the atmosphere as (Simic et al., 2009):

- Pressure Vessels,
- Reactive chemical waste,
- Radioactive waste,
- Silver salt and radiographic waste,
- Mercury and cadmium,
- Ampoules of heavy metals,
- Halogenated plastics (PVC).

The most acceptable methods for disposal of these wastes are recycling, sterilization and disinfection. For treatment of medical waste may be used chemical disinfection alone or in combination with encapsulation or mechanical destruction. The effect of chemical disinfection depends on the characteristics of chemicals, contact time with chemical waste, as well as characteristics of the wastes treated. Chemical disinfection is suitable for all medical waste, except for large or recognizable body parts, animal carcasses, radioactive and cytotoxic waste.

Disinfection of medical waste steam is based on exposure to infectious waste crushed action of steam at high temperatureand pressure. The disadvantage of this procedure is that it requires skilled operators and is not suitable for chemical and pharmaceutical waste.

Ionizing gamma radiation is used to sterilize medical equipment used is case sensitive to high temperatures. Gamma radiation is suitable for all medical waste except for large and identifiable body parts, animal carcasses, radioactive and cytotoxic waste.
In the recent past often for medical waste treatment plant using technology based on Non-Ionising Radiation microwave radiation.

CONCLUSION

Medical Waste Management is a systemic problem that usually begins in the wards and waiting rooms of health facilities. Managing medical waste in an environmentally sound manner primarily involves their classification at the place of occurrence. It is not enough to waste generated in health care only to classify the medical community, it is necessary to refine the selection of medical waste in a particular category. This classified waste should be disposed of in appropriate containers so you do not come or comes in to minimize the negative environmental impact and a staff that comes in contact with him.

In the Republic of Srpska in addition to financial and technical aspects necessary to establish an integrated management of medical waste, it is necessary to raise the awareness of employees in health care and the entire population through written and electronic media, in schools and education campaigns.

REFERENCES

Bera, M., Mihajlov, A., Hodolič, J., Agarski, B.: Analiza stanja opasnog otpada iz medicinskih ustanova u Srbiji i svetu, 3. Konferencija o kvalitetu života, Festival kvaliteta 2008., Kragujevac, 13-15.05.2008.

Simić, S.: Tehnologije reciklaže otpada, Glas srpski-Grafika, Banjaluka, Mašinski fakultet, Istočno Sarajevo, 2010.

Simić, S., Simić, J.: Upravljanje opasnim otpadom iz zdravstvenih ustanova, Druga međunarodna naučno-stručna konferencija o upravljanju otpadom, Industrijski otpad II, Tara, 14-17.09.2009., str. 133-139.

Marinković, N., Vitale, K., Janev Holcer, N., Džakula, A.: Zbrinjavanje medicinskog otpada-zakonodavstvo i njegova provedba, Medical Waste Management in Croatia, Zagreb, 2006., str. 339-345.

Stević, M., Dizdarević, Z., Kapetanović, O.: Zbrinjavanje medicinskog otpada, Dijagnostičko terapeutski vodič, Sarajevo, 2006.

I International Conference
„ECOLOGY OF URBAN AREAS“ 2011

FACTOGRAPHIC REVIEW ANALYSIS OF BED OCCUPANCY IN THE FUNCTION OF GENERATION OF MEDICAL WASTE IN GENERAL HOSPITAL BIJELJINA

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ABSTRACT

Starting from the definition of statistics as a scientific discipline that deals with the collection, analysis and interpretation of data and frequency of occurrence of the mass use of statistical methods in research and publications, and the need for the study estimates the amount of medical waste generated per bed in 2010 on the level of bed occupancy in general hospital Bijeljina, was created this study.

In this study collected data on medical waste generation per bed general hospital in Bijeljina, in 2010. year. Conducted a survey and then using the one-dimensional linear regression model analyzed the impact of bed occupancy in the generation of medical waste per bed.

Calculating the Pearson correlation coefficient, determining and analyzing the trend function, we found that an increase in bed occupancy for each percentage leads to increased amounts of medical waste generated by 0.1 kg / bed.

Based on the research in this paper, we can conclude that there is a high growth medical waste generated in the general hospital Bijeljina, due to the lack of recycling activities.

Management general hospital Bijeljina is necessary to decide on the performance of educational process for employees at all levels in order to enable the separation and selection of medical waste on-site.

Keywords: Medical waste, one-dimensional linear regression model, estimate the amount of medical waste, availability of beds.

INTRODUCTION

Medical Waste Management presents series of environmental challenges and take on more and more attention in most urban centers.

Medical waste includes all waste generated in health facilities and a heterogeneous mixture of classic trash, infectious, pathological, and laboratory waste, organic materials, packaging and other chemical waste. World Health Organization (WHO) has classified the medical waste on hazardous and non-hazardous medical waste. Based on WHO statistics the average structure of medical waste generated in a medical institution is shown in the diagram (see Figure 1). Non-hazardous waste (general waste) occupies about 80%, and hazardous waste about 20% (pathological and infectious waste 15%, chemical and pharmaceutical waste 3%, 1% of the blade and a special hazardous waste 1%). (Chaerul M. et. Al.2007)

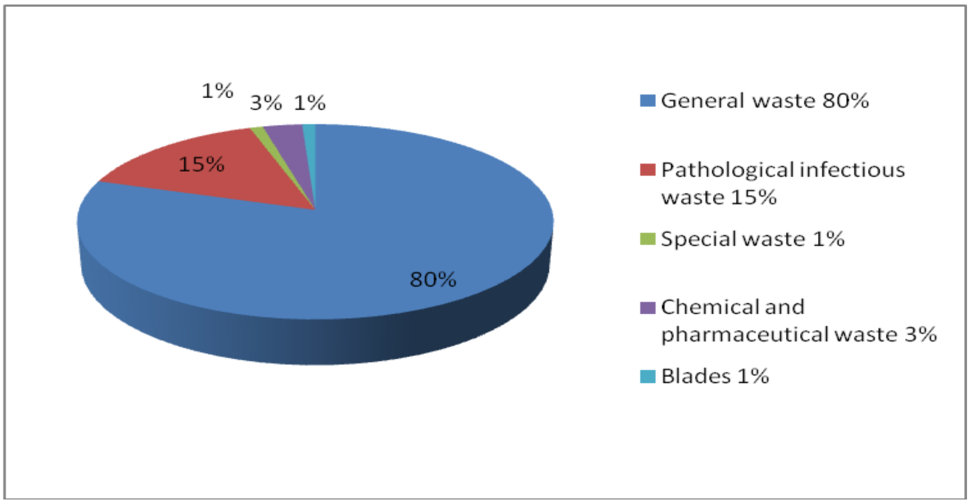

Figure 1. The structure of medical waste based on WHO

At the beginning of XXI century in Bosnia and Herzegovina numerous health facilities, currently do not implement enough effort in managing medical waste in accordance with the recommendations of the World Health Organization and the EU Directives. Hospitals as major sources of medical waste generated in practice are not made of waste segregation at source and in most cases the waste is collected together with the SWM and ends without pre-treatment on the landfill, which poses a serious threat to environmental quality and public health. Medical waste management problems were discussed in many studies. The main problems related to lack of legal framework for separating hazardous from non-hazardous medical waste, lack of educational training of medical waste management in health facilities and lack of monitoring the amount of generation. (Stankovic, A.et. al. 2008).

Studies reporting that the amount of generated medical waste varies in relation to changes in legislation. (Askarian M.et.al. Fisher S. Mohee R. Bdour A. et.al.) It is necessary to manufacture three- or five-year plan for disposal of infectious and other medical waste, including the development and application of the principles detailed instructions on handling this type of waste at all levels of health care. (Svraka, A. V. et.al. 2008)

In order to establish an adequate system of management of medical waste, it is necessary to estimate the amount of waste generated per bed, based on a number of influential factors associated with the generation rate in the general hospital Bijeljina, such as number of beds, bed occupancy, etc.. Calculating the Pearson correlation coefficient, determining and analyzing the trend function, we found that an increase in bed occupancy for each percentage increase in volume leads to the generation of medical waste per bed of 0.1 kg.

RESEARCH METHODOLOGY

Starting from the definition of statistics as a scientific discipline that deals with the collection, analysis and interpretation of data mass phenomenon, due to frequency of use of statistical methods in research and publications, research in this paper are based on collecting data on bed occupancy and estimate the amount of generating medical waste in the general hospital in Bijeljina. General Hospital in Bijeljina, as the largest source of medical waste generated in the municipality of Bijeljina, provides health care for 153,827 insured persons with total 313 beds and average bed occupancy of 72.1% per annum is shown in the diagram (see Figure 2).

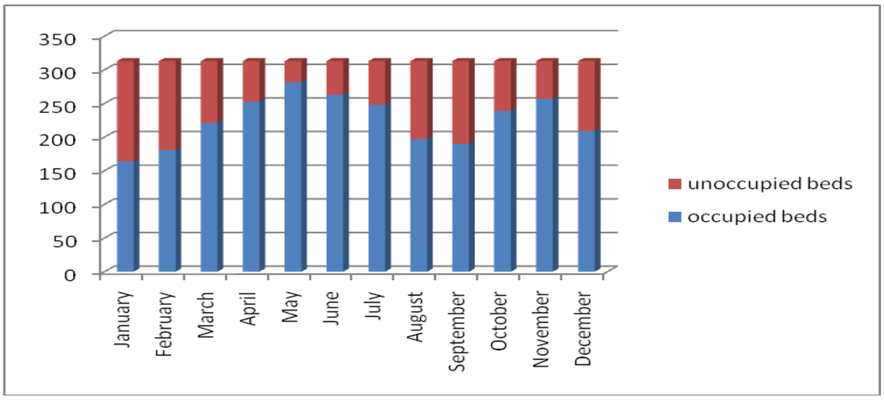

Figure 2. View the nomber of beds in the general hospital in Bijeljina between January and December of 2010

Surveys were conducted in 2010. The information provided were related to waste management system, assess the amount of waste, the number and availability of hospital beds, methods of collection and transport, reducing and recycling waste disposal methods and other operating conditions. As a result of surveys conducted in the general hospital in Bijeljina in 2010, came to the approximate average amount of medical waste generation of 1.9 kg/bed/day.

The absence of a system of monitoring the amount of generation leads to some inaccuracy of data, and should be taken with some reserve. Some data provided statistical estimates have been reduced to improve the accuracy of assessments, and qualitative impact on the prediction of growth of waste quantities generated per bed.

The types and quantities of medical waste generated per hospital bed varies depending on the type of health institutions (Trifkovic S. et. al. 2011). Notice that most medical waste generated in the diagnosis, treatment and immunization of patients.

In this regard, data from the consulted literature and data on the estimated daily quantity of medical waste generated in various countries and regions of the world are shown in Table 1(Gluszynski, 1999, Shaprio et. al, 2003, Mohee, 2005, Yang et al, 2006).

Table 1: Quantities of medical waste in some countries and regions of the world

Cantries and regions	Daily amounts	Measure unit
USA	7-10	kg/bed
South America	3	kg/bed
West Europe	3-6	kg/bed
East Europe	1,4 - 2	kg/bed
Taiwan	2,76-3,76	kg/bed
Korea	0,48	kg/bed
Japan	0,25	kg/bed
Jordan	0,1-3	kg/bed
Poland	2,6	kg/bed

Many factors are involved in generating medical waste, often build upon each other and require a comprehensive analysis.

In order to successfully estimate the amount of medical waste per bed general hospital in Bijeljina, it is necessary to examine the statistical impact of factors related to the generation of waste, through the following parameters and values:

- Monthly movement of bed-occupancy of hospital beds,
- The estimated current amount of waste per bed per month (for 2010.).

Movement of occupancy of hospital beds according to the general hospital Bijeljina for the period from January to December 2010. expressed as a percentage, is shown in the diagram (see Figure 3).

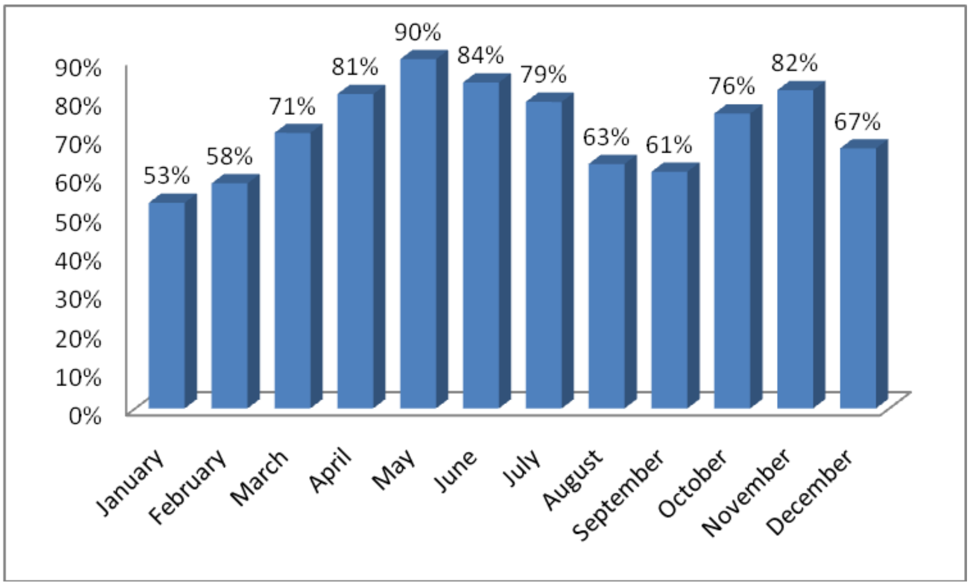

Figure 3. Movement of bed occupancy in the general hospital in Bijeljina between January and December of 2010

One-dimensional linear regression model can explain the impact of bed occupancy, which is related to the assessment of the amount of medical waste per bed, as a significant factor prediction.

By using one-dimensional linear regression model:

$$Y = -4{,}7 + 0{,}1X$$

leads to the relationship of parameters on bed occupancy and monthly estimates of the amounts of medical waste generated per bed general hospital in Bijeljina.

Calculating the Pearson correlation coefficient, determining and analyzing the trend function, we found that an increase in bed occupancy for each percentage increase in volume leads to the generation of medical waste per bed of 0.1 kg.

Based on the parameters of the bed occupancy we calculate the amount of medical waste generated per bed in 2010. year. We came to the data, the average amount of medical waste generated per bed of 2.5 kg.

RESULTS

Amounts of medical waste generated consists of hazardous and nonhazardous waste and vary depending on many factors of influence, such as types of health facilities, staffing and the number of beds.

The research in the general hospital Bijeljina shown in Table 2 shows the total number of available beds and the number of filled beds on a monthly basis for 2010. year, and the number of vacant beds in percentage.

Table 2: View the occupancy of beds in general hospitals for 2010 Bijeljina

Month	The percentage of occupied beds	The percentage of unoccupied beds	Total
January	53%	47%	100%
February	58%	42%	100%
March	71%	29%	100%
April	81%	19%	100%
May	90%	10%	100%
June	84%	16%	100%
July	79%	21%	100%
August	63%	37%	100%
September	61%	39%	100%
October	76%	24%	100%
November	82%	18%	100%
December	67%	33%	100%
Average:	72,1%	27,9%	100%

Applying the one-dimensional regression model:

$$Y= -4{,}7+0{,}1X$$

leads to the relationship between the parameters of bed occupancy and the amount of medical waste generated. If average bed occupancy increased from 72.1% to 100%, then the amount of medical waste generated per bed increased from 2.5 kg to a height of 5.3 kg. Therefore, increasing bed occupancy of 27.9% increasing the amount of waste generated per bed of 2.8 kg.

Calculating the coefficient of determination, R^2, leads to dependence of amounts of medical waste generated per bed occupancy. In this case the coefficient determination is $R^2 = 0.89$ and shows that the amount of medical waste generated per bed depends on bed occupancy at 89%, and that other factors influence with 11%. The model is representative because the coefficient of determination is approximately one.

DISCUSSION

Although there are a variety of influential factors on generation of the amounts of medical waste per bed in general hospital Bijeljina in the provision of health services, as the most influential factors were selected: the availability of beds.

In the empirical part of the paper was applied one-dimensional regression analysis model, which creates prerequisites for an explanation of the dependencies between these influencing factors.

Calculating the Pearson correlation coefficient, and the determination and analysis of the trend function, we found that:

- The increase in bed occupancy for each percentage leads to an increase in the amount of medical waste generated per bed of 0.1 kg / day.
- An increase in the average bed occupancy of 72.1% to 100%, there is an increasing of amounts of medical waste generated from 2.5 kg / bed height to 5.3 kg / bed.

CONCLUSION

Based on the research in this paper, we can conclude that there is a possibility of increase in medical waste generated in the general hospital Bijeljina, due to the lack of recycling activities.

General Hospital Bijeljina have not sufficient resources for the recycling of medical waste. There are not enough trained staff to manage medical waste.

It is essential that the management of general hospital Bijeljina make a decision and approaches to training of staff to the successful separation and selection of medical waste at the source.

The share of potentially hazardous medical waste, which presents 2o% of the total amount of medical waste, can be further reduced by 1-5% with the use of appropriate procedures of separation at source.

Since the general hospital is one of the largest sources of medical waste generated in the municipality of Bijeljina it is necessary that employ staff make a serious effort to reduce the bulk and increase the degree of separation and segregation of medical waste.

REFERENCES

Chaerul M. Tanak M. Shekdar A. V. *A system dynamics approach for hospital waste management, Waste Management 28, 442-449.*

Stanković, A., Nikić, D., Nikolić, M. (2008) *Treatment of medical waste in Nišava and Toplica districts, Serbia, Waste Manag Res, vol. 26, 3. pp.309-313.*

Askarian M. Vakili M. Kabir G. *Results of a hospital waste survey in private hospitals in Fars Province, Iran, Waste Management 24, 347-352.*

Fisher S. *Healthcare waste management in UK:the challenges facing healthcare waste producers in light of changes in legislation and increased pressures to manage waste more efficiently, Waste Management 25, 572-574.*

Mohee R. *Medical wastes characterization in healthcare institutions in Mauritius. Waste Management 25, 575-581.*

Bdour A. Altrabsheh B Hadadin N. Al-Shareif M. *Assessment of medical wastes management practice: a case study of the Northern Part of Jordan,Waste Management 27, 746-759.*

Svraka, A. V,. Vučina, Z., Filipović-Hadžiomeragić A., Mulaomerović, M.,(*2008) Methods of removing infectious and laboratorys'waste in clinic centers, HealthMed, Vol.2, no.4, p. 265-272.*

Trifković S. Pavlović M. Radovanović LJ. Pekez J. Desnica E. (2011), *Analysis projections of quantity medical waste generation in relation to the effects of factors, HealthMed,vol.5 (4), p. 986-990.*

UNEP, 2002. *Tehnical Guidelines on the Environmentally Sonud Management of Biomedical and Halthcare Waste, Basel Convencion, United Nations Environment Programme.*

Pijalović (Tahmaz) V, Kudumović M. (2010) *Analysis of health expenditure in the EU8 countries and Bosnia and Herzegovina, HealthMed 4 (4): 822-828.*

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APPENDIX[1]

1 Papers received after printing the proceedings

I International Conference
„ECOLOGY OF URBAN AREAS“ 2011

EMERGING SUBSTANCES IN SURFACE AND GROUNDWATER IN NOVI SAD AREA

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ABSTRACT

The emerging substances are contaminants that have been recently discovered in the environment due to their long-term, pseudo resistance and increased use in all industrial and humanity activities. Emerging substances (EmS) are detected in very low doses within the range of ppb, ppt and lower. Most emerging substances are ubiquitous and are wide spread in everyday life and applied in pharmaceutical and chemical industry, as cosmetic products, in electro industry, in agriculture, nanotechnology and nanomaterial and others. European legislation did not regulate the status and the maximum allowed concentration of most EmS. EmS might jeopardize surface water and ground water resources, particularly, drinking water production. The preliminary results of Danube surface water in the vicinity of Novi Sad show presence of benzotriazole and caffeine. In some samples of groundwater the most frequently detected were diclofenac, ibuprofen, carbamazepine and metamizol metabolites 4-AAA and 4-FAA, within 19 pharmaceuticals that were analyzed in Serbia.

Keywords: emerging substances, pharmaceuticals, surface and ground water, low doses.

INTRODUCTION

Water is essential for life and strategic resource for every country and population. Its availability and sanitary safety is highly connected with the health and economy status. Burden of disease due to polluted water is a major public health problem throughout the world. Groundwater is a compex natural resource with a high degree of a spatial variability. Although is a „hidden resource“ which occurs beneath the surface, it is nonetheless susceptable to a wide range of external pressures pf various types, including chemical contamination and depletion through over-pumping, from which it cannot be easily protected (Dimkic et al., 2008). There is an incomplete understanding of weather or not groundwater quality is declining over time on a wide scale (at a river basin, country or regional level), or if, in fact, there are significant large scale changes in groundwater quality taking place which are the result of reductions in recharge, climate change, or over - explanation. Two aspects of groundwater resource protection are the focus of waste management: groundwater quality protection and groundwater quantity protection.

More than two million inhabitants and industry in Vojvodina use groundwater for their water supply, captured from aquifers at different depths, ranging from 20 to more than 200 m. There is large number of aquifers in water-bearing media of younger chrono-stratigraphic units – Quaternary and Pliocene.

In Vojvodina, nearly 70% of groundwater is abstracted from deep, regional aquifers. The over-exploitation problem has been present in the Bačka and Banat regions since the early 1980’s, when the rate of abstraction for public and industrial water supply exceeded natural recharge of the basic water bearing complex (BWC). The impact of over-exploitation is primarily seen in declining groundwater levels in the wider areas of groundwater sources (resulting in increasing abstraction costs), declining yield, and in some cases local land subsidence. Extreme drawdowns were recorded in the wider zones of water sources; lowering of piezometric head in the past 3 decades is present in the regions of north Bačka and north Banat (between 20 and 30 metres).

A forecast of the effects of future groundwater abstraction at the current rate (roughly 4.5 m^3/s) or higher showed that that there will be a further decline in groundwater levels, in some areas by several dozen meters.

The quality of groundwater in Bačka, Banat and Srem is characterized by distinctive inequality, ranging from acceptable water quality to water that requires a high level of treatment. Groundwater chemistry in central Bačka is characterized by elevated concentrations of organic substances, arsenic, iron and manganese, while in the catchment area of the Tisa and in western Bačka (Odžaci), $KMnO_4$ demand is greater than 20 mg/L, and even as high as 100 mg/L (the prescribed limit value is 8 mg/L). Other characteristics of this groundwater include permanently elevated iron concentrations, sometimes as high as 3 mg/L, and the absence of manganese, nitrite and nitrate.

Based on recorded values, there are several areas with extremely high arsenic concentrations (> 50 μg/L): northern, western and southern Backa, and northern and central Banat. A relatively narrow zone between the towns of Zrenjanin and Žitište (central Banat), is characterized by highly-mineralized groundwater (in excess of 1200 mg/L), and high concentrations of iron (generally 0.4 but also above 2 mg/L), arsenic (up to 200 μg/L), and the ammonium ion (over 2 mg/L), as well as significantly high Natural Organic Matter (NOM) levels in groundwater (with $KMnO_4$ demand occasionally exceeding 200 mg/L). Over the past decade, major efforts were made (especially in the Town of Zrenjanin) to find a suitable technology for the treatment of this groundwater; 9 pilot plants were installed and tested but the results were not satisfactory. A highly complex technology (aeration, flocculation/sedimentation, ozonation, multilayer filtration and disinfection, and in some cases reverse osmosis) is required to treat this groundwater (Dimkic et al., 2011). Chemicals are a part of modern life and are present in all spheres of human life. The biggest number of organic and inorganic chemicals belongs to emerging chemicals. EmS contribute to our well being, high life expectancy and economic prosperity. Millions of EmS entering the environment – every year espetially in urban areas. There are four stages of the urban water cycle which are presented in Figure 1.

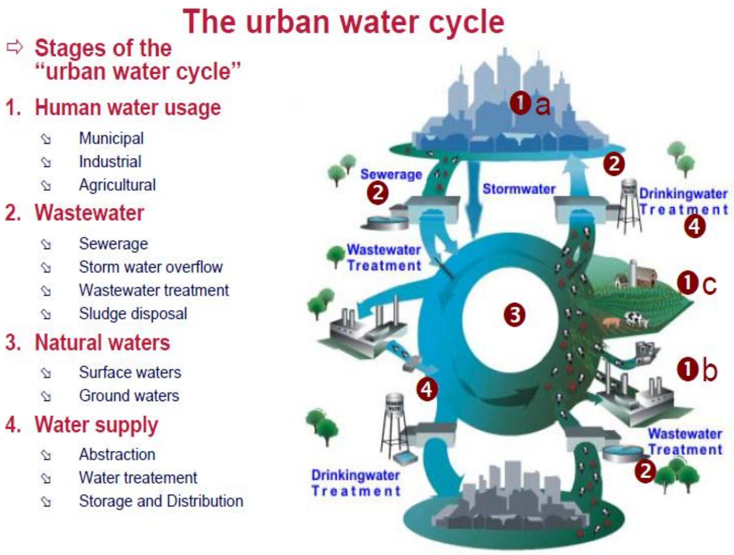

Figure 1. The urban water cycle

In Europe, millions of people depend on river surface waters (Danube, Meuse, Rhine) as the sources of drinking water. Surface waters are contaminated with thousands of chemical compounds originating from industry, agriculture, household use which number is still increasing. Therefore the presence of EmS residues in the environmental mediums has become a subject of growing concern in the past decade.

Project NORMAN identified a list of the currently most frequently discussed EmS today (http://www.norman-network.net). According to NORMAN EmS can be defined as substances that have been detected in the environment, but which are currently not included in routine monitoring programs at EU level and whose fate, behavior and (eco)toxicological effects are not well understood. Within NORMAN EmS are divided into 23 categories (classes) with 79 subcategories/subclasses with examples of individual emerging substances whose list is still open (Table 1).

Table 1: Emerging substances – most frequently discussed

Category / class	Sub-class	Individual substances
Algal toxins	Cyanotoxins	Microcystin-LR, Microcystin-RR, Microcystin-YR
Antifoaming agents	Antifoaming agents	Surfinol-104
Antioxidants	Antioxidants	2,6-Di-tert-butylphenol, 4-tert-Butylphenol, BHA, BHQ, BHT
Antifouling compounds	Antifouling compounds	Irgarol
	Organotin compounds	Dibutyl tin ion, Monobutyl tin ion, Tetrabutyl tin ion, Diphenyltin ion, Triphenyltin ion
Bio-terrorism/ sabotage agents	Bio-terrorism/ sabotage agents	Chloropicrin
Complexing agents	Complexing agents	DTPA, EDTA, NTA, Oxadixyl, TAED
Detergents	Aromatic sulphonates	Naphthalene sulphonic acid
	Alcohol ethoxylates (AEs), Alkanol amides, Alkyl glucamides (AGs), Alkyl polyglucosides (APGs), Alkyl sulfates (AS), Alkylether sulfates (AES), Alkylphenol ethoxylates (APEOs), alpha-Olefin sulfonates (AOS), Amine ethoxylates, Cocamidopropyl betaine, Fatty acid diethanolamides (FADAs), Organosilicones, Polyethylene glycols, Secondary alkane sulfonates (LAS)	
	Linear alkylbenzene sulfonates (LAS)	C10-C14-LAS, C12-LAS
	Ethoxylates/carboxylates of octyl/nonyl phenols	4-Nonylphenol di-ethoxylate (NPE2O), 4-Nonylphenol mono-ethoxylate (NPE1O) 4-Nonylphenoxy acetic acid (NPE1C), 4-Nonylphenoxyethoxy acetic acid (NPE2C), 4-Octylphenol di-ethoxylate (OPE2O), 4-Octylphenol mono-ethoxylate (OPE1O), 4-Octylphenoxy acetic acid (OPE1C), 4-Octylphenoxyethoxy acetic acid (OPE2C)
Disinfection by-products (drinking water)	Iodo-trihalomethanes, Bromoacids Bromoacetonitriles, Bromoaldehydes, Haloacetic acids (chloro-, bromo-, iodo-)	
	Other disinfection by-products	Bromate, Cyanoformaldehyde, Decabromodiphenyl ethane, Hexabromocyclododecane (HBCD), NDMA
Plasticizers	Phthalates	Benzylbutylphthalate (BBP), Diethylphthalate (DEP), Dimetylphthalate (DMP), Di-n-butylphthalate (DBP), Di-n-octylphthalate (DOP)
	Other	Bisphenol A, Triphenyl phosphate
	Benzophenone derivatives	2,4-Dihydroxybenzophenone
Flame retardants	Brominated flame retardants	1,2,5,6,9,10-Hexabromocyclododecane (HBCD),Tetrabromo bisphenol A (TBBPA), Tetrabromo bisphenol A bis (2,3 dibromopropylether), Hexabromocyclododecane (isomers), Decabromodiphenyl ethane
	Polybrominated diphenylethers	2,2\',3,4,4\',5\',6-Heptabromodiphenyl ether (BDE 183) 2,2\',4,4\',5,5\'-Hexabromodiphenyl ether (BDE-153) 2,2\',4,4\',5,6\'-Hexabromodiphenyl ether (BDE-154)

		2,2\',4,4\',5-Pentabromodiphenyl ether (BDE-99) 2,2\',4,4\',6-Pentabromodiphenyl ether (BDE-100) 2,2\',4,4\'-Tetrabromodiphenyl ether (BDE-47) 2,2',3,3',4,4',5,5',6,6'-Decabromodiphenyl ether (BDE-209) Technical Decabromodiphenyl ether, Technical Octabromodiphenyl ether Technical Pentabromodiphenyl ether
	Organophosphates	Tri-(dichlorisopropyl)phosphate, Triethylphosphate, Tri-n-butylphosphate, Triphenylphosphate Tris(2-chloroethyl)phosphate
	Chlorinated paraffins	Long chain PCAs (lPCAs, C>17), Medium chain PCAs (mPCAs, C14-17), Technical PCA products
Fragrances	Fragrances	Acetylcedrene, Benzylacetate, Benzylsalicylate, Camphor, g-Methylionone, Hexylcinnamaldehyde, Isoborneol, Isobornylacetate, Isoquinoline, d-Limonene, Methyldihydrojasmonate, Methylsalicylate, p-t-Bucinal, Terpineol
	Nitro musks	Muskketone, Muskxylene, Musk ambrette
	Macrocyclic musks	
	Polycyclic musks	AHTN (Tonalide), Galaxolide, OTNE, AHDI (Phantolide), ADBI (Celestolide), ATII (Traseolide)
Gasoline additives	Dialkyl ethers	Methyl-tert-butyl ether (MTBE)
Industrial chemicals	Industrial chemicals	TCEP, Triphenyl phosphine oxide
Nanoparticles	Carbon fullerenes	Buckyballs (Fullerene C-60)
	Carbon nanotubes	Carbon nanotubes - single-wall, Carbon nanotubes - multi-wall, Carbon nanotubes - coated
	Carbon black	Carbon black
	Silicon-based	Silicon Carbide, Silica
	Titanium dioxyde	Titanium dioxyde
	Aluminium Oxide	Aluminium Oxide (powder), Aluminium Oxide (fibre)
Perfluoroalkylated substances and their transformation products	Perfluoroalkylated substances	2-(N-ethylperfluorooctanesulfonamido)-ethyl alcohol (N-Et-FOSE) 2-(N-methylperfluorooctanesulfonamido)-ethyl alcohol (N-Me-FOSE) 6:2 Fluorotelomer sulfonate (6:2 FTS) Alcohol N-methylperfluorooctane sulfonamidoetanol (N-MeFOSE) N-ethylperfluorooctanesulfonamide (EtFOSA) N-methylperfluorooctanesulfonamide (MeFOSA) N-methylperfluorooctanesulfonamidoethyl acrylate (N-MeFOSEA) Perfluorobutanesulfonate anion (PFBS), Perfluorodecane sulfonate (PFDS) Perfluorodecanoic acid (PFDA), Perfluorododecanoic acid (PFDoA) Perfluorododecanoic acid (PFDoA), Perfluoroheptanoic acid (PFHpA) Perfluoroheptanoic acid (PFHxA), Perfluorohexane sulfonate (PFHS) Perfluorononanoic acid (PFNA), Perfluorooctane sulfonamide (PFOSA) Perfluorooctane sulfonamidoethanol (FOSE), Perfluorooctane sulfonate (PFOS) Perfluorooctanesulfonyl fluoride (POSF), Perfluorooctanoic acid (PFOA) Perfluorosulfonamide, Perfluorotetradecanoic acid (PFTDA) Perfluoroundecanoic acid (PFUnA)
	Fluorotelomer alcohols	4:2 FTOH, 6:2 FTOH, 8:2 FTOH, 10:2 FTOH, 12:2 FTOH
	Perfluorosulfonamido alcohols	
Personal care products	Sun-screen agents	4-Methylbenzylidene camphor, Benzophenone, Benzophenone-3, Butyl methoxydibenzoylmethane, Ethylhexyl methoxycinnamate, Eusolex, Homosalate, N,N-Diethyltoluamide, Octocrylene, Oxybenzone
	Insect repellents	N,N-diethyl-m-toluamide (DEET), Bayrepel

	Carriers	Octamethylcyclotetrasiloxane (D4), Decamethylcyclopentasiloxane (D5) Dodecamethylcyclohexasiloxane (D6), Hexamethyldisiloxane (HM or HMDS) Octamethyltrisiloxane (MDM), Decamethyltetrasiloxane (MD2M) Dodecamethylpentasiloxane (MD3M)
	Parabens (hydroxybenzoic acid esters)	Methyl-paraben, Ethyl-paraben, Propyl-paraben, Isobutyl-paraben
Pesticides	Polar pesticides and their degradation products	Amitrole, Bentazone, Bromofos-ethyl, Carbazole, Carbendazim, Carboxin, Glyphosate, Chloridazon, Clopyralid, Chlorpropham, Chlorpyrifos, Chlorotoluron, 2,4 D, Dicamba, Desethylterbutylazine, Desmedipham, Desmetryn, Diazinon, Diclobenil, d-Dichlorvos, Dinoterb, Endosulfan-sulfate, Ethoprophos, Ethofumesate, Fluroxypyr, Heptenophos, Iodofenphos, Imidacloprid, MCPA, MCPB, MCPP (Mecoprop), Metalaxyl, Methomyl, Metamitron, Mevinphos, Phenmedipham, Prometryn, Prometon, Secbumeton, Terbutryn, Terbutylazine, Thiabendazyl, Triadimefon
	Other pesticides	Cypermethrin, Deltamethrin, Permethrin
	New pesticides	Sulfonyl urea
	Degradation products of pesticides	Desisopropylatrazine, Desethylatrazine
	Antimicrobial agents	Dichlofluanide
Biocides	Biocides	Triclosan, Methyltriclosan, Chlorophene
Pharmaceuticals	Analgesic	Acetaminophen (paracetamol), Codeine, Hydrocodone
	Anorexic	Fenfluramine
	Anthelmintic	Ivermectin
	Antibacterial	Amoxicillin, Ampicillin, Azithromycin, Chloramphenicol, Chlortetracycline, Ciprofloxacin, Clarithromycin, Cloxacillin, Danofloxacin, Dicloxacillin, Doxycycline (anhydrous), Doxycycline (monohydrate), Enoxacin, Enrofloxacin, Erythromycin, Flumequine, Josamycin, Lincomycin, Methicillin, Minocycline, Norfloxacin, Novobiocin, Ofloxacin, Oleandomycin, Oxacillin, Oxytetracycline, Penicillin G, Penicillin V, Roxithromycin, Spiramycin, Sulfadiazine, Sulfamerazine, Sulfamethazine
	Anticonvulsant	Sulfamethoxazole, Sulfapyridine, Carbamazepine, Primidone
	Antidepressant	Tetracycline, Tiamulin, Citalopram, Escitalopram, Sertraline, Fluoxetine, Fluvoxamine, Paroxetine
	Antidiabetic	Glyburide (glibenclamid; glybenzcyclamide), Metformin
	Antiemetic	Diphenhydramine
	Antihistaminic	Loratadine
	Antihypertensive	Nadolol, Verapamil
	Anti-inflammatory	Aceclofenac, Acemetacin, Acetylsalicylic acid (aspirin), Alclofenac, Diclofenac, Fenoprofen, Fenoprofen calcium salt dihydrate, Ibuprofen, Indomethacin, Ketoprofen, Meclofenamic acid, Mefenamic acid, Naproxen, Phenylbutazone, Phenazone, Propyphenazone, Tolfenamic acid
	Antimicrobial agent	Clotrimazole
	Antineoplastic	Cyclophosphamide, Cyclophosphamide (anhydrous form), Daunorubicin, Doxorubicin, Epirubicin, Fluorouracil, Ifosfamide
	Antiulcerative	Famotidine, Lansoprazole, Omeprazole, Ranitidine
	Antiviral	Acyclovir
	Anxiolytic	Alprazolam, Bromazepam, Diazepam, Lorazepam, Medazepam, Meprobamate, Nordiazepam, Oxazepam, Temazepam
	Beta-Blockers	Acebutolol, Atenolol, Betaxolol, Bisoprolol, Carazolol, Metoprolol, Oxprenolol, Pindolol, Propranolol, Sotalol, Timolol
	Blood viscosity agents	Pentoxifylline
	Bronchodilators	Albuterol, Albuterol sulfate, Clenbuterol, Fenoterol, Salbutamol, Terbutaline

	Diuretic	Caffeine, Furosemide, Hydrochlorothiazide
	Lipid regulators	Bezafibrate, Clofibric acid, Etofibrate, Fenofibrate, Fenofibric acid, Gemfibrozil, Lovastatin, Mevastatin, Pravastatin, Simvastatin
	Sedatives, hypnotics	Acecarbromal, Allobarbital, Amobarbital, Butalbital, Hexobarbital, Pentobarbital, Aprobarbital, Secobarbital sodium
	Steroids and hormones	17-alpha-Estradiol, 17-alpha-Ethinylestradiol, 17-beta-Estradiol, Beta-sitosterol, Cholesterol, Diethylstilbestrol, Estriol, Estrone, Estrone 3-sulphate, Prednisolone, Dexamethasone, Bethametasone, Mestranol
	Psychiatric drugs	Amitryptiline, Doxepine, Imapramine, Nordiazepam, Zolpidem
	X-ray contrast media	Diatrizoate, Iohexol, Iomeprol, Iopamidol, Iopromide
Trace metals and their compounds	Trace metals and their compounds	Tetramethyllead, Tetraethyllead
Anticorrosives	Benzotriazoles	
	Methylbenzotriazoles (MBT)	4-Methyl-1H-benzotriazole, 5-Methyl-1H-benzotriazole, 5,6-Dimethyl-1-H-benzotriazole
	Tolyltriazoles (TT)	Tolyltriazole, 4-/5-Tolyltriazole (TTri)
Wood preservatives	Phenols	para-Cresol
Other	Drugs of abuse	Cocaine, Codeine, Dihydrocodeine, Heroin, Hydrocodone, Morphine, Oxycodone
	Benzothiazoles (BT)	Benzothiazole, 2-Mercapto-benzothiazole, Benzothiazole sulfonic acid
	Nicotine metabolite	Cotinine

Some portion of EmS will enter wastewater as part of the influent. Unless specifically removed by wastewater treatment processes, they may persist and be released into receiving waters as trace pollutants. Some fraction of the organic compounds used for agricultural purposes will runoff into a surface water body, while another fraction of the compounds will infiltrate and reach the groundwater system.

The term trace pollutant indicates very low concentrations of an environmental contaminant in the $\mu g\,L^{-1}$ range or lower which is one of the basic properties of EmS. It is challenging to develop a comprehensive list of compounds labeled as EmS and such a list must be dynamic and open, as new chemicals are continuously developed and produced.

It is believed that long-term consumption of EmS can cause adverse health effects in most organisms at concentrations as low as a few ng L^{-1}. Predicting the human health effects caused by exposure to EmS is a difficult task.

The objectives of this paper are to provide an overview on EmS in the surface and ground water, with most frequently detected EmS in order to prioritize EmS research needs.

THE MAIN CLASSES/CATEGORIES OF EMERGING SUBSTANCES

There is not a clear agreement about which compounds can be considered as EmS. Most of them have been present in the environment for a long time, but their significance and finding are only now being elucidated and, therefore, they are generally not included in the legislation. EmS can be classified under this category according to their chemical class (chemicals of totally new structure), type of use (new uses in industry or in consumer realms), type of effect (new discovered effects), source (new or previously unknown origins for existing chemicals), and exposure (pathways that had not been anticipated or had been previously discounted as not possible). Taking into account these criteria, compounds that can be considered as EmS are the pharmaceuticals and personal care products

(PPCPs), steroids, xenoestrogens and other endocrine disrupting compounds (EDCs), methyl *tert*-butyl ether (MTBE) and related compounds, surfactants and their metabolites (alkylphenolic compounds, linear alkylbenzenesulfonate (LAS) and sulfophenyl carboxylates (SPC)), drinking water disinfection by-products (DBPs) including *N*-nitroso-dimethylamine (NDMA) and nitrosamines, gasoline additives, brominated flame retardants (polybrominated diphenyl ethers), industrial additives and agents, algal toxins, and other pathogens, organotins, perfluorooctanoic acid (PFOA) and perflluorooctanesulfonate (PFOS), pesticide degradation products, chiral contaminants, chemical warfare agents, and a variety of miscellaneous chemicals such as caffeine, cholesterol, etc.

Exposure to EmS in the aquatic ecosystem is of particular concern, since aquatic organisms are subjected to continual impact of EmS. This fact makes these pollutants, even those that have relatively short environmental half-lives, to be assumed as “pseudopersistent”. Moreover, the polar and non-volatile nature of some drugs prevents their escape from the aquatic realm.

Pharmaceuticals. The possibility of emission of pharmaceuticals in the environment has been recognized in environmental science since several decades. Conventional municipal sewage treatment plants appeared to play an important role in the introduction of pharmaceuticals in the environment purifying household waste water mainly by subsequent application of bacterial degradation of organic matter, and coagulation/flocculation for the removal of suspended solids and phosphates. In these processes, which are predominantly optimized for the degradation of waste of natural origin, organic contaminants are primarily removed by bacterial degradation and sorption to solids. The past decades have shown that this treatment is rather inadequate in removing pharmaceuticals in effluents and receiving waters in their original form, or as degradation products. Besides household sewage, other emission sources of human pharmaceuticals are waste waters from manufacturers, hospitals, and disposal of unconsumed drugs via solid waste. It is estimated that up to 65% of sold pharmaceuticals are never consumed.

Furthermore, large quantities of pharmaceuticals, e.g. antibiotics and inflammatory drugs do not pass sewage treatment. Several studies have reported that some pharmaceuticals are not completely removed by drinking water treatment and are found at trace levels in drinking water. It was demonstrated that the environment is also contaminated with drugs with predominantly non-medical applications. It is estimated that up to 5% of the world population uses illicit drugs, like cocaine, heroin, cannabinoids (hashish, marijuana), and amphetamine-like stimulants (such as ecstasy). In 2005, Zuccato et al. published a first systematic study on the presence of cocaine and its degradation product benzoylecgonine in surface and waste water samples from the Italian river Po. The results were interesting not only from an environmental but also from a societal-forensic point of view. Based on the measured concentrations, the authors calculated that cocaine consumption was considerably higher than estimated. In addition, also non-controlled stimulatory compounds, such as caffeine from coffee, tea, and soft drinks and nicotine from tobacco were often included in these investigations. Illicit and non-controlled drugs were structurally found at ng/L or lower concentrations in waste and surface waters. Degradation in sewage treatment plants varied considerably between different drugs. The most frequently found compound was benzoylecgonine, pointing to the use of cocaine.

Personal care products, PCPs. PCPs comprise active ingredients of cosmetics, toiletries, and fragrances. They are applied as preservative or to alter odor, appearance, touch, or taste. One group of PCPs consists of compounds used as fragrance, such as polycylic musks. A second group comprises preservatives like parabenes applied in shampoos, creams, and toiletries to prevent bacterial decay. Furthermore, disinfectants like triclosan and clorophene are used on a large scale. Triclosan for example has been used for decades in a wide variety of consumer products, ranging from toothpaste and hand soap to toys and socks. Compounds such as benzophenone in sun screen lotions that block UV light have gained interest of environmental chemists and biologists. Alkylated siloxanes are compounds used in soaps, hair-care products, etc. PCPs enter the environment *via* sewage treatment effluent as a result of showering, washing off, washing clothes, etc., but are also directly released in surface waters by recreational activities as swimming and sunbathing. PCPs are observed regularly in effluents and surface waters worldwide. Some of them can accumulate in exposed organisms. This was illustrated by observation of triclosan and clorophene in bile from bream in the Dutch River Dommel. Some personal care products are suspected to have potentially adverse potencies, such as estrogenic hormone-like activity (UV blockers, parabens), developmental toxicity (UV blockers), and extreme bioaccumulation (musks).

Nanoparticles. Nanoparticles constitute a rapidly growing research area. They are extremely small in size with diameters between 1 and 100 nm and have properties that differ from smaller (molecules) or larger (bulk materials) particles of the same composition. Besides inorganic compounds, such as TiO_2 and nanosilver, and also organic compounds, such as carbon nanotubes and ‘‘nano-C60’’, fullerene, are examples of nanoparticles. They can be of natural origin as well as manufactured and a wide variety of applications is foreseen or already implemented (in medicine and food industries). Meanwhile, questions about their environmental fate and possible human-health risks arise. Due to their small size, their surface is relatively large and their chemical reactivity and biological activity remain relatively high. Nanoparticles can enter the body and cells more easily than larger particles. It is suggested that they might evoke inflammatory responses and DNA damage. However, very little is as yet known about possible toxic properties of nanoparticles. Although currently environmental data are scarce, techniques for the analysis of nanoparticles in environmental samples are developing fast, and it is expected that monitoring data will become available soon.

Flame retardants, FR. Flame retardants are a class of chemicals that are widely used in plastics, textiles, furnishing foams, sofas, computers, televisions and other contemporary products, to slow down inflammation in the event of a fire and reduction of fire risks. In the past, mainly polybrominated biphenyl and polybrominated diphenyl ethers were used for this purpose. These compounds are structurally similar to ‘‘conventional’’ contaminants as polychlorinated biphenyls, and likewise is their behavior in the environment. Brominated FRs are structurally detected in tissues, blood and breast milk of wildlife and humans. This is worrying, that these compounds and their degradation products have several potentially toxic properties, such as the ability to disrupt the thyroid, androgenic and estrogenic hormone systems, toxicity for the nervous system and they might also be carcinogenic. Because of their low solubility in water, they tend to sorb to sediments in rivers instead of reaching high concentrations in water. Another class of FRs are organophosphate FR with tributylphosphate and tris(2-chloroethyl)phosphate as important representatives. Their widespread use may even increase since many brominated FR have been banned. Organophosphate FR, for which toxicity data still are scarce, are persistent, although better soluble in water than brominated ones, and several studies have reported their presence in surface and waste waters (Vojinovic Miloradov et al., 2011).

PSEUDOPERSISTENCY

Persistency is one of the most important criteria in the environmental assessment of chemicals. Even if there is some degree of degradation of EmS, the parent compounds will nevertheless be present at constant levels in the environment if the input rate is higher than their rate of degradation or mineralization. This can be called second order persistency or pseudo persistency – $V_{input} > V_{degradation}$. A long half life of chemicals in the environment results in a wide range for the chemicals. That is, they will be present in big compartments for a long time. For chemicals and transformation products with such properties, it is not possible to carry out a risk assessment.

Very often EmS do not become degraded, i.e. they are not, or are only incompletely, broken down to water, carbon dioxide and inorganic salts. Unknown transformation products can result from such biological and chemical processes such as hydrolysis, redoxreactions or photolysis. These unknown chemical entities can remain in the environment and can also be toxic for humans and environmental organisms. The situation may be worse as there is usually much less knowledge about the dead end transformation products with regards to their fate, and their effects on the environment than on the parent compounds. Persistency is one of the most important criteria in the environmental assessment of chemicals.

INSTEAD OF CONCLUSION

Improvements in chemical analysis techniques (HPLC-TOF-MS^2) during the last decades have led to the discovery of myriads of EmS in surface waters and groundwaters at very low concentrations (ppb and ppt and lower), that could not be registered and detected earlier. EmS exhibits the negative impact of the widespread use of emerging chemicals in our modern society on the environment and casts on us the responsibility to seek for ways to deal with their presence in all compartments of the environment especially for drinking water sources.

The new awareness of presence of EmS in very low doses, their pseudopersistancy, no regulations for their maximal allowed concentration, unknown negative effect on environment, biota and human beings, are seeking the new concept and scenario of surface and groundwater protection and management.

This new approach focused on EmS requires holistic joint efforts of the scientific community and water sector.

Our preliminary results of Danube surface water in the vicinity of Novi Sad are showing presence of benzotriazole, caffeine. Pharmaceuticals diclofenac, ibuprofen, carbamazepine and metamizol metabolites 4-AAA and 4-FAA were detected in the groundwater in Serbia. This is the first research of this kind done in Danube surface water near Novi Sad and is part of the national and international projects.

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REFERENCES

Dimkic, M., Brauch, H.J., Kavanaugh, M. (2008). Groundwater management in large river basins, IWA Publishing, Alliance House, 12 Caxton Street, London SW1H 0QS, UK.

Dimkić, M., Đurić, D., Milovanović, M., Laušević, M., Jevtić, G., Petković, A. (2011). Water Research and Management, 1 (1), 29-45.

NORMAN FP6 network laboratories monitoring emerging pollutants http://www.norman-network.net.

Vojinović-Miloradov, M., Turk Sekulić, M., Radonić, J., Mihajlović, I., Stošić, M. (2011) Emerging substances of concern – a shift in traditional thinking, 15th International Eco-Conference / 9th Eco-Conference on Environmental Protection of Urban and Suburban Settlements, Novi Sad.

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TRANSBOUNDARY AIR QUALITY MONITORING ISSUES IN ROMANIAN AND SERBIAN BANAT REGION

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ABSTRACT

This paper presents the objectives and first results obtained from parallel monitoring campaigns of air quality in the border area between Romania and Serbia, so called Banat region. The monitoring campaigns are a tool in a project founded thru IPA Cross Border Cooperation Programme Romania – Serbia. We believe that the quality of life, at all levels, can only be improved trough regional cooperation and our universities are leading poles of social, economic and scientific sustainable development in entire Banat region. For the moment air quality parameters in Banat region are almost unknown. In the Timis county have been recently deployed some monitoring stations but their location is fixed and not always wisely chosen. For the Serbian Banat these stations simply do not exists, or are equipped with obsolete low resolution equipments.

In this paper first results obtained from air quality monitoring campaigns are presented and discussed, relevant concentrations of O3, NOx, CO, NMHC, CH4 and PMs measured on cross-border Banat area are presented.

Keywords: air quality monitoring (AQM), environment, cross-border pollution.

OVERVIEW OF THE AQM EQUIPMENTS USED

The equipments used are part of the air quality monitoring mobile laboratory and procedures used are in full compliance with ISO/CEN 17025:2005 standard for quality assurance in analytic laboratories. The laboratory is the property of "Politehnica" University of Timisoara and more details and information's (including certifications) can be found on www.mediu.ro

Linde and DKD (Deutsche Kalibrierdienst) calibrations gases (NO, SO2, CO, CH4 in N2) were used.

The mobile laboratory is equipped with reference point instruments for major pollutants (SO_2, O_3, NOx, CO, CH_4, NMHC, THC and PM10). Meteorological sensors (wind speed and direction, air temperature, pressure and humidity) are mounted around the mobile laboratories. The following pollutants have been continuously measured, with 10 second resolution, over the entire measuring episode with high precision equipment:

- SO_2 measured with Environnement AF21M instrument, measurement principle is UV fluorescence, reference method: EN 14212:2005. The combined measurement uncertainty is U = 1.76 % for recorded values;
- NO, NO_2 and NOx measured with Environnement AC31M instrument, measurement principle is chemiluminescences, reference method: EN 14211:2005. The combined measurement uncertainty is U = 2.06 % for recorded values;

- O_3 measured with Environnement O341M instrument, measurement principle is UV photometry, reference method: EN 14625:2005. The combined measurement uncertainty is U = 6.98 % for recorded values;
- CO and CO_2 measured with Environnement CO12M instrument, measurement principle is NDIR (Non Dispersive Infrared), reference method EN 14626:2005. The combined measurement uncertainty is U = 4 % for recorded values;
- CH_4, NMHC and THC measured with Horiba APHA370 instrument, measurement principle is FID (flame ionization detection), reference method EN 12619:2002. The combined measurement uncertainty is U = 0.9 % for recorded values;
- PM10 (suspended particles, fraction PM10), TSI DUSTTRACK, measurement principle is light scattering / laser.

Table 1: Equipments used and relevant informations

Pollutant	Methods	Standard	Equipment	Measurement uncertainty
CO	NDIR	EN 14626:2005	Environnement CO12M	4 %
NO (NO2, NOx)	Chemiluminescence	EN 14211:2005	Environnement AC31M	2.06 %
O3	UV photometry	EN 14625:2005	Environnement O341M	6.98 %
CH4, NMHC, THC	FID (flame ionization detection)	EN 12619:2002 EN 13526:2002	Horiba APHA 370	0.9 %
SO2	UV fluorescence	EN 14212:2005	Environnement AF21M	1.76 %
PM10	Gravimetric / Light scattering	EN12341	TSI Dusttrack	5 %
CO, SO2, NO, NO2, NOx, PM10, O3, NMHC		EN 14626:2005, EN 14211:2005, EN 14625:2005, EN 14212:2005, EN12341	AIRPOINTER	N/A

TIMISOARA AIR QUALITY CAMPAIGN

Timisoara was first mentioned as a place in either 1212 or 1266. The territory later to be known as Banat was conquered and annexed by the Kingdom of Hungary in 1030. Timisoara grew considerably during the reign of Charles I, who, upon his visit here in 1307, ordered the construction of a royal palace. Timisoara's importance also grew thanks to its strategic location, which facilitated control over the Banat plain. John Hunyadi established a permanent military encampment here, and moved here together with his family. In 1552, Ahmed Pasha conquered the city with a 16,000 Ottomans and transformed it into a capital city in the region. Timisoara was the first mainland European city to be lit by electric street lamps in 1884. It was also the second European and the first city in what is now Romania with horse drawn trams in 1867. Gustave Eiffel, the creator of the Eiffel Tower in Paris, built one of Timisoara's footbridges over the Bega. According to the last Romanian census, from 2002, there were 317,660 people living within the city of Timisoara, making it the fourth most populous city in Romania. The Timisoara metropolitan area has a population of 365,545. [1]

A view over the monitoring site is given in figure 1, the location chosen was considered representative for the Eastern industrial area of Timisoara.

Figure 1. View of the first Timisoara measurement site

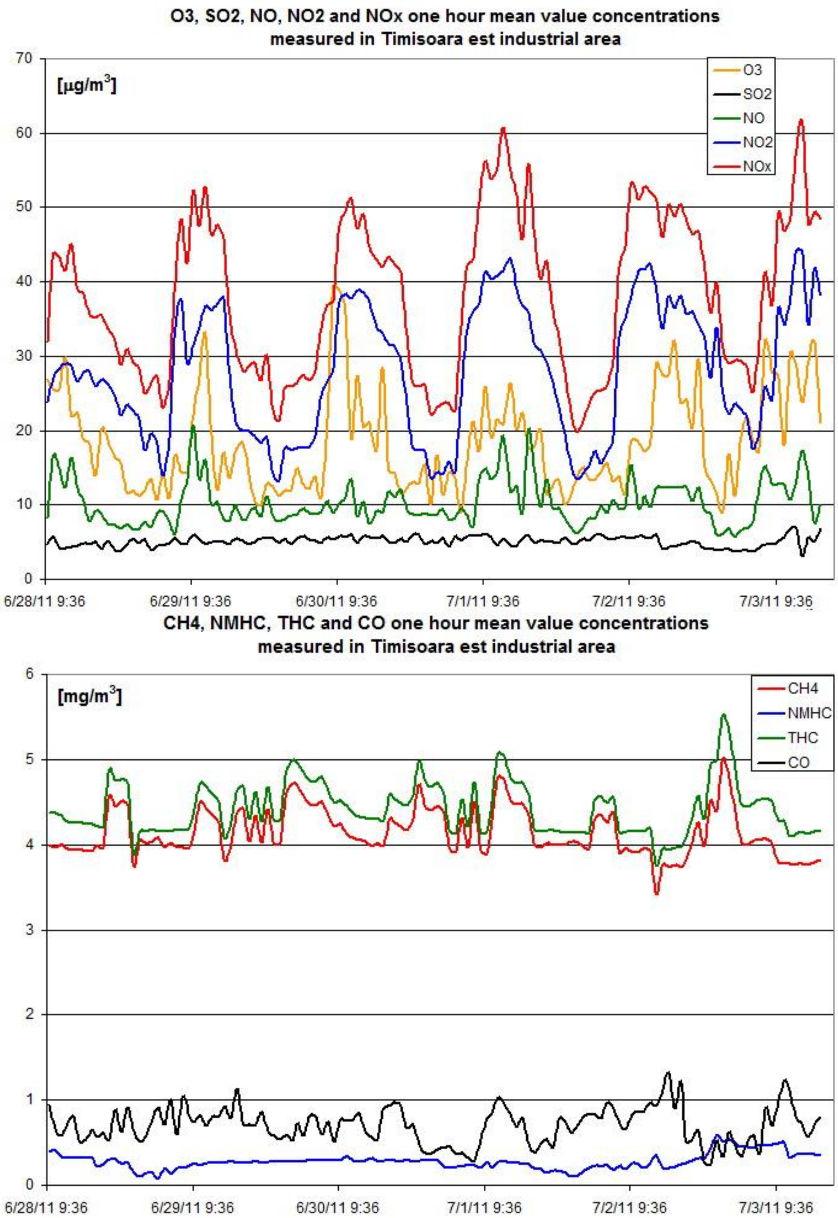


Figure 2. Hourly mean values recorded for O_3, SO_2, NO, NO_2, NOx, CO2, CH4, NMHC, THC and CO in Timisoara east industrial area

Table 2: Daily mean values for relevant pollutant concentration in ambient air for Timisoara AQM Campaign

Day	O_3	SO_2	NO	NO_2	NO_x	CH_4	NMHC	THC	CO	CO2	PM10
06/28/11	22.36	4.64	11.71	27.20	38.91	3.96	0.32	4.28	0.66	400.20	48.995
06/29/11	16.10	4.88	9.45	26.30	35.75	4.17	0.22	4.39	0.78	400.16	39.066
06/30/11	18.48	5.39	9.55	26.22	35.77	4.27	0.28	4.55	0.70	400.03	48.554
07/01/11	16.93	5.32	11.23	28.72	39.95	4.30	0.25	4.55	0.59	400.62	44.630
07/02/11	17.78	5.15	10.24	28.81	39.05	3.99	0.22	4.22	0.77	389.89	48.407
07/03/11	21.95	4.75	10.24	30.44	40.69	4.06	0.45	4.50	0.68	389.61	50.058

ZRENJANIN AIR QUALITY CAMPAIGN

Zrenjanin or *Becicherecu Mare* in Romanian language is a city and municipality located in the eastern part of Serbian province of Vojvodina. It is the administrative centre of the Central Banat District of Serbia. In 2002, the city's population was 79,773, while the Zrenjanin municipality had 132,051 inhabitants. Zrenjanin is the largest city in the Serbian Banat, the third largest city in Vojvodina (after Novi Sad and Subotica) and the sixth largest city of Serbia. Economical, scientific and cultural cooperation between Zrenjanin and Timisoara is at highest level and the two cities are officially recognized as “sister cities”. In 2007, it was declared the City of the Future and, in 2008, the World Bank ranked it first among the cities/towns in Serbia with regard to the overall organization of its business environment. In just two years, Zrenjanin concluded over 20 contracts on Greenfield investments with foreign and domestic companies, to the value of over EUR 400 million. New industrial zones are popping up on the perimeter of the city and, from Zrenjanin, to Europe and the world, products are delivered of the textile, machine, foodstuffs, chemical, electrical, pharmaceutical, and other industries. Its development has lasted for almost seven centuries, because, as a settlement under the name of Becskerek, it was first recorded in historical documents way back in 1326. [2]

Figure 3. View of the Zrenjanin/Ecka measurement site

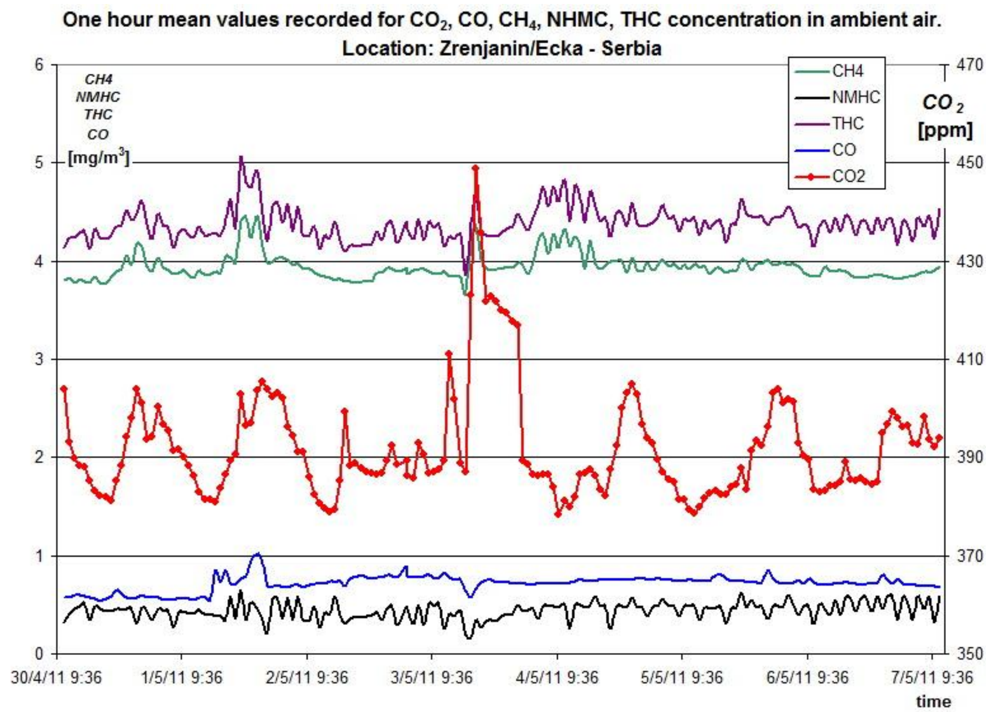


Figure 4. Hourly mean values recorded for CO2, CH4, NMHC, THC and CO in Zrenjanin/Ecka location

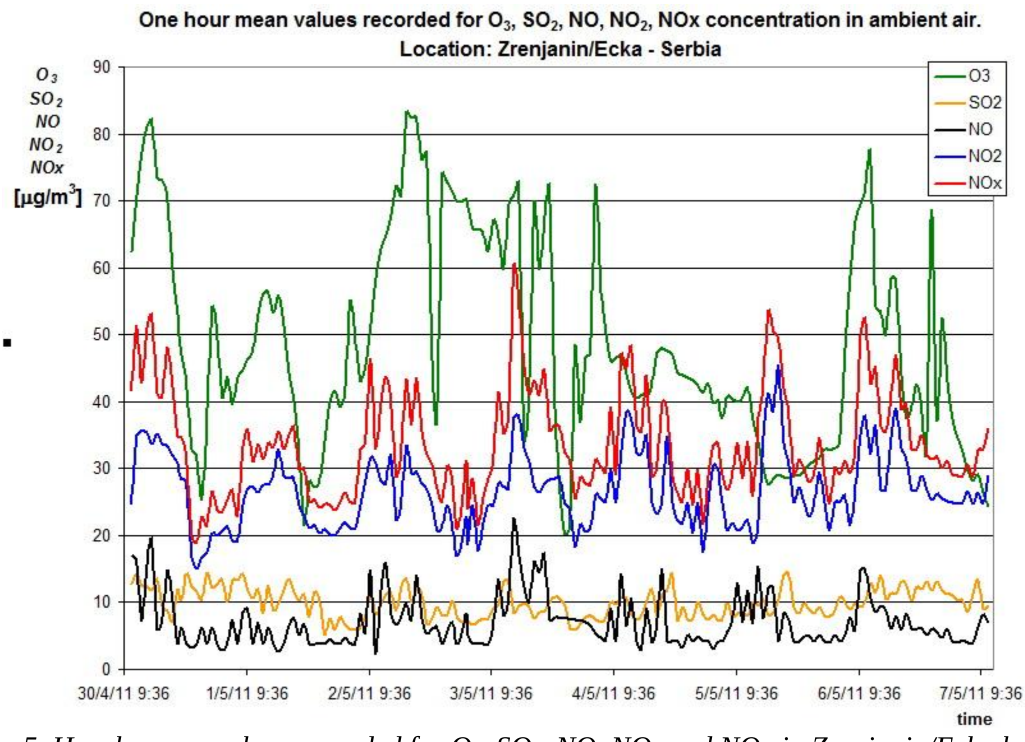


Figure 5. Hourly mean values recorded for O_3, SO_2, NO, NO_2 and NOx in Zrenjanin/Ecka location

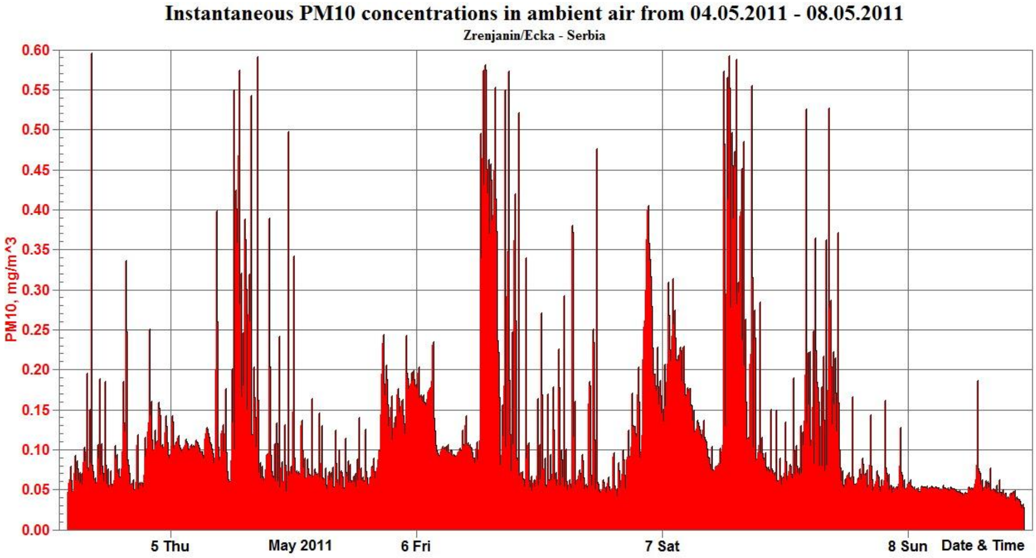


Figure 6. Instantaneous PM10 recorded values in Zrenjanin/Ecka location

PANCEVO AIR QUALITY CAMPAIGN

Pančevo (Serbian Cyrillic: Панчево) is a city and municipality located in the southern part of Serbian province of Vojvodina. The City of Pančevo is located in South Vojvodina, at the confluence of the Tamiš and the Danube rivers, at the very edge of the Panonian Plain. It is the economic, cultural and administrative centre of South Banat and one of the most important industrial centres in the Republic of Serbia. Including its 9 surrounding villages, the city area covers 755 km2. Pančevo is just 15 km away from Belgrade and 40 km away form the Nikola Tesla International Airport. Its ethnically diverse population numbers 128,447 of which majority are Serb. 67% of them are working-age population and 10% are with college or university education which is well over the Republic average.The climate is exceptionally agreeable with the annual average of 12ºC. Today, Pančevo is the centre of oil, chemical, and petrochemical industries whose potential and participation in the gross domestic product exceed that of Montenegro. [3]

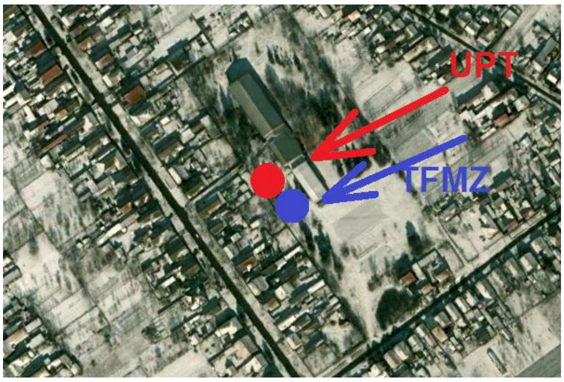


Figure 7. View of the Pancevo measurement site

The AIRPOINTER and UPT Mobile Laboratory where used in the same location in Pancevo AQM campaign. Instruments characteristics, performances and principles of operations were described in previous reports. In the next figures the concentrations measured for relevant air pollutants are presented.

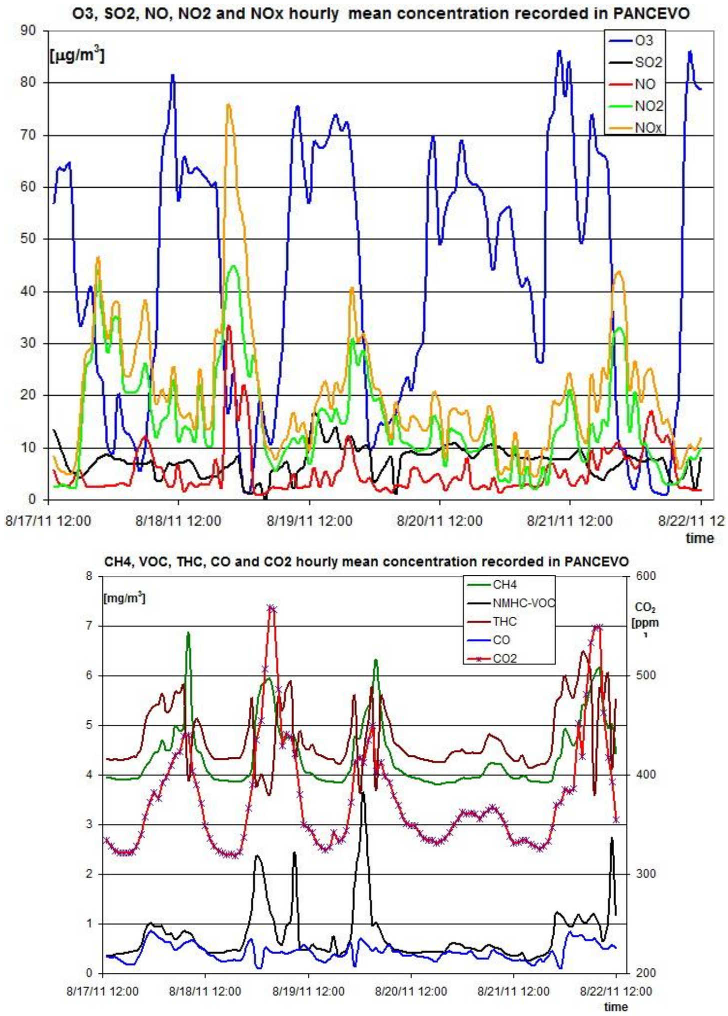


Figure 8. Hourly mean values recorded for O_3, SO_2, NO, NO_2, NOx, CO2, CH4, NMHC, THC and CO in Timisoara east industrial area

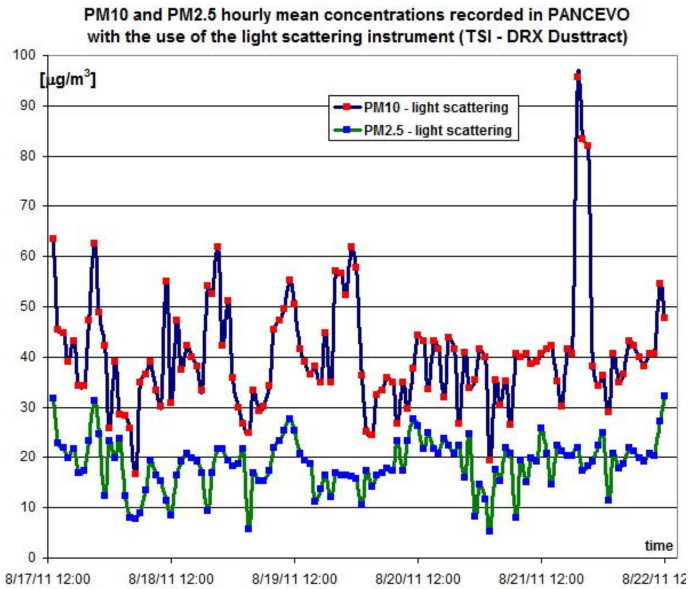
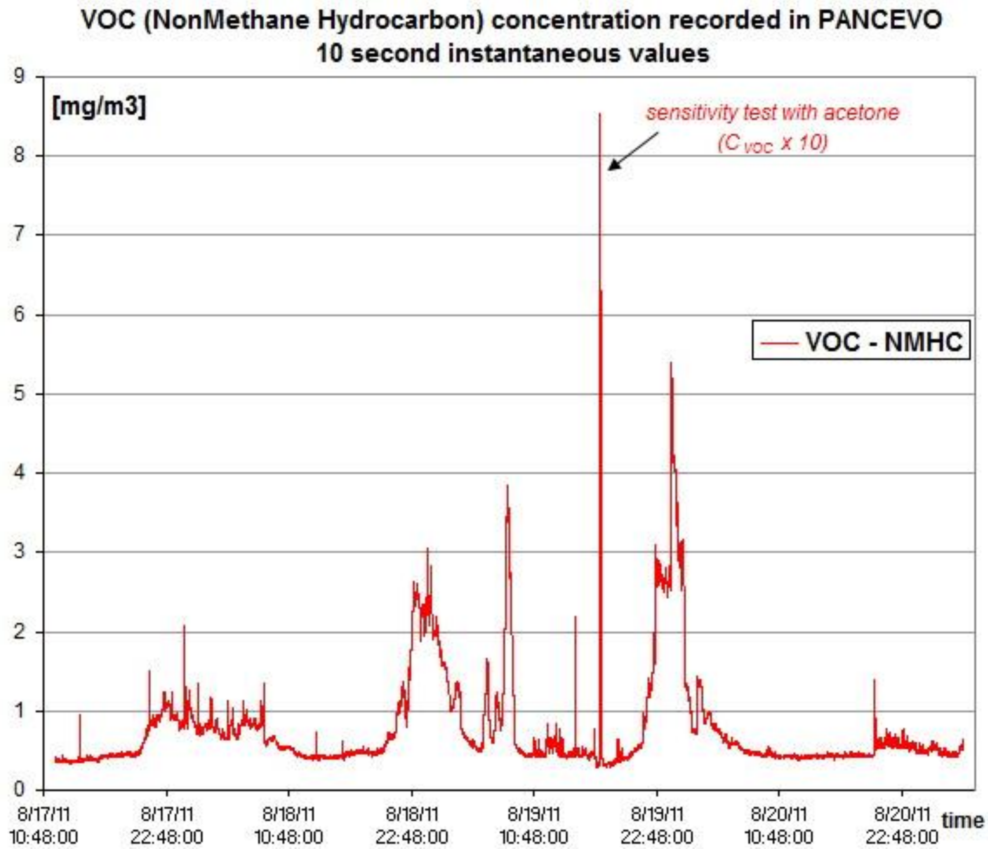


Figure 9. Hourly mean values recorded for PM10 and PM2.5 in Pancevo with Dustrack (light scattering)



Figuree 9. Instantaneous values recorded for NMHC (VOC) in Pancevo, with UPT Mobile Laboratory Hourly mean values recorded for PM10 and PM2.5 in Pancevo with Dustrack (light scattering)

BOR/KRIVELJ AIR QUALITY CAMPAIGN

The data analisis for the Bor campaign is still in progress but the most interesting data recorded were for SO2 imissions and are presented in figure 10.

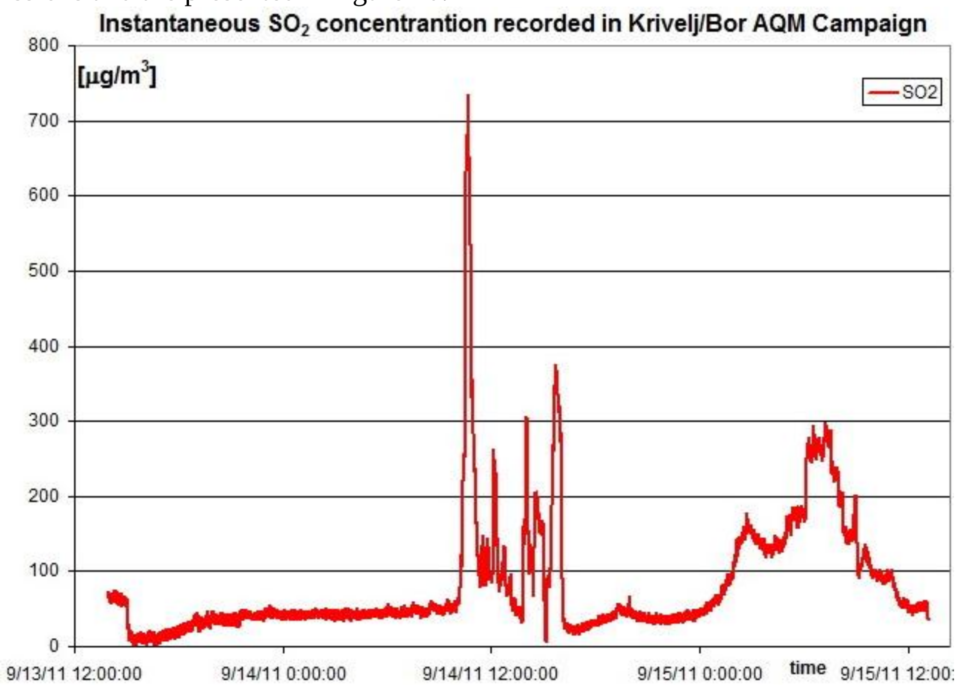


Figure 10. Instantaneous values recorded for NMHC (VOC) in Pancevo, with UPT Mobile Laboratory hourly mean values recorded for PM10 and PM2.5 in Pancevo with Dustrack (light scattering)

KIKINDA/BANATSKI VELIKO SELO AIR QUALITY CAMPAIGN

The results obtained in the Kikinda campaign are presented in figure 12 in a comparative graphics between Kikinda and Banatski Veliko Selo. It is easy to observe that tha Banatski Veliko Selo location can be considered an “background” site due to very low concenrations recorded for NOx, PM, VOC and SO2.

Figure 11. View of the Kikinda / Banatski Veliko Selo measurement site

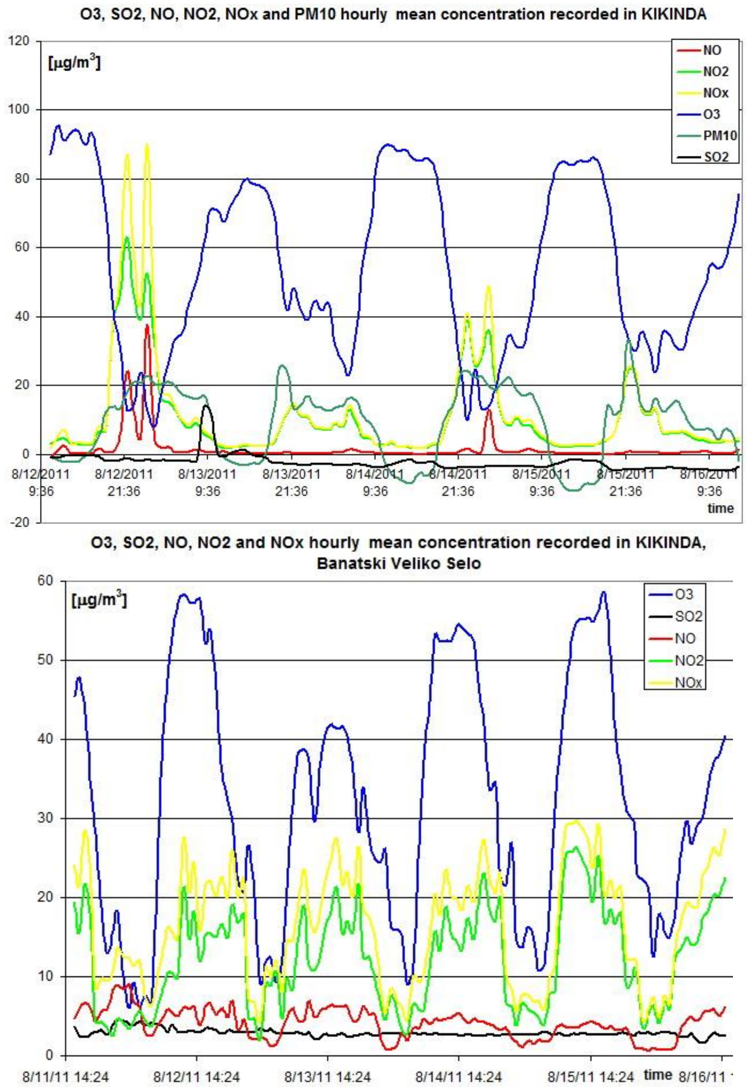


Figure 12. Hourly mean values recorded for O_3, SO_2, NO, NO_2, NOx, CO2, CH4, NMHC, THC and CO in Timisoara

CONCLUSIONS

Some topics are of particular concern to many European citizens. One of these is air quality. This is also one of the areas in which Europe has been most active in recent years. The European Commission has aimed to develop an overall strategy. Member States are required to transpose and implement new directives on air quality which set long-term quality objectives. But it is also our direct responsibility to cope with this problem, changing our day by day behavior.

Like the availability of capital, manpower, or transport infrastructure, the quality of air is likely to become a determining factor in the location of investment and therefore economic growth of a region. The way in which not only cities, but also companies, organize their transport systems will become, without any doubt, one of the major priorities of years to come.

Table 3: EU air quality standards [4]

Pollutant	***Concentration***	***Averaging period***	***Permitted exceedences each year***
Sulphur dioxide (SO2)	350 μg/m3	1 hour	24
	125 μg/m3	24 hours	3
Nitrogen dioxide (NO2)	200 μg/m3	1 hour	18
	40 μg/m3	1 year	n/a
PM10	50 μg/m3	24 hours	35
Carbon monoxide (CO)	10 mg/m3	Maximum daily 8 hour mean	n/a
Ozone (O3)	120 μg/m3	Maximum daily 8 hour mean	25 days averaged over 3 years

**Under the new Directive the member State can apply for an extension of up to five years (i.e. maximum up to 2015) in a specific zone. Request is subject to assessment by the Commission. . In such cases within the time extension period the limit value applies at the level of the limit value + maximum margin of tolerance* (48 μg/m3 for annual NO2 limit value).
***Under the new Directive the Member State was able to apply for an extension until three years after the date of entry into force of the new Directive (i.e. May 2011) in a specific zone. Request was subject to assessment by the Commission. In such cases within the time extension period the limit value applies at the level of the limit value + maximum margin of tolerance* (35 days at 75μg/m3 for daily PM10 limit value, 48 μg/m3 for annual PM10 limit value).

For the campaign conducted in Kikinda, Zrenjanin and Vrsac we can observe that the recorded values for air pollutants concentration are, in vast majority, considerably under the permissible limits, with the observation that the PM10 concentrations are very close to the limits. In the case of the first Timisoara campaign all gaseous pollutants are under the limit with the exception of PM10. Serious air quality issues have been observed in Pancevo and Bor. For Pancevo the recorded concentration of NMHC (VOC) is very high and, knowing those VOCs are known cancer precursors that issue should be of serious concern for local authorities. For the Bor campaign the mobile laboratory has setup in Krivels, about seven kilometres away from Bor. However the recorded concentrations for SO_2 were very high, close to the limits. This should be further investigated with continuous measurements conducted in Bor.

The VOCs problem in Pancevo is well knownin Serbia, the Ministry of Science and Environmental Protection – Directorate for Environmental Protection of the Republic of Serbia and the Ministry for the Environment and Territory of the Republic of Italy, in the framework of the Memorandum of Understanding "*Cooperation on environmental protection*", developed a number of initiatives towards the joint promotion of sustainable development.

On the basis of the conclusion of the activities undertaken by the UNEP Balkan Task Force, that identified the South Zone Industrial Complex (SZIC) of Pančevo as one of the most critical environmental hot spots in the Republic of Serbia, and on the basis of the “Environmental monitoring and sustainable requalification of selected industrial areas in the Republic of Serbia” undertaken by the the Ministry for the Environment and Territory of the Republic of Italy, in October 2004 the Ministry of Science and Environmental Protection of the Republic of Serbia and the Ministry for the Environment and Territory of the Republic of Italy launched the “Pančevo Action Program” within the event “L’Italia a Belgrado 2004” as a pilot integrated project promoted and financed by the Italian Ministry of Environment, Land and Sea.

The SZIC is consists of three plants: HIP Azotara (fertilizer plant), HIP Petrohemija (petrochemical plant) and NIS Refinery (petroleum derivates).

Several environmental problems had to be urgently addressed in the Pančevo area, such as:

- surface water pollution and ground water contamination, caused by uncontrolled release of chemicals during NATO bombing of the Industrial Complex in 1999, as well as past and present emissions of chemicals and the past subsoil and sediments contamination;
- air pollution from industrial emissions;
- contamination of surface soil from spills and leaks of hydrocarbons, as consequence of the NATO bombing, and from the uncontrolled disposal of hazardous wastes;
- risks of industrial accidents (including explosion and contamination from toxic substances) affecting the safety of the industrial and adjacent residential areas.

The South Zone Industrial Complex of Pančevo represents a strategic resource for Serbian national economy. It is located close to the town and it is strictly linked with it, in economic, social and environmental terms. These environmental risks involve the 130,000 inhabitants in the Municipality and 7,000 workers in the industrial areas; air emissions affect the city and the region of Belgrade, while the wastewater discharges into the Danube could have downstream and even trans-boundary effects on the water quality of the rivers. [5]

ACKNOWLEDGEMENT

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REFERENCES

Web resources, *http://en.wikipedia.org/wiki/Timişoara*

Web resources, Zrenjanin Municipality official webpage: http://www.zrenjanin.rs/

Web resources, Pancevo Municipality official webpage: http://www.pancevo.rs/

Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008, on ambient air quality and cleaner air for Europe, and Directive 1999/30/EC from 22 April 1999

Web resources, http://www.taskforcecee.com/activities/view/pancevo-action-program