4TH INTERNATIONAL SYMPOSIUM ON ENVIRONMENTAL AND MATERIAL FLOW MANAGEMENT

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4TH INTERNATIONAL SYMPOSIUM ON ENVIRONMENTAL AND MATERIAL FLOW MANAGEMENT

Plenary lectures:

IMPACT OF METALLURGICAL PLANTS ON ENVIRONMENT AND MEASUREMENT OF PROTECTION

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Abstract: For a long time, urban areas have been places of human life and development centers. They may be endangered due to pollution of air, water and land.
In the recent years, air pollution reaches such proportions that require a special attention in terms of taking technical, technological, financial and economic, administrative and legal measures to protect the air. The basic and most common sources of air pollution are: industrial plants (technological processes), transport, energy (power plants and heating plants), and local boilers and furnaces in households.
Water pollution is increasing. Different measures for rational use of water, reducing the amount of pollution and waste water, and protection of water resources are constantly being undertaken. The basic and most common sources of water pollution are: industrial plants and facilities, transportation, agriculture, towns and settlements.
In addition, the environment is polluted by production and inadequate waste management and noise production.
Industrial plants, especially metallurgical, due to the nature of technological processes and high emissions of harmful substances, cause multiple environmental consequences also to the environment, threatening the quality of the environment and the health of the population in industrial and urban areas, especially if there are not available measures to control and reduce emissions.
This paper presents the results of monitoring of emissions from metallurgical plants and combustion plants and their impact on air quality and water in industrial-urban area of Zenica.
The results presented in this paper can serve as a roadmap for measures to prevent / reduce and control emissions, improving the living conditions of the population and the sustainable management of environmental protection in industrial and urban areas of Zenica.

Keywords: emission sources, emission of harmful substances, environment, air pollution, water pollution, environmental quality.

1. INTRODUCTION

At the beginning of the third millennium, the air quality in urban areas in Europe, due to growing industrialization, receives a special attention. In industrial and urban areas, the

problem of air and water pollution is much higher, especially in areas with developed base industries such as ironworks [1].

The present emissions of harmful substances have the multiple environmental consequences, threaten the environment quality and the health of the inhabitants of industrial and urban areas, especially if the effective available measures are not undertake in order to control and limit emissions and negative impacts on the environment [2,3].

Research and monitoring the environmental quality in urban and industrial areas is one of the first steps towards a solution, in most countries of the world, present problems of environmental pollution [4]. The study and monitoring the environmental quality aim to control and reduce the harmful substances [2].

In regard to monitoring air quality, a special attention was given to sulfur dioxide (SO_2), total suspended particles (TSP), particulate matters PM10, nitrogen oxides (NOx) and other pollutants. Sulfur dioxide is a traditional air pollutant and monitoring its concentration is of a particular interest to characterize the air quality as it states the World Health Organization (WHO, 2000). It originates predominantly from the oxidation of sulfur compounds. Measurement of particles matter PM10 (d <10 microns), SO_2, NOx and other pollutants in the air of Zenica basin has been continuously implemented for many years by using the automatic monitoring stations [5].

Industrial and thermal power plants have many options today to harmonize the production with more stringent requirements for preservation of environment quality. In this way, they can respond effectively to the challenges of the strict requirements for sustainable development. Therefore, many leaders in the steel industry, and in other sectors, start to adapt their procedures to reduce emissions into environment and impacts on the environment, and to improve their business image. They launched voluntary projects to reduce emissions and protect the environment. The best available techniques and eco-design are effective tools for achieving this goal.

Zenica steel plant is on the track to realize this goal, which is defined in the plan of adjustment. The implementation of projects, defined in this plan, has already achieved high results regarding reduction of emissions of dust into the air and water, reduction of waste generating and noise, etc. The goal is to harmonize this steel plant with the European environmental standards and BAT by 2015, which is a very ambitious goal, given the inherited poor environmental practices and the lack of effective measures for environment protection.

This paper presents the results of monitoring emissions from metallurgical and thermal power plants, and as well, their impact on quality of air and water in industrial-urban area of Zenica. Also, the paper presents the results of the implementation of the adaptation plan in relation to limit and control of emissions into the air and water and environment protection.

2. EMISSION OF HARMFUL SUBSTANCES INTO THE AIR FROM METALLURGICAL PLANTS

The following table presents data on annual emissions of dust, SO_2 and VOC.

Table 1. Emissions of dust, SO2 and VOC

Parameters	1985.	1988.	1990.	2008.	2009.	2010.	2011.	2012.
Steel production (t/g)	1.896.266	1.906.000	1.090.000	607889	517286	610518	669320	678240
Coal consumption (t/g)	447.204	399.845	465.000	95473	170616	171328	151187	168234
Emission of SO_2 (t/g)	74.000	72.202	60.752	21100	20640	23450	24615	25390
Emission of dust (t/g)	20.206	12.200	6.532	2955	2890	3282	3360	3385
Volatile organic substance (t/g)	4.638	4.534	3.078	1406	1375	1564	1640	1610

An overview of the results of measurements of dust and SO_2 from primary metallurgical plants and industrial power plants is given in the following diagrams.

Dust emission of the coke plant is more than three times higher than the threshold limit value of 50 mg``/m^3, due to the worn-out walling of the coke furnace. However, dust emission from agglomeration is a little bit bigger than the threshold limit value, and emission from the steelworks and blast furnace is a little bit below the limit value of 50 mg/m^3.

Emission of SO_2 from agglomeration, steelworks and blast furnaces is lower than the threshold value, and emission from the coke plant is slightly higher than the limit value of 500 mg/m^3.

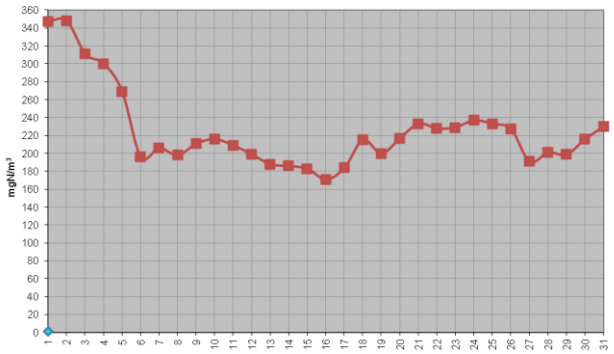

Figure 1. Emission of dust from the coke plant

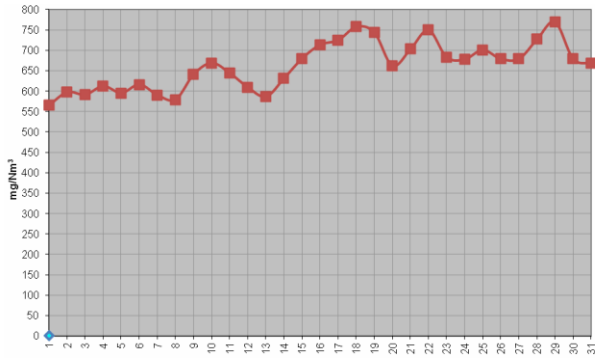

Figure 2. Emission of SO2 from the coke plant

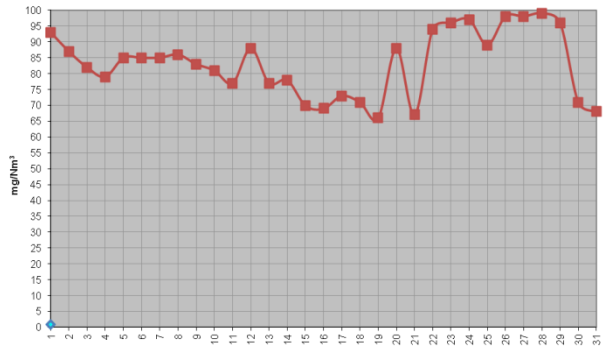

Figure 3. Emission of dust from agglomeration machine IV

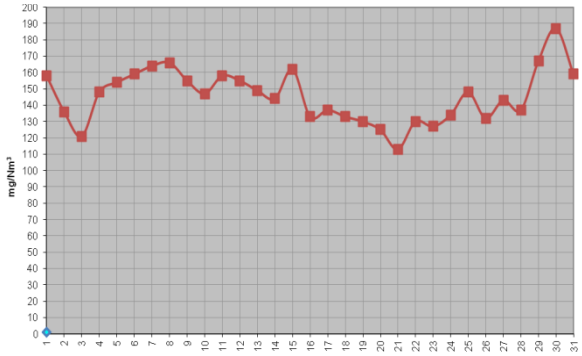

Figure 4. Emission of SO_2 from agglomeration machine IV

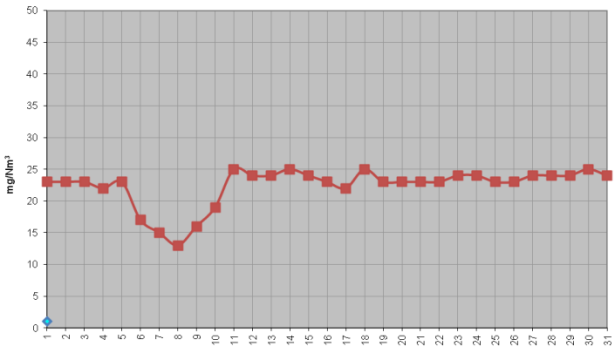

Figure 5. Emission of dust from blast furnace

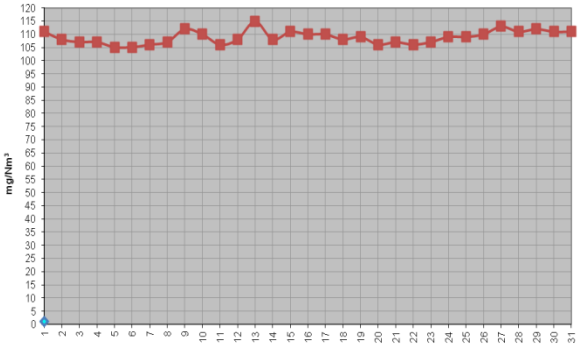

Figure 6. Emission of SO_2 from blast furnace

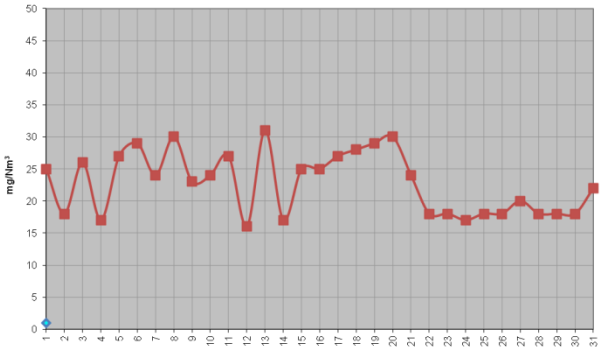

Figure 7. Emission of dust from BOF Steelworks

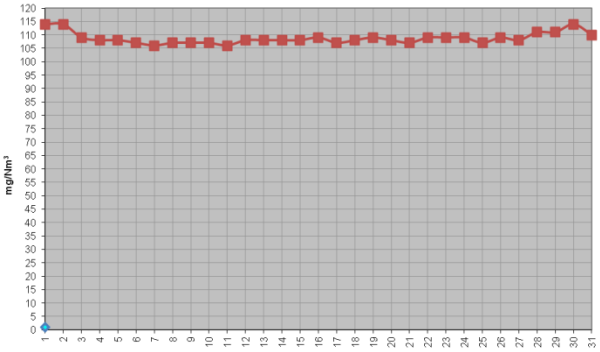

Figure 8. Emission of SO_2 from BOF Steelworks

3. EMISSION OF HARMFUL SUBSTANCES INTO THE AIR FROM THERMAL POWER PLANTS

The following table presents data on the emission of dust and SO_2 from industrial power plant, where coal is burned and technological gas (gas from blast furnace and coke gas). Dust emission is higher than the threshold limit value of 50 mg/m^3, due to the burning of coal and the effectiveness degree of installed electric separators which allow fine particles to go through. The emission of SO_2 is below the threshold limit value for the incineration of coal, which is 2000 mg/m^3, but it is higher than the limit value for the combustion of technological gases, which is 800 mg/m^3. This emission would be much higher if only coal was burnt, as it was used to be done in the past, when there were burnt approximately 350,000 t/g of coal with a sulfur content of approximately 3.5%. Implementation of the project on combined fuel combustion (coal and technological gas) was done in order to reduce emissions of SO_2 and dust.

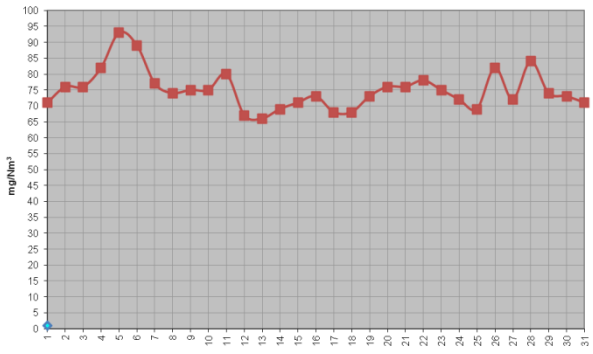

Figure 9. Emission of dust from industrial power plant

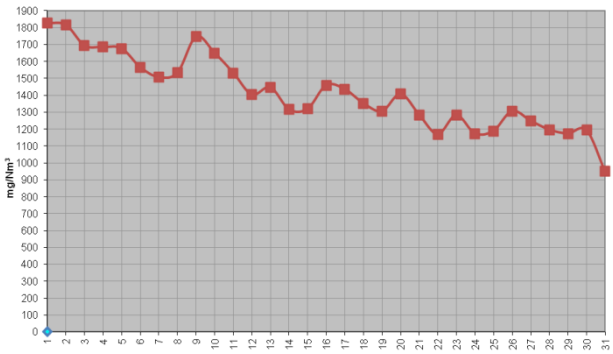

Figure 10. Emission of SO_2 from industrial power plant

Emission into the air from the local boiler plants within the industrial-urban area of Zenica, where coal has been dominantly burnt in the total quantity of app. 7156 t/g, amounts:

- Emission of SO_2 in the local coal boiler plants: 1171 - 9782 mg/m^3 or a total of 385.5 t/g,
- Emission of NO_x in the local coal boiler plants: 126 - 689 mg/m^3 or a total of 22.4 t/g,
- Emission of CO in the local coal boiler plants: 70 - 5575 mg/m^3 or a total of 8.1 t/g.

Although emission from the boiler plants is relatively low and much lower than the emission from industrial power plants and other industrial sources, it significantly affects the value of air quality regarding dust, SO_2, NO_x and CO in the industrial-urban area of Zenica, due to low sources (chimneys) and orographic conditions (deep basin). This has been proven by using the intended measurements and by applying specific software models (Aermod and Selma Gis).

4. AIR QUALITY CONDITION IN INDUSTRIAL-URBAN AREA OF ZENICA

Survey of results of air pollution measurements from monitoring stations in the industrial-urban area of Zenica is given in the following table.

Table 2. Average values of air pollution in Zenica in the period 2006.–2012.

Pollutant	Indicator	Measuring units	2006.	2007.	2008.	2009.	2010.	2011.	2012.	Standard
Sulfur dioxide (SO_2)	Average C-98 Cmax	µg/m^3	**73** **280** 399	**102** **389** 759	**98** **453** 707	**121** **312** 527	**104** **323** 441	**139** **419** 560	**144** **376** 503	50 125
Total partuculate matter (TPM)	Average C-98 Cmax	µg/m^3	77 301 406	75 278 526	89 329 618	90 287 520	97 330 605	123 **397** 653	125 **390** 751	150 350
Lead in TPM	Average	µg/m^3	0,32	0,34	0,17	0,14	0,10	0,11	0,18	2
Cadmium in TPM	Average	ng/m3	7,0	17,4	12,1	8,6	1,6	5,1	5,2	40
Precipitated powder	Average	mg/m^2.day	179	162	199	**223**	**319**	**355**	**245**	200
Lead in Precip.powder	Average	mg/m^2.day	0,084	0,05	0,062	0,072	0,07	0,075	**0,111**	0,1
Cadmium in Precipitated powder	Average	mg/m^2.day	0,0012	**0,005**	0,0017	**0,0023**	0,0007	0,0014	**0,0022**	0,002
Zinc in Precip. powder	Average	mg/m^2.day	-	-	0,236	0,40	**0,438**	**0,418**	**0,417**	0,4
Steelworks in Zenica			2006.	2007.	2008.	2009.	2010.	2011.	2012.	
Coke production		MT	-	-	240092	253578	367365	438230		
Production of agglomerate		MT	-	-	335262	668166	850640	949265		
Production of iron		MT	-	-	242655	482269	620935	684734		
Production of steel		MT	-	-	228252	517286	610518	669320	678240	
Production of steel in EAF		MT	480035	553289	379637	-	-	-	-	
Production of coke gas		GJ	-	-	1784299	2100944	2135710	3649915		
Production VP gas		GJ	-	-	1729904	2758528	3639065	4312011		
Energy coal		T	90192	95913	95473	170616	171328	151187	168234	

From the data presented in Table 1, it can be seen that the concentration of measured pollutants in the air has a trend of slight increase, which is a result of burning coal with the increased sulfur content and growth of metallurgical production, and as well, the insufficient implementation of measures for controlling and limiting emissions, and also, unfavorable topographic conditions of the area [4,5]. The average concentration of SO_2 is higher than air quality standards recommend. Also, the average values of precipitated dust and heavy metals in the precipitation powder have been in the last 3-4 years higher than the air quality standards. Total Particule Mater (TPM) and Pb and Cd in TPM are lower than air quality standards, but they have a trend of slight increase. Air quality would probably have been significantly worsened, if many projects for reduction of emissions and air protection were not implemented.

Daily concentration of SO_2 varies depending on the season, and it is at highest in the winter due to the combustion of coal with high sulfur content, used as a mean of heating (Figure 11). Daily concentration of SO_2 in the winter season exceeds the threshold concentration warning of 500 µg/m^3 and is several times higher than it.

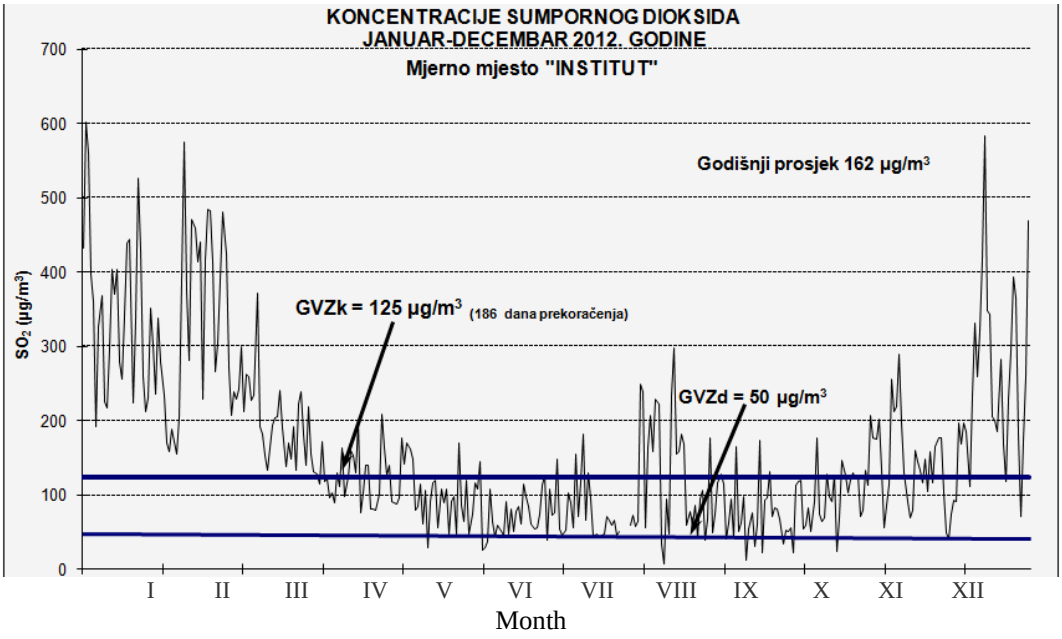

Figure 11. Daily concentration of SO2 in 2012

Total Suspended Particles (TSP) have a similar dynamics during the annual seasons and the highest concentration of TSP occurs during the winter season (Figure 12).

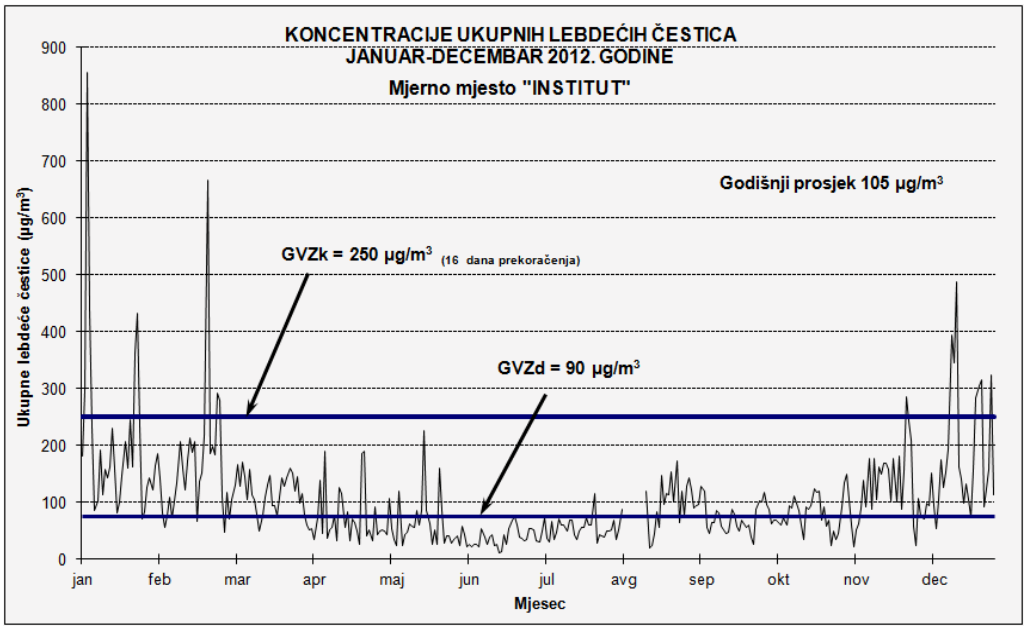

Figure 12. Daily concentration of TSP in 2012

Due to the growing consumption of coal with higher sulfur content and scope of metallurgical production, there is a trend of growth of average annual concentration of SO_2 (Figure 13) and total suspended particles (Figure 14) in the ground layers of the atmosphere.

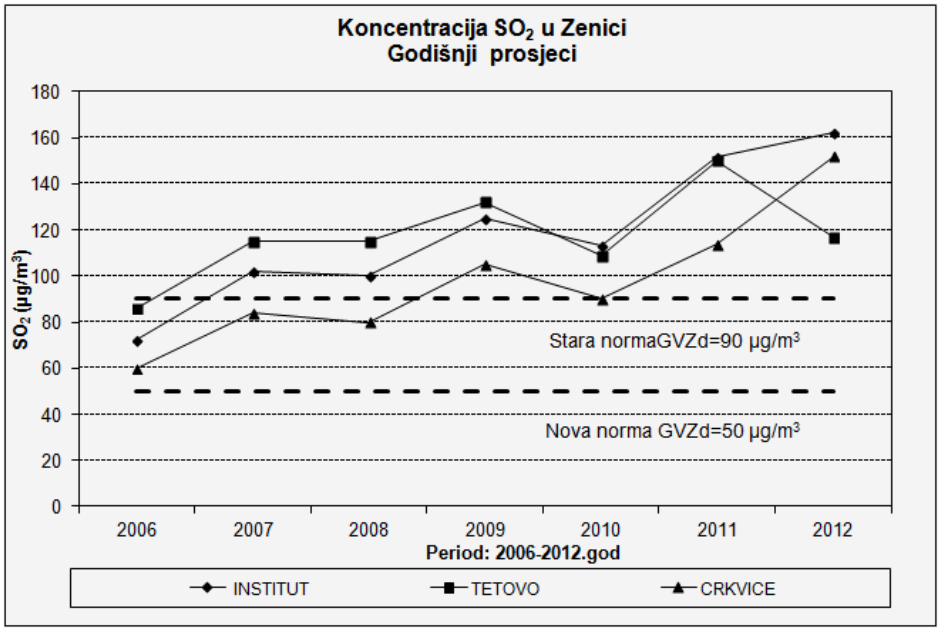

Figure 13. Annual average amounts of concentration of SO_2 for the period 2006 – 2012

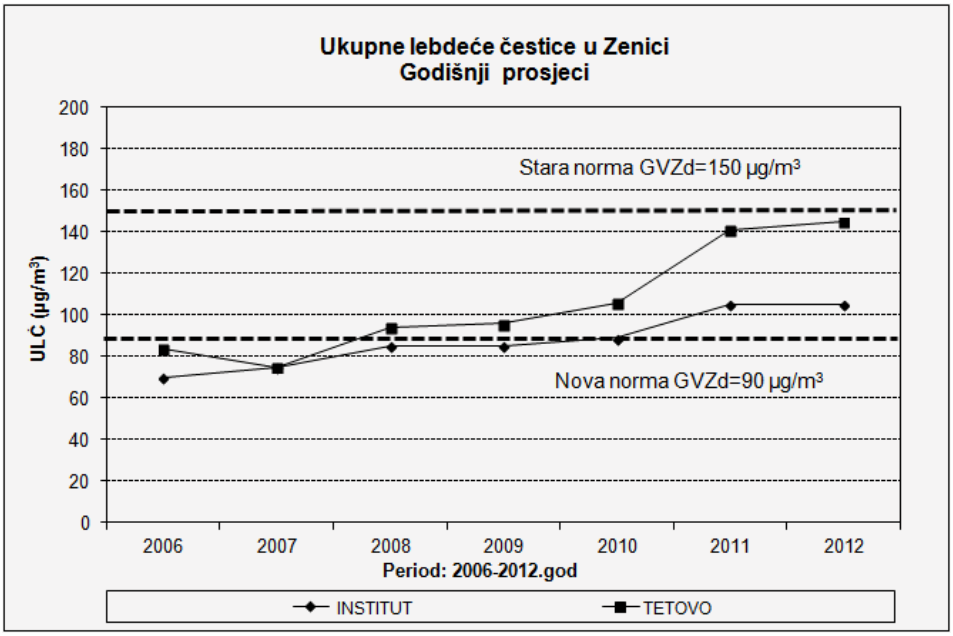

Figure 14. Annual averages of concentration of TSP for the period 2006-2012.

Reasons for air pollution in industrial-urban area of Zenica are following [6,7]:

- Integrated metallurgical manufacturing is done in the same valley where the city of Zenica is placed,
- Raw materials and fuel are inadequate because of high sulfur content,
- Many harmful substances are present in the raw materials and emitted into the atmosphere (eg. lead, cadmium),
- Modern technologies are slowly introduced instead of old technological procedures,
- Installation of devices for treatment of waste gases is slow (for control and limitations of emissions),
- There are adverse weather conditions in the winter when, during the days of stable atmospheric temperature inversions, occur episodes of high air pollution,
- There are high emissions of SO_2, dust with a high content of heavy metals (lead, cadmium, zinc), hazardous volatile organic compounds and other pollutants (hydrogen sulfide, fluoride, etc.),
- There are adverse orographic conditions (deep basin), etc.

In the winter, episodes of high air pollution occur as a consequence of present emissions, increased burning of coal with a high sulfur content, unfavorable orographic conditions (deep valley) and steady state of the atmosphere with a temperature inversion [8]. The inversion layer hinders/prevents the dispersion of pollutants in the upper layers of the atmosphere, and it causes the accumulation of pollutants in the ground layer of the atmosphere and the occurrence of episodes of high air pollution. Some episodes last for a few days until the weather situation changes and the inversion layer breaks. Implementation of emergency measures for reducing emissions in industrial plants (high emission sources) gave no significant results. On the basis of various studies it was concluded the low-emission sources dominantly influence the accumulation and high concentration of pollutants in the air.

5. MEASURES FOR CONTROL AND LIMITATION OF EMISSIONS INTO THE AIR

In order to reduce emissions into the air and to adapt the work of metallurgical and other industrial plants to the strict environmental standards and legislation on environmental protection, several major projects were realized:

- Some old metallurgical plants were torn down (4 coke batteries, 8 SM furnaces, 3 blast furnaces, electric furnace, etc.),
- Reconstruction of four electric separators of the thermal plant and 8 electric separators of the agglomerate machine was done,
- Automatization of systems for management of purification of waste gases (electric separators) in the agglomeration was done,
- Scrubbers on the transport systems of agglomeration were replaced with more efficient bag filters,

- A system for purification of waste gases on the platform of the blast furnace was installed,
- A bag filter on the mixers was installed,
- A system for dustfree induction of coal into coke furnaces and coke extrusion was installed,
- There were installed the devices for sealing the front door inlet to the columns of coke plant,
- Systems for purification of waste gases in BOF steelworks were repaired,
- Quality maintenance and control of technical systems for purification of waste gases was undertaken,
- Substitution of coal with gas fuels in the thermal plant to reduce emissions of SO_2 and dust was done,
- Measuring devices for automatic monitoring of emissions of dust, SO_2 and NOx were installed at five primary metallurgical plants and an industrial power plant etc.

Implementation of the above-mentioned projects significantly reduced the dust emission, which is now, in most plants, lower than the emission standards, what greatly contributed and decreased the loading of the atmospheric air and improved the air quality in industrial-urban area of Zenica. [9]

6. RELEASE OF INDUSTRIAL WASTE WATER AND IMPACT ON WATER RESOURCES

All facilities and plants in the industrial zone are characterized by the use of industrial water (boiler plant water, wet dusting and cleaning of gases, cooling of aggregates, slag and ash transport, washing, etc.), taken from the river Bosna on a water collector. The maximum amount of the taken industrial water is in the closed (recirculating) systems, which are refilled. A large amount of waste water comes from the industrial zone, which varies in quantity and quality, depending on the nature of the technological processes, production volume and the implementation of measures for water management.

Industrial waste waters are discharged at three outlets in the river Bosna, together with the mine and urban waste water.

A certain purification of industrial waste water is done in industrial plants, and urban waste water is discharged into the main industiral collector with no prior purification.

Monitoring industrial waste water is done according to the prescribed schedule. Results of testing the waste water quality are shown in the following table.

Tabel 3. Results of monitoring of industrial waste water

Parameters	Limit	Main Collector	Rolling Mill Unit Collector	Perimetral Canal	Business zone Zenica1	Coal Mine	City of Zenica
Flow Average (m^3/dan)	-	27321	16653	18967	2885	3978	7274
Temperature (^{0}C)	30	24	23	23	17	21	20
Total suspended solids (mg/l)	35	**413**	**850**	**51**	**65**	**50**	**280**
Turbidity	-	127	234	57,5	43,2	19,9	89,1
pH value	6,5-9,0	8,3	8,1	8,5	8,2	7,8	7,8
Electr. Conductibility (µS/cm)	-	1001	1329	791	746	1505	798
Alkalinity (mg/l)		212	210	260	296	440	300
Residual at 105°C (mg/l)	-	1104	1506	728	666	1322	600
Residual at 550°C (mg/l)	-	772	984	460	486	1012	278
Volatile matter at 550°C (mg/l)	-	332	522	268	180	310	322
COD (mgO_2/l)	125	<30	<30	<30	<30	38	**164**
BOD_5 (mgO_2/l)	25	<6	<6	<6	<6	9	**43**
Total N (mg/l)	15	9,0	3,4	3,6	2,2	7,6	**25,8**
NH_4-N (mgN/l)	10	6,7	1,5	1,0	1,5	5,2	**23,0**
NO_3-N (mg/l)	10	0,8	0,8	1,3	0,7	1,0	1,1
NO_2-N (mg/l)	-	0,443	0,179	0,123	0,094	0,469	<0,005
Total P (mgP/l)	2,0	0,26	0,05	0,16	0,22	0,52	**2,53**
Chlorides (mg/l)	250	45,4	71,0	42,6	17,0	34,1	31,2
Sulphates (mg/l)	200	**219**	**423**	**285,2**	196,2	**300**	82,8
Test for toxicity	>50	Not toxic		Not toxic		Not toxic	
Specific quality parameters							
Sulphides (mg/l)	0,1	**0,80**	-	-	-	-	-
Cyanide (mg/l)	0,5	0,03	-	-	-	-	-
Fluoride (mg/l)	10	1,01	-	-	-	-	-
Phenols (mg/l)	0,1	0,05	-	-	0,01	0,03	**0,19**
Total oil and grease (mg/l)	20	6	16	-	-	-	-
Mineral oil (mg/l)	10	<0,1	<0,1	-	-	-	-
Detergents (mg/l DBS)	1,0	0,5	-	-	-	-	-
PAH (mg/l)	0,01	0,004	0,003	-	-	-	-
TOC (mg/l)	30	12,0	-	-	-	-	-
Iron (mg/l)	2,0	0,99	0,11	-	-	-	-
Manganese (mg/l)	1,0	<0,2	0,2	-	-	-	-
Nickel (mg/l)	0,5	0,002	0,001	-	-	-	-
Zinc (mg/l)	2,0	0,258	0,143	-	-	-	-
Copper (mg/l)	0,5	0,004	0,004	-	-	-	-
Total chrome (mg/l)	0,5	0,003	0,009	-	-	-	-
Arsenic (mg/l)	0,1	<0,01	0,01	-	-	-	-
Lead (mg/l)	0,5	0,028	0,028	-	-	-	-
Cadmium (mg/l)	0,1	<0,001	<0,001	-	-	-	-
Mercury (mg/l)	0,01	<0,001	<0,001	-	-	-	-

On the basis of the investigation of industrial waste water, the following is established:

- concentration of suspended solids at all outlets were higher than the prescribed limit values,
- concentration of sulfates was higher than the prescribed limit values at all outlets, except in the city collector,
- quality of waste water at the main collector outlet does not meet the required standards due to the increased concentration of suspended solids (413 mg/l), sulfates (219 mg/l) and sulfides (0.8 mg/l),
- quality of waste water released from collectors of the rolling mill does not meet the required standard, because of the increased concentration of suspended solids (850 mg/l) and sulfates (423 mg/l),
- in the city collector, which is connected to the main collector without prior waste water treatment of municipal waste water, were measured the higher values of suspended solids (280 mg/l), COD (164 mg/l), BOD_5 (43 mg/l), total nitrogen (25.8 mg/l), ammonia (23 mg/l), total phosphorus (2.53 mg/l) and phenol (0.19 mg/l) comparing to the prescribed limit values, and because of that, the urban waste water should be separated from the technological from industrial zone and purified separately prior to discharge to the surface waters,
- quality of water discharged from the peripheral channel, business zone and mines meets the required standards,
- industrial waste water has no high pollution load, because of purification in multiple primary systems prior to discharge into the river Bosna,
- state of the quality of the industrial waste water is better than it was in the previous period, because of the measures taken to protect water (repair of recirculation systems, reduction on the amount of waste water discharge and heaviness of its pollution, etc.).

7. STATE OF QUALITY OF WATER RESOURCES

Bosna river basin is quite burdened, because it covers 20.4% of the territory of B&H, where 40.l2% of the total population lives, including the area of Zenica. In Bosna river basin, the largest number of industrial plants is concentrated, and their activities pollute the quality of this watercourse. Quality of water of the river Bosna is shown in the following table.

Tabel 4. Results of monitoring of water of Bosna river.

Parameters	Unit	Limit	Results
Temperature	^{0}C	-	16,0
Turbidity	NTU	-	26,9
pH value	-	6,0 – 9,0	8,1
Colour	Pt/Co colour unit	-	20
Dissolved oxygen	mg/l	-	5,2
Electr. Conductibility	μS/cm)	-	497
Residual at 105 ^{0}C	mg/l	1500	424
Residual at 550 ^{0}C	mg/l	-	312
Volatile matter at 550 °C	mg/l	-	112
Total suspended solids	mg/l	80	43
Alkalinity-m	mg/l	-	5
Alkalinity-p	mg/l	-	184
COD-Cr	mg/l	-	<30
BOD5	mg/l	-	<6
Total N	mg/l	7	2,5
NH4-N	mg/l	-	0,8
NO3-N	mg/l	0,25 – 1,5	0,8
NO2-N	mg/l	1,5 - 10	0,06
Total P	mg/l	0,25 – 1,5	0,18
Chlorides	mg/l	-	14
Sulfates	mg/l	-	80
Test for toxicity	mg/l	-	No toxic
Sulphides	mg/l	-	1,6
Total oil and grease	mg/l	-	9,0
Detergents	mg/l	-	0,2
Phenols	mg/l	-	0,01
TOC	mg/l	-	22

Water quality in the river Bosna meets the required standards. Therefore, the industrial waste water, discharged into the river Bosna, does not influence in any significant degree the deterioration of the quality of the above-mentioned watercourse, because the waste water brings into the watercourse only minor quantities of harmful substances.

8. MEASURES FOR WATER PROTECTION

In order to protect water and to adjust work of metallurgical and other industrial plants to the environmental standards and legislation on environmental protection, several major projects and measures were realized:

- Integration of water management into the production process in order to reduce the amount and load of waste water pollution,
- The application of the principles of clean production,
- Draining away the waste water in a separate sewerage system with installed wastewater treatment plants by sections,

- Industrial water recirculation systems were built, what practically meant that within the normal operation of the plant, in the sewerage system were discharged only minimum amounts of waste water
- In agglomeration, scrubbers are replaced with bag filters, what significantly decreases the amount of water for dust removal from waste gases,
- Quality maintenance and control of technical systems for purification of waste water,
- Every month, monitoring industrial waste water on 20 measuring stations is done.

Implementation of the mentioned projects and measures significantly reduced the amount and heaviness of the pollution of industrial waste water, what contributed significantly to decreasing the load and improving the quality of the river Bosna. By most parameters examined, the river Bosna in the area of Zenica now has I-II quality class, and previously had a III-IV class. This has contributed to the revitalization of biocenosis and ecosystems in this watercourse. [7]

9. CONCLUSION

A continuous monitoring of air and water quality in industrial-urban area of Zenica is a fundamental requirement for the assessment of environmental quality, investigation of the production activities on environmental quality, testing the effects of implemented projects and measures for environmental protection, assessment of potential opportunities for construction of new production resources, implementation of measures for protection of health of inhabitants, informing the public, inspection, etc. Monitoring emissions and air quality is essential for industrial and urban areas such as Zenica region for the purpose of environmental protection management. Without monitoring, it is not possible to provide an effective environmental protection management, what is a basic requirement for ensuring conditions to protect environmental quality and human health in the industrial-urban areas. A model of integral environmental protection management in industrial-urban area of Zenica gave significant positive effects on reducing the load and improving the environmental quality. However, strategic goals of environmental quality status have not yet been reached, and they imply that the state of the quality of air, water and soil has to be within the allowed limits of quality and stability of ecosystem.

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SUSTAINABILITY AT UNIVERSITIES EXEMPLIFIED BY THE ENVIRONMENTAL CAMPUS BIRKENFELD

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Abstract: The responsibility for sustainable actions opens up great opportunities for economy and society. However, sustainable development and material flow management still need to be more present in the conscience of society. Sustainability and sustainable actions are part of the major social challenges and also influence initiatives and cooperation of different actors. Sustainability plays an important role in many other countries as well. In order to make use of the significant potential of the science of sustainability, it is crucial to further develop the science system and especially the subject "sustainability" at universities. Transformation knowledge as well as trans-disciplinary cooperation will have to play an important role in science. Thus it is possible to deal with the question which change processes could be introduced to develop into a sustainable society. A wide diffusion of research and development from universities to the fields of economy, municipality, authorities, ministries, companies and society seems to be important and enables a close cooperation which promotes trans- disciplinary activities and thus makes use of the significant potentials of a science of sustainability. An integrative and interdisciplinary approach is necessary to establish an education of sustainable development. Environmental consciousness cannot simply be added to existing subjects. According to sustainable development, environmental consciousness should be a recurring theme in the whole course of studies right from the start. To be able to cope with the challenges of the 21st century on a national and international level, it is important to encourage a scientific culture that works on the future problems of our society across the borders of special disciplines. The key elements to achieve a "highly efficient zero emission university" are the networking of all involved actors, the development of renewable energies, participation in sustainable education as well as the improvement of existing systems, which will be exemplified by the Environmental Campus Birkenfeld.

Keywords: Sustainable Development, Zero Emissions University, Sustainable Management, Environmental Management

DETERMINING THE OPTIMAL CONDITIONS OF THE INDUSTRIAL WASTE TREATMENT USING FACTORIAL EXPERIMENTAL DESIGN

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Abstract: The aim of this study was to perform a laboratory investigation to assess the feasibility of extraction or copper from the copper flotation waste. This industrial waste material, generated as the byproduct of pyrometallurgical copper production, always contains a significant amount of Cu together with trace amounts of other toxic elements such as Fe, Sn, Sb, As, and Pb. It is usually being disposed at the tailing ponds in the vicinity of the copper smelter plant. The tailing ponds usually have large uncovered horizontal areas which are exposed to weathering. The release of heavy metals into the water and soil is usually resulting in a number of environmental problems. On the other hand, amount of copper in this raw material is high enough to be economically utilized using adequate leaching methods. In this study, the leaching characteristics of copper flotation waste from the Bor Copper Mine, Serbia have been investigated for potential copper extraction.

Keywords: Copper flotation waste, MLRA, mathematical modeling

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Conference papers:

ARSENIC AS ENVIRONMENTAL POLLUTANT

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Abstract: This paper analyses arsenic pollution of air, water and soil. Years of mining and metallurgical activities in Bor have had a considerable environmental impact. Based on the conducted measuring of air quality, average annual concentrations of arsenic in ambient air are provided for the period 2003-2013. Content of arsenic in the River of Bor, river sediment and soil in the area of Bor Municipality was analysed for the subject period.

Keywords: arsenic, pollution, environment

1. INTRODUCTION

Arsenic is a toxsic element that affects human health [1-5] and recognized as a carcinogenic element [6-8]. Antropogenic activities such as the smelting of Cu together with natural phenomena are responsible for the emission of arsenic into the atmosphere [9].

Toxity of arsenic in surface waters [10] is reflected in its effect on the river sediments [11,12] plant and animal world, as well as health of humans [12-14].

Metallurgy is a big pollutant of environment. Creation of high quantities of waste gas, water and solid waste and low recovery of matter and energy in technological processes are the cause of environmental pollution.

Development of technology and application of new technical solutions in pyrometallurgy aim at increase in inlet raw material recovery, improvement of energetic efficiency, cost-efficient business and environmental protection.

2. METHODS AND MATERIALS

Figure 1 presented a map of the Bor Municipality area with measuring points of air quality control. Three measuring locations were included, in the town and in its surrounding: 1. City park (500m from the the stack in the smelter in the east wind direction); 2. Jugopetrol (in the direction of the prevailing North wind); 3. Institute (1km from the smelting complex).

Mining and Metallurgy Institute Bor measured the air quality in Bor in the period from 2003. to 2008. and from 2010. to 2012.

Institute of Public Health "Timok" Zaječar measured the air quality in Bor in the period from 2008. to 2010.

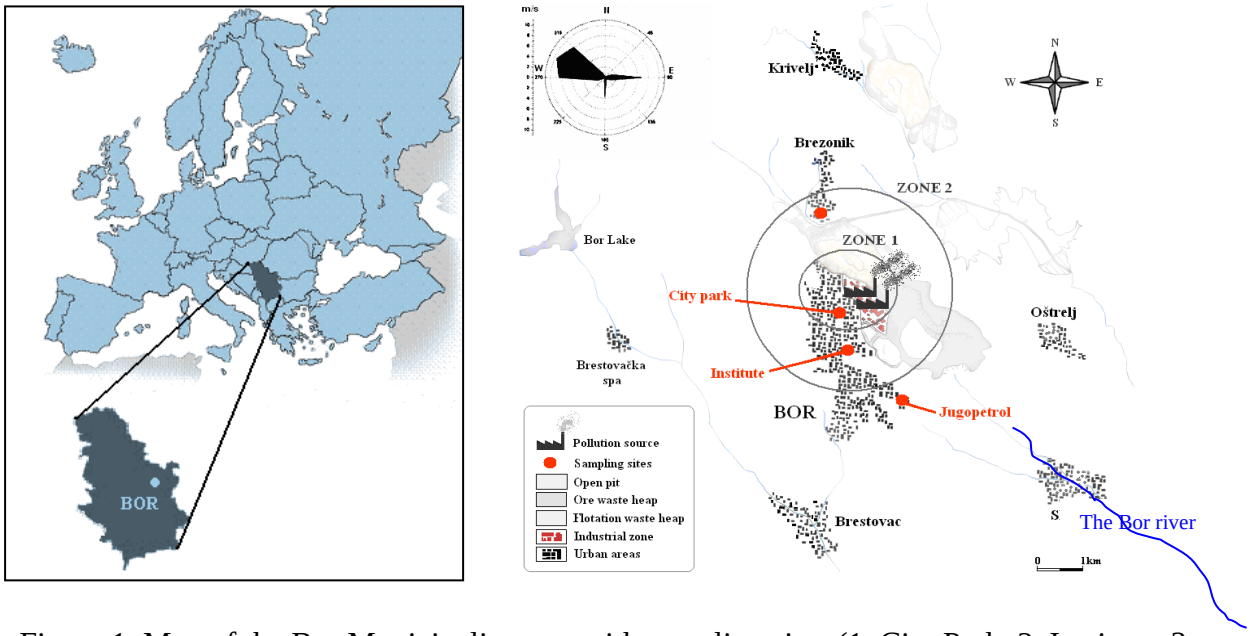

Figure 1. Map of the Bor Municipality area with sampling sites (1. City Park, 2. Institute, 3. Jugopetrol) and location of Copper Smelter smokestacks.

Sampling of suspended particles was conducted through samplers of ambiental air Model LVS 3 Sven Leckel and Model MVS 6 Sven leckel, Germany.

Arsenic in suspended particles was determined through atomic absorption spectrometry with graphite furnace pursuant to the standard SRPS ISO 9835:1993.

Mining and metallurgical activities have had a significant impact on the natural water streams in Bor region. The Bor and Krivelj river present an open waste water collector (for industrial and communal waste water) and they are degraded. After the confluence of The Bor river into The Krivelj river, The Bela reka river is formed which goes into the Timok. Waste industrial water goes into a collector without prior treatment, from where it is sent to The Bor river which severely pollutes the river itself and affects the quality of the Timok [15,16].

Public Health Institute Timok analyses The Bor river four times per year at the measuring point "Slatina". Effluent samples were analysed by using the Atomic Absorption Spectrophotometer UNICAM 969-SOLAAR, As – vapour sistem, UNICAM-VP90/Fi-90.

3. RESULTS AND DISCUSSION

The measured values of As ng/m^3 in particulate matter (PM 10) in ambient air in the period 2003. – 2012. is presented in the figure 2.

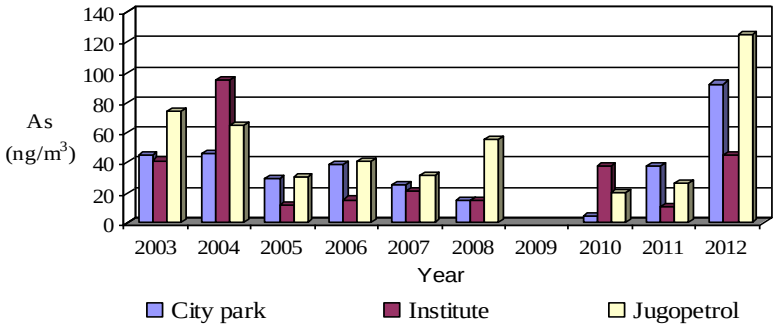

Figure 2. Average annual values of As ng/m^3 in particulate matter (PM 10) in ambient air in the period 2003. – 2012.

Table 1. Limit value of suspended particles PM_{10} and As in ambiental air as per the regulations of Republic of Serbia (offical Gazette RS no.63/2013)

Pollutant	Annual limit value
PM_{10}	40 µg/m^3
As	6 ng/m^3

Figure 3 present average annual content of arsenic in The Bor river at the measuring point "Slatina".

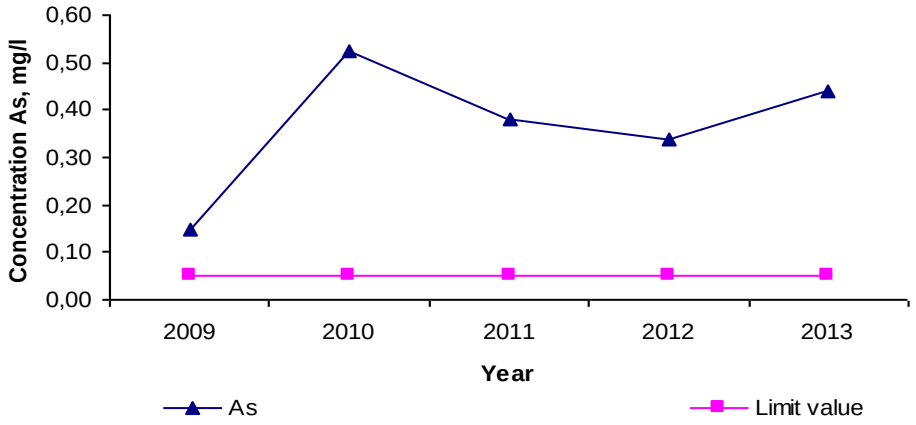

Figure 3. Average annual content of As mg/l in the Bor river from 2009. to 2013.

Characterization of the river sediment in Bor was done within the UNEP Project. Determining the capacities for environmental monitoring in Bor in September 2002 at the following locations:

- Sediments in the Bor river before the confluence with the Krivelj river (sample ID 10-33)
- Sediments in the Krivelj river at the confluence with the Bor river (sample ID 10-34)
- Sediments in the Bor river after the confluence with the Krivelj river (sample ID 10-33)

Table 2. Analytical results of the Bor river sediment in 2002 [11,12,17,18]

Parameters / sample ID	10/33	10/34	10/35	Serbian Standards, mg/kg		
				MCL in soil	Soil (mg/kg absolutely dry matters)	
					Limit value	Remedial value
pH	7,69	4,56	6,39	/	/	/
As, mg/kg	315	291	310	25	29	55

UNEP's report (2002) shows that the analyzed samples have indicated higher pollution with arsenic, as well as increase of soil acidity.

The project "Assesment of Environmental Monitoring Capacities in Bor – Mission Report", 2002. included soli analysis. The results of measurements are shown in Tables 3 and 4.

Table 3. Results of the test soil quality in the municipality of Bor [11,12]

Parameters	Soil samples									
Place of sampling	Brestovac		Vražogrnac		Krivelj		Slatina		Oštrelj	
Number of samples	10/10	10/11	10/12	10/13	10/14	10/15	10/16	10/17	10/18	10/19
Sampling depth of soil, cm	10	40	10	40	10	40	10	40	10	40
pH	6,80	7,41	7,33	7,17	7,42	7,56	6,70	6,82	7,64	7,92
As(mg/kg)	2,4	2,85	27,6	32,2	19,2	8,62	36,0	9,2	25,8	45,2

Table 4. Contents of As,mg/kg of the tested plants [11,12]

Parameters	Soil samples and tested plants									
Place of sampling	Vražogrnac		Slatina		Oštrelj		Krivelj		Brestovac	
Number of samples	10/20	10/21	10/22	10/23	10/24	10/25	10/26	10/27	10/28	10/29
Tested plants	onion	peas	onion	onion	salad	onion	horseradish	clover	onion	strawberry
As(mg/kg)	<0,005	0,027	0,042	0,57	0,052	0,017	0,025	0,017	0,01	0,017

Average contents of arsenic in the soil of Bor municipality are under the allowed 25 ppm. An average content of arsenic in plants is usually significantly lower then in soil.

Arsenic content in plants is considerably lower than in the soil where they are grown. Usual arsenic content in plants is 1-7mg/kg of dry substance. Arsenic is indispensable substance for plants. Low concentrations stimulate growth of the root. High concentrations have negative effect on sprouting, growth and development of plants. It reduces fruit size and production. Allowed arsenic concentration for edible parts of plants in Germany is 2,6 mg/kg. Arsenic concentration of the fruit and vegetables sprayed with pesticides can be over 0,5mg/kg. Concentration of arsenic that can be tolerated for food (fruit, wine) must not exceed 1mg/kg. Arsenic is light and is easily transmitted. Analyses of clover and hay from different locations showed arsenic presence and increase of concentrations closer to the source of emission(metallurgical complex in Bor). Arsenic reaches food chains of animals by fodder. Consuming milk, dairy products and meat people take in this carcinogenic substance which can cause serious disorders [19].

4. CONCLUSION

The average content of As in the ambient air for the period 2003.-2013. was above the limits by the legislation of the Republic of Serbia. Also, the increased content of arsenic in The Bor river and sediment confirms the influence of anthropogenic factors on the environment. Analyzed soil samples showed an increase in arsenic pollution and increase soil acidity. Arsenic has a high degree of absorption in the soil and accumulate in the surface layers. It is very toxic element and affect human health.

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NEW SOLUTION FOR CONTACT SPEED MEASUREMENT OF MINING SKIPS MACHINES

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Abstract: Beside of monitoring transport system performance, there is a need for tracking dynamic behavior of the mining skips machines. For this reason, this paper has demonstrated a new solution of industrial equipment for contact speed measurement of export containers on mining skips machinery. The proposed technical solution is the original author's solution created by multi-year monitoring and experimental work with a variety of technical systems. Industrial solution is based on a stationary device that optically and periodically measures the rotation speed of the driving drum, mining skip speed of machines and records kinematics peaks. The solution is obtained based on the observation that requires "Regulation on technical norms in the transportation of people and material within the mine shafts" "Službeni glasnik SRJ", no.18/92. The developed prototype is tested and adapted to performances of export machines ASEA HSDE 2.5 in the mine basin Bor for rated speed of vertical transport up to 16 m/s.

Keywords: mining skips machines, contact speed measurement

SORPTION OF Pb(II) FROM AQUEOUS SOLUTION BY A POWDER MIXTURE OF MYRIOPHYLLUM SPICATUM AND BENTONITE

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Abstract: Aquatic weed *Myriophyllum spicatum* is undesirable plant in many countries which must be removed continuously. It has been confirmed that aquatic plants can be used as biosorbents for the removal of heavy metals. Clay minerals as bentonite can be successfully employed as adsorbents of many waste water pollutants such as heavy metal ions. In the present study the (bio)sorption efficiency of two different materials: *Myriophyllum spicatum* and bentonite and their different mixtures has been investigated for the removal of lead ions from aqueous solution. Best capacity 81 mg/g showed mixture of 75% *M. spicatum* and 25% bentonite. Selected powder mixture was characterized by Fourier Transform Infrared Spectroscopy (FTIR). The kinetic studies indicated that the sorption process of the lead ions followed well pseudo-second-order model. Selected material mixture can be applied as an efficient, low cost, and environmentally friendly (bio) sorbent for the removal of lead ions.

Keywords: *Myriophyllum spicatum*, bentonite, sorption, lead ions

BIOSORPTION OF METHYLENE BLUE ONTO CORN COB

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Abstract*:* In this study, the usefulness of corn cob as a low-cost adsorbent for the removal of methylene blue (MB) from aqueous solution has been investigated in batch experiments. The influence of initial MB concentration on biosorption process has been studied. Langmuir and Freundlich isotherms, at pH 5 and 298 K, were used to describe sorption equilibrium data. The MB adsorption isotherm follows the Langmuir model and maximum biosorption capacity value is 35,67 mg/g. A comparison of the results obtained with adsorptive capacities of some adsorbents previously investigated indicates that corn cob could be a promising biosorbent for removal of MB from aqueous solution.

Keywords: Biosorption, corn cob, Methylene Blue

1. INTRODUCTION

Wastewater from industries such as dyestuff, textiles, leather, paper, printing, plastic and food [1] contain various dyestuffs. This wastewater contains a variety of organic compounds and toxic substances, which are harmful to fish and other aquatic organisms [2]. One of the most commonly used chemical in listed industries is Methylene Blue (MB). Molecular structure of MB is illustrated in Figure 1.

Figure 1. Molecular structure of Methylene Blue

The presence of dyes in water, even at very low concentrations, is highly visible and not desirable due to its harmful effects. In contact with human and animals MB can cause eye burns which may be responsible for durable violation to the eyes. On inhalation, it can give

rise to short periods of rapid or difficult breathing while ingestion through the mouth produces a burning sensation and may cause nausea, vomiting, profuse sweating, mental confusion and methemoglobinemia [3,4,5]. For that reason, the treatment of wastewater containing dye is of big interest because of its harmful influence on human and animal health.

Several methods have been used for the removal of dyes from wastewater. These include physiochemical, chemical and biological methods such as coagulation and flocculation, ozonation, electrochemical methods, fungal decolonization [6,7,8,9] etc. Difficult process handing and high cost of operation, production of sludge or potential toxic byproduct are the main disadvantages of these techniques.

Biosorption is an effective technique for removal of dye from waste water and become an alternative to conventional techniques of wastewater treatment, due to its low operating coast, environmental friendly nature and high sorption efficiency [10,11,12,13].

In this work the usefulness of low cost and locally available agricultural wastes corn cob (OK) for MB removal from aqueous solution are presented.

2. MATERIALS AND METHODS

2.1. BIOSORBENT PREPARATION

Corn cobs were obtained from local farm near the Belgrade, Serbia. Biomaterial was milled with mill (KHD Humbolt Wedag AG) and <1 mm fraction was chosen for the biosorption experiment without any pre-treatment.

2.2. PREPARATION OF STOCK SOLUTION

Stock solution was prepared by dissolving precise amount of MB (p.a. grade) in deionized water. Desired solutions of different MB concentrations were prepared by diluting of stock solution to the desired concentrations. pH was determined by pH meter SensION type MM340, Hach.

2.3. BATCH EXPERIMENTS

In order to study the effect of important parameters like initial dye concentration on the biosorbent capacity of MB removal, batch experiments were performed by mixing of 0,01 g of biosorbent in 50 mL of MB solution of different concentration (from 1,2 to 12 mg/L). The mixture including the MB solution and biosorbent were shaken during 48 h in mechanical shaker at 250 rpm at ambient temperature and at pH 5. At the end of the given contact time contents of the flasks were filtered. Concentration of total MB remaining in the filtrate was analysed by spectrophotometer Spekol 1300 at 620 nm.

Refer to (1) the adsorption capacity of the biosorbent – the amount of MB sorbed per gram of sorbent (q, mg/g) was calculated:

$$q = (C_i - C_{eq}) \cdot V / m \quad (1)$$

where V is solution volume (L), m is mass of the sorbent (g), and C_i and C_{eq} (mg/L) are the initial and final concentration of the MB in the solution, respectively.

3. RESULT AND DISCUSSION

3.1 EFFECT OF INITIAL MB CONCENTRATION

Figure 2 illustrates the adsorption of MB onto corn cob as a function of initial MB concentration. It can be seen that the biosorption capacity of MB was increased with increasing the initial MB concentration.

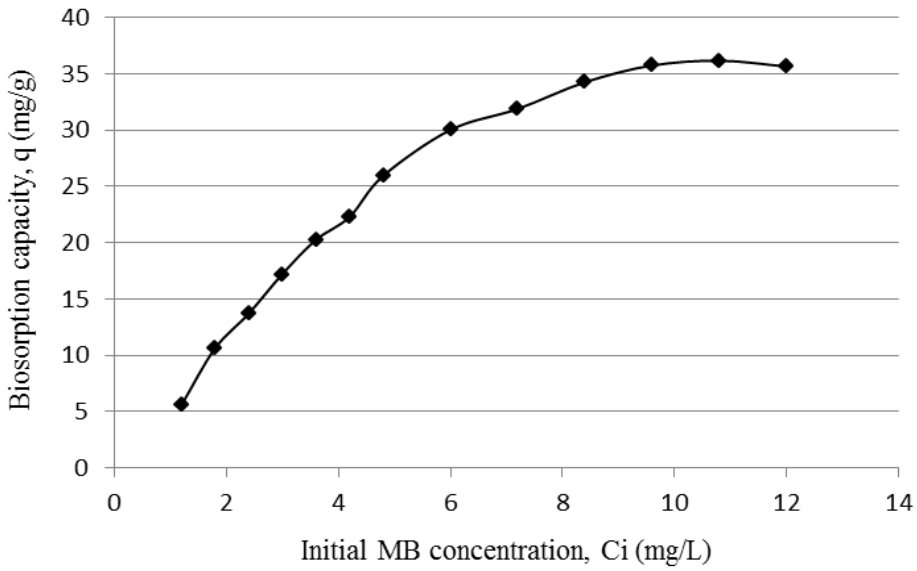

Figure 2. Effect of initial concentration of MB adsorption on corn cob (pH 5, V= 50 mL, m=0,01 g and t=48 h)

3.2 ADSORPTION ISOTHERMS

Experimental data were fitted to the two isotherm models: Langmuir (1) and Freundlich (2).

$$q=\frac{q_m K_L C}{1+K_L C} \quad (1)$$

$$q = K_F C^{1/n} \quad (2)$$

where q (mg/g) is amount of MB adsorbed per mass of adsorbent, C (mg/L) is equilibrium MB concentration, q_m (mg/g) and K_L (L/mg) are the Langmuir constants related to the maximum capacity and energy of adsorption, respectively, K_F ($L^{1/n}$ $mg^{1-1/n}$/g) and *1/n* are the Freundlich constantsrelated to the adsorption capacity and intesity, respectively.

The Langmuir and Freundlich adsorption isotherms are shown in Fig. 3. The constants for these isotherms are given in Table 1. In agreement to the correlation coefficient (R^2=0.955), the MB adsorption isotherm follows the Langmuir model and maximum biosorption capacity value is 35,67 mg/g.

Table 1. Langmuir and Freundlich isotherm constants

Langmuir			Freundlih			Experimental value
q_m (mg/L)	K_L(L/g)	R^2	K_f	1/n	R^2	q (mg/g)
35,67	6,44	0,955	26,43	0,232	0,919	35,67

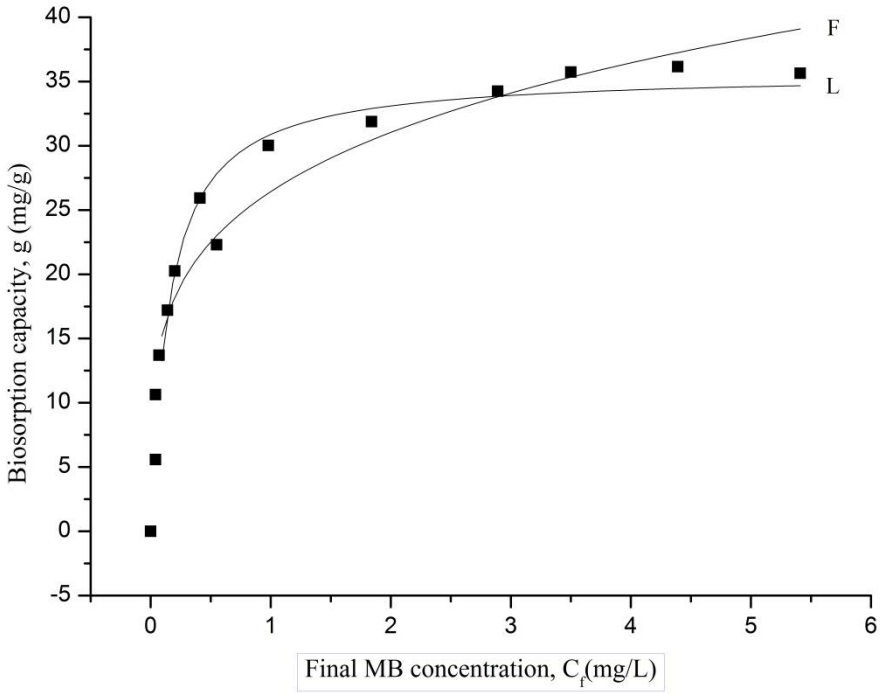

Figure 3. Langmuir and and Freundlich isotherms of MB adsorption

Table 2 presents the comparison MB biosorption capacity for corn cob and different biosorbents described in the literature. The biosorption capacity of corn cob is mainly higher or similar than that of the majority of other biosorbent reported.

The differences in biosorption capacity of various biomaterials perhaps because of diferent surface characteristics such as porosity, activity, presence of different functional groups etc.

Table 2. Comparison of the biosorption capacity of different biosorbents

Biosorbents	Biosorbent capacity (mg/g)	Ref.
Garlic peel	82,64	[10]
Cherry sawdust	39,84	[11]
Hazelnut shell	38,22	[12]
Rice husk	28	[13]
Pitch-pine sawdust	27,78	[11]
Cotton waste	24	[13]
Banana peel	20,8	[14]
Orange peel	18,6	[14]
Wheat shells	16,56	[15]

4. CONCLUSION

In this work the posibillity of the low cost biomaterial (corn cob) was investigated for removal of MB from aqueous solution in a batch experiment. Adsorption equilibrium was better described by the Langmuir isotherm model than the Freundlich model. The monolayer adsorption capacity of corn cob for MB was found to be 35,67 mg/g. Based on all results and comparison of the results obtained with adsorptive capacities of some adsorbents previously investigated it can be concluded that the corn cob is an effective and alternative biomass for the removal of MB from aqueous solution.

ACKNOWLEDGEMENT

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IMPROVEMENT OF PICO HYDROPOWER PLANT ON THE RADOVLJANSKA RIVER

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Abstract: The work carried out numerical simulations of flow in a small bulb turbine using the software package CFX. The turbine was installed in one of the pools of a trout farm Jablanica in the Radovanska river. Built small pipe turbine was unregulated. In the periods of low discharge the turbine was inactive. An improvement of built-in turbine has been done installing regulated inlet guide vanes. The first, using CFX software, power efficiency curve of unregulated bulb turbine had been obtained. Then, power efficiency curves of the turbine for several different positions of inlet guide vanes were calculated. Comparisons of the efficiency curves of analyzed turbines were performed. The advantage of the solution with regulated inlet guide vanes was shown. The described solution was built in the hydropower plant.

Keywords: bulb turbine, flow simulation, turbine regulation

1. INTRODUCTION

The Radovanska river is located in Eastern Serbia in the region of municipal city Boljevac. On the left bank of the river, near to it's underground exit trout farm Jablanica has been built. Following the fall of the field parallel to the river, there are six concrete pools cascading set for trout farming. Apart from these pools, there are two large pools built in clay excavation.

Micro-climatic conditions of trout farm are suitable for life and growth of trout varieties of fish because there is no freezing of water during winter. The farm is located in a valley surrounded by mountains that protect it from the winds.

Average mean flow of the river, according to data from the official registry, is 350 l/sec at the site of water intake. In the dry season the water flow drops to about 100 l/sec. Drought is customary during autumn.

Water intake, which is located on the concrete bulkhead river, is Tyrol type. Since the affected water contains drawn and suspended sediment behind the intake, there are two pools for deposition of sediment. Then the water is released into the fields for growing fish.

For the current production levels pond uses an average of 250 l/sec of water. Minimum amount of water is dependent on the time of year, the amount of fish that are grown and feeding intensity.

When there are unfavorable hydrological conditions, the amount of water used is less than 90 l/sec. In such situations it is necessary to perform the aeration of the water to increase the oxygen content.

Pond is not connected to the public electrical grid. Required electrical energy was produced using fuel oil generator. According to the cadastre of small hydropower plants, in the immediate vicinity of the pond, it has been planned to build a small hydro power plant. It is not certain when that will be.

From the above described the idea arose that the water used in the process of raising fish at the outlet of the pond can be used to produce electricity. Namely, after the fish ladder, which are arranged in cascade in four levels, the water is collected in the sump and discharged into the river.

The relative elevation of the water table in the collection basin is 94.50 meters and the elevation of the water in the drain channel is 92.20 meters. As seen on Figure 1 there is a drop of 2.30 meters which could be used for power generation turbines.

Hydraulic losses would be small due to the small length of penstock and profiled inlet of the tube. Penstock diameter is D=430 mm and its length 8.10 meters.

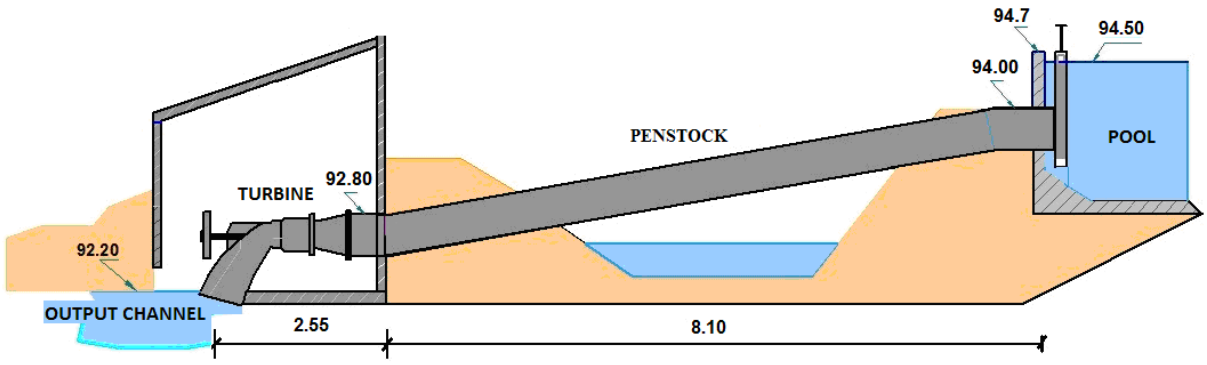

Figure 1

In 2011. pico hydropower station was built. Unregulated bulb turbine was installed. The geometry of built-in turbine had been obtained by scaling the small tubular turbine of known geometry and characteristics [1,2]. Impeller diameter turbine has been 300 mm, and penstock diameter 430 mm. The

output diameter of the diffuser has been 500 mm, the length of the diffuser 950 mm, so that the angle of the diffuser has been 6^o. The turbine had secured a stable supply of electricity in gross head from H=1,80 to H=2,30 meters. It's rotation speed was n=320 rpm and optimal efficiency discharge of Q=210 l/sec. Asynchronous generator has worked at 760 rpm.

Implemented solution photos are given in Figure 2.

Figure 1

In dry periods, when flows are lower, unregulated bulb turbine couldn't provide the minimum power necessary for the stable operation of the system. Electronic speed controller of the turbine, which had been working on the principle of sharing power between ballast heaters and consumers [3], during dry periods system operation was often interrupted due to lack of power. Therefore, fixed guide vanes of the turbine were replaced with adjustable guide vanes. Turbine impeller has remained unchanged. Implemented solution to the problem is described in this paper.

Previous unregulated and new regulated turbine solutions were simulated using CFD software Ansys CFX. The results of calculations are presented in the work. Detailed description of the calculation results was given for the previous turbine solution in [4], and for new turbine solution in [5].

2. PREVIOUS TURBINE SOLUTION – UNREGULATED TURBINE

Based on the dimensions given in the introduction to the paper geometric model of previous turbine solution was established. It had impeller with 4 fixed blades and 7 fixed guide vanes. Shape of guide vane was curved, as part of a cylindrical surface. The blades of impeller and guide vanes were made from sheet metal of constant thickness. The thickness of the blades of the impeller was 5 mm, the thickness of the guide vane was 3 mm. Incoming and outgoing edges of the impeller blades and guide vanes are round-arched.

Discretisation mesh was formed using the program CFX-Mesh and Ansys TurboGrid. CFX-mesh was used for the preparation of unstructured mesh of input and diffuser. The mesh was adjusted to the application of wall functions. The program Ansys CFX, when using the SST turbulence model, predicted the automatic transition of the laminar sub-layers to the wall functions, depending on the dimensionless coordinates y^+. For the formed mesh, dimensionless thickness of the first layer of the mesh was $y^+ < 2$, according to recommendations for the calculation of the laminar sub-layers.

Geometry of previous unregulated turbine is shown in Figure 3

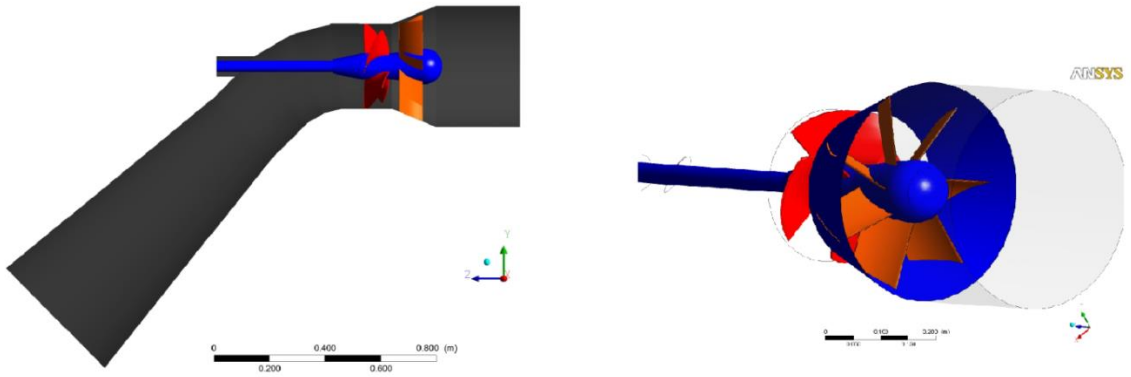

Figure 3

Using software Ansys CFX, the characteristics of unregulated turbine were obtained. The calculation results are given in Figure 4.

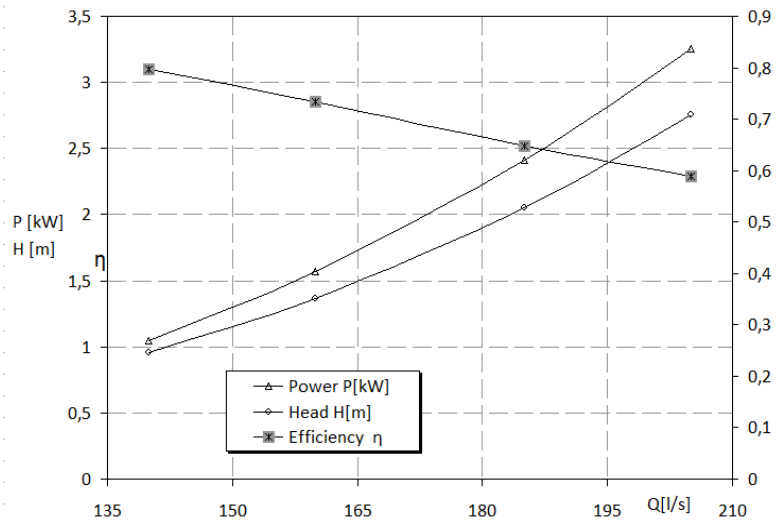

Figure 4

As mentioned in the introduction, this unregulated turbine had been operated at gross heads between H=1.80 and H=2.30 meters and at discharges greater than Q=180 l/sec.

3. NEW TURBINE SOLUTION – ADJUSTABLE GUIDE VANES

In order to provide electricity during the whole year, reconstruction of the existing unregulated turbine started. It is obvious that the problem can be solved by regulation of the turbine. The old, unregulated turbine impeller was retained, and regulation was achieved

using adjustable guide vanes. This solution minimized the costs and shortened the time of implementation.

The preliminary technical solution is presented in Figure 5.

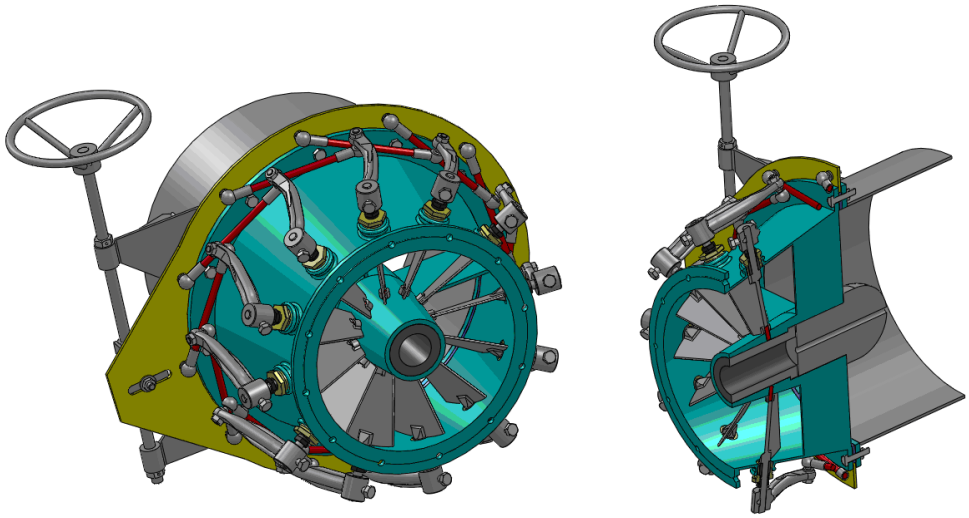

Figure 2

Reconstructed turbine had 12 guide vanes. Moving guide vanes were flat plates with a thickness of 3 mm. The calculation was performed for 4 angles $\alpha = 15^0;\ 30^0;\ 45^0;\ 60^0$ of the guide vanes. Calculation procedure was identical to the already described for the case of the unregulated turbine.

Grids of the impeller blade and the guide vanes for $\alpha = 45^0$ are given in Figure 6.

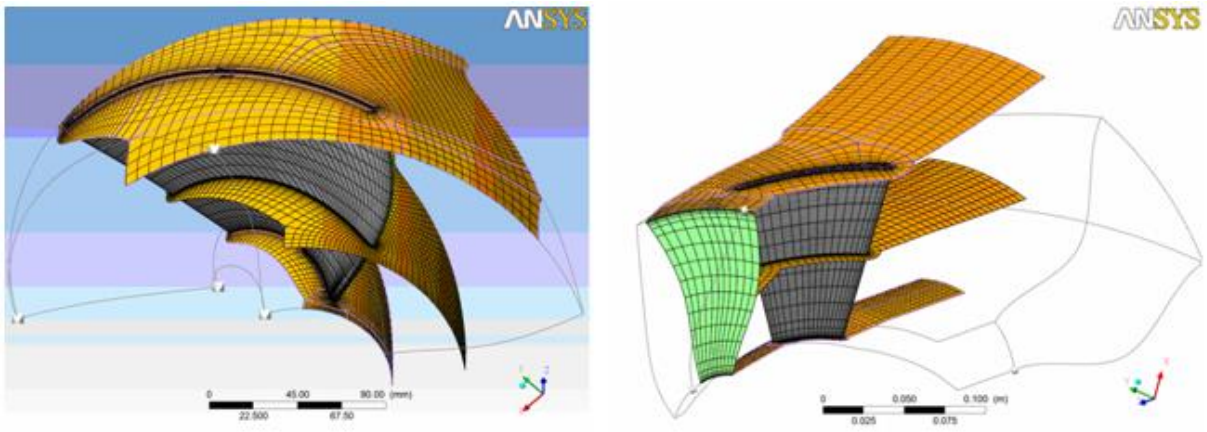

Figure 3

Grid of the diffuser is shown in Figure 7.

Figure 7

Description of the calculation procedure was given in detail in [5]. Figure 8 shows the results of calculations for gross head H=2.30 meters for the whole range of changes in the angles of guide vanes.

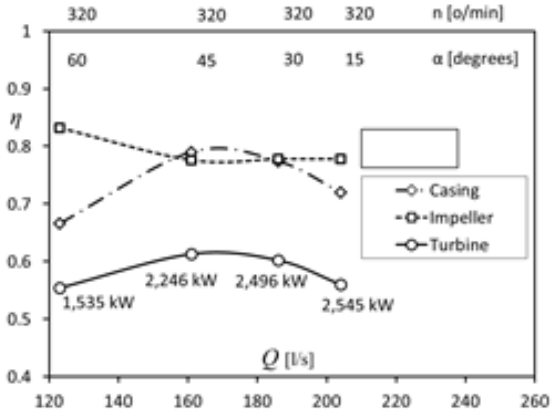

Figure 8

On the basis of calculations performed, during the autumn of 2013, turbine with adjustable guide vanes was produced. The photo of produced adjustable guide vanes is shown on Figure 9.

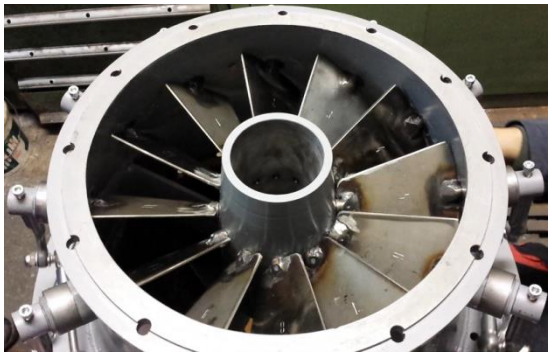

Figure 9

It turned out that the turbine, in the range of gross head of H=1.80 to H=2.30 m and discharges greater to Q=90 l/sec, has worked stable. The proposed and implemented solution has provided permanent work of the hydropower station throughout the whole year.

The price of the implemented solution, with adjustable guide vanes as flat plates, is somewhat lower turbine efficiency coefficient in the discharges greater to Q=180 l/sec. For example, at discharge of Q=192 l/sec, efficiency coefficient of the unregulated turbine is $\eta = 0,627$ and of the regulated turbine $\eta = 0,588$. It is seen, that the relative difference in turbine efficiency coefficient, of unregulated and single regulated turbine is 6.2% relative to unregulated turbine.

4. CONCLUSIONS

For unregulated turbine there were carried out simulations in the area of gross head of H=1.80 to H=2.30 meters and the domain discharges of Q=120 l/sec up to Q=210 l/sec. It turned out that the unregulated turbine was stable for discharges Q > 180 l/sec. Unstable operation of pico hydropower station occured during the autumn months, when the plant was not working.

The problem is solved by introducing a regulation of the turbine guide vanes. Because of the need for quick solutions, 7 fixed cylindrical guide vanes was replaced with 12 adjustable guide vanes. Adjustable guide vanes are flat plates. Regulated turbine operates in all flow conditions during the whole year, ie. with dischages Q > 90 l/sec.

The price of the implemented solution is reducing the turbine efficiency coefficient approximately 7% in the domain of Q > 180 l/sec. The produced electricity is sufficient for the needs of island operation of electric devices in the trout farm Jablanica.

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SOFTWARE RELATED TO PROTECTION OF ENVIRONMENT THROUGH WATER QUALITY SAMPLING

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Abstract: Within this research paper detailed analysis of the possibilities for the development and construction of the information system of the company Regional Water Supply System-Pristina with respect to monitoring of water quality in the lake Gracanica near Pristina, with goal to improve the environment and water quality, is presented.

Keywords: information system water, water quality

1. INTRODUCTION

The system shall be implemented in order to facilitate the work of professionals and analysts and to achieve full transparency of the obtained data on the quality of drinking water and to, also, provide "online" monitoring of the results and the availability of collected information to the authorized users via the Internet and to provide usage of the lake Gracanica beaches at any time with certainty that the customers are enjoying a clean and safe water.[3]

This paper presents possible representation of reliable and efficient software solution capable to monitor water resources in a way that will allow obtaining immediate answers to the problems of environmental protection and sustainable development, energy waste and increase production volume, which can restore confidence in the future, such as caring for natural resources fully in line with the economic and human development. [9]

Also in this meticulous research paper, the concept of solution with requirements and needs of users and potential limitations is presented, based on the research and review of relevant literature an overview of technologies and techniques for measuring the quality of water, as well as a possible model of the information system of the "Regional Water Supply and Sewage" Pristina-Gracanica, in whose jurisdiction is the lake Gracanica, where the configuration of such a system, database implementation plan and the economic aspect of the cost-effectiveness of building such a system is shown. [8]

During the development of the information system, the important basis for obtaining the prestigious international "Blue Flag" is presented, with the task to keep the beaches clean, safe and ecological, and to allow the users to enjoy the pleasant surroundings trough fulfillment of the conditions on the quality of swimming water in natural swimming areas. Having this in mind, collected microbiological and physico-chemical data are processed throughout the swimming season in one of the approved public institutions. The procedure to obtain the Blue Flag envisages, in order to obtain it for the current year, that water analysis

results from the previous year should be attached to the request. In Serbia, the control of water quality for swimming is performed, in major cities, in the Institutes of Public Health or other accredited institutions.

Table 1. Mandatory values of microbiological parameters [5]

Parameter	The recommended value	% Results in an acceptable sample is greater than the recommended value	The required values	% Results in an acceptable sample is greater than the requested value
Total coliform bacteria	500/100 ml	20%	10,000 / 100 ml	5%
Coliform bacteria of fecal origin	100/100 ml	20%	2000 / 100 ml	5%
Faecal streptococci	100/100 ml	10%	-	-

Table 2. Standard values of physico-chemical elements [5]

Parameter	The recommended value	Acceptable% of the sample score higher than the recommended values	The required values	Acceptable% of the sample score higher than the required values
PH Value	6 to 9	5%		
Color and transparency water	Inconspicuous	5%		
The content of mineral oil	Water: Oil stains are not visible so that there is no noticeable odor Soil: The beach must be controlled to such pollution example, where the incident cases accepted municipal and / or regional plan are applied	5%		
Surface active substances	On the surface, there is no foam that lasts	5%	<0.3 mg / L	10%
Phenols	No specific smell	5%		
Transparency	Visibility at depth> 1m, or because of geography at depth <1m	5%	In-depth visibility > 2m	10%
Stained remnants and floating materials, such as wood, plastic products and glass, rubber or any other substances	The absence of heavy water in the waste to and the ground	5%	The absence of any harmful substances and the material both in water and in the soil	10%

2. EXPERIMENTAL WORK

The information system should collect and process data for the Blue Flag obtaining and this means the proper hardware and software for recording and processing of data. [7] In the case of information system of the "Regional Water Supply and Sewerage" Pristina-Gracanica

which is in charge for the lake Gracanica, the same can be arranged through the buoy used for data acquisition from the water and the computer system at the company headquarters Regional Water Supply and Sewerage. In the above mentioned company the project which uses the Oceanic buoy may be located - a buoy that collects data from a variety of measuring devices installed on it. These data are transmitted via radio to the computer system on the coast, where they can be processed, stored and displayed on the website.

The value of the equipment at Oceanic buoy is about 2 million RSD, and in Figure 1 one of the Oceanic buoys is presented.

In order to present it simplified, the system is divided into four sub-categories, namely:

- buoy with measuring instruments and other electronics
- stations for receiving the read data
- equipment and software
- system data.

To understand the complexity of such an information system the basic elements of a system for recording, storing and transferring data are presented further. Buoy for the company Regional water and sewer for the lake Gracanica can be equipped, as shown in Figure 2, with instruments for recording the following elements:

- temperature and relative humidity,
- water temperature 2 meters below the surface,
- temperature, pressure and salinity of the water at a depth of about 19 meters,
- wind speed and direction,
- the direction and speed of water currents in 5 different depths,
- Current location of the Buoy (both side slopes)
- time and geographical location (GPS).

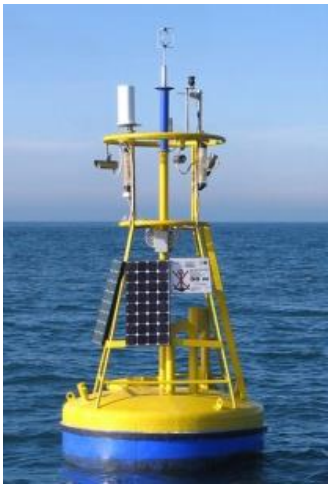

Figure 1. Oceanographic buoys [4]

The supplier of the system has developed special software for this purpose. User software for transfer and storage of the read data from buoys in the IT Center of the company Regional water and sewer consists of three programs:

- Mbp_buoy,
- Registration
- Terminal

Where the first two automatically starts when you turn on the computer and work continuously as the two processes in the background. Program Mbp_buoy controls all communication with the buoy subsystem simultaneously gathering read data. The function of the program is, as the name suggests, processing and storing the received data in L mySQL database.[2]

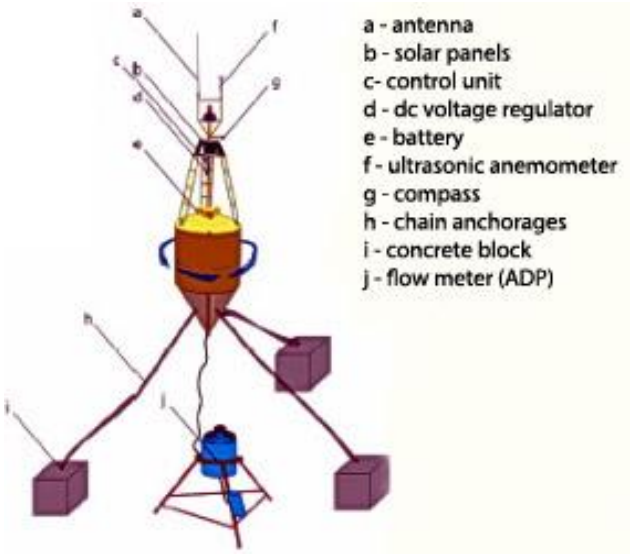

Figure 2. Buoy with measuring instruments anchored with three concrete blocks [4]

3. RESULTS AND DISCUSSION

Approximate investment cost of installing measuring devices into a single buoy are given in Table 3

Table 3. Estimated investment costs of the buoy with the necessary tools [1]

1.	buoys and related equipment (solar panels, rails)	**€ 13,000.00**
2.	anchoring equipment (chain, rope, anchor)	**€ 400.00**
3.	sensors specification	**€ 15,000.00**
4.	Equipment for online measurement	**€ 2,500.00**
5.	equipment for GSM data transfer to the central	**€ 4,000.00**
TOTAL:		**€ 34,900.00**

Terminal is the user program and serves as a user interface for setting parameters and buoys as an interface to access the terminal instruments in the buoy. All three programs share data with each other via shared memory while the synchronization is being performed trough the traffic lights and messages (signals). [6]

As it is shown the cost of buying a buoy along with the accompanying instruments are estimated at € 34,900.00. To these costs, the cost of buying and installing the server software shall be added, web applications and utilities that read and store the measured information in a database, which roughly amounts to another 5.000,00 €.

From this it might be estimated that the total investment for the installation of three buoys is around € 70,000.00. Of course, with the purchase of a number of buoys and possible interest of other countries for this project there can be some reduction in expenses.

This estimate of the investment the necessary maintenance costs are lacking and must be taken into account. According to the EuroGOOS maintenance fee, which includes the calibration of instruments, operating costs, maintenance and certification data for a single buoy cost from 15,000 to 80,000 € a year and it mainly depends on: [10]

- location of the buoy (high seas, offshore, free-floating)
- people and technical equipment needed for access to and maintenance of buoys,
- size of ship / boat that is used to access the buoy
- characteristics and the number of instruments and sensors.

Since in presented case the buoy is at a relatively accessible position, it does not require special vessels and a large number of people and in that respect it can be estimated that the cost of maintaining the entire system will be around € 40,000.00 per year which also includes sensor calibration by authorized institutions, maintenance of buoys, databases, software and hardware.

In the current system of sampling the indicative price of one sample is 300,00 € which means that the owner of the swimming area respecting the criteria of the program Blue Flag is obliged to pay annually for sampling during the summer swimming season around € 6,000.00.

From the above it can be concluded that the current method of funding would not be sufficient to cover the operating annual costs. This is the reason why the system is designed in a way that it can provide services to other entities that are not directly related to the program Blue flag. The system has particular importance in situations where it is necessary to prevent potential contamination of bathing water, because it provides a current information about the potential dangers when the reaction of relevant authorities is needed. Also, the system is of great importance for all those dealing with the prediction of individual phenomenon, such as algal blooms, water circulation, and so on.

4. CONCLUSION

Reliable and efficient operation of the system which is capable to monitor water resources in a way that will allow getting instant answers to the problems of environmental pollution, energy waste and increase in production volume, can restore confidence in the future, such as caring for natural resources fully in line with the economic and human development. In respect to sustainable development it is necessary to enable satisfying the needs of present generations without compromising the ability of future generations to also meet their needs, especially those which concern the need for a clean and beautiful environment.

Blue Flag Programme aims to improve the human consciousness to meet the environmental standards and this can be achieved through a series of environmental activities in which the people must have the main role. One of the requirements of the Blue Flag program is quality of the water. Continuous monitoring of the lake Gracanica may be an indicator of the efficiency of the environmental movement and the national programs for sustainable development.

Monitoring the situation without active participation is not enough. It is important to have a system for continuous control that needs to be efficient and fast in order to allow the competent authorities to have immediate insight into the quality of swimming water and that their response in the event of an uncontrolled increase of the observed parameters of quality, can be immediate and meaningful. This can be achieved only with measuring devices that are operating 24/7/365 and which are integrated into a system that is described in this research work.

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AN INTEGRATED FUZZY AHP AND TOPSIS APPROACH FOR RANKING COPPER CONCENTRATES

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Abstract: In this paper Fuzzy multi-criteria decision making (FMCDM) integrated model was proposed to evaluate samples of copper concentrates in respect to their beneficial and harmful components. Integrated FMCDM methodology consists of two well known methods-Fuzzy Analytic Hierarchy Process (Fuzzy AHP) method, which was used to determine relative weights of criteria and Fuzzy Technique for Order Preference by Similarity to Ideal Solution (Fuzzy TOPSIS), which was used to rank investigated samples. The obtained empirical results enable better understanding of developed integrated FMCDM model and provide reliable decision support tool for decision makers, which enables them to increase efficiency of technological process and facilitates environmental management.

Keywords: multi-criteria decision making, fuzzy logic, AHP, TOPSIS, environmental management, copper production

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ECOENGINEERING ALGORITHMIZATION OF OIL LENSES EXTRACTION

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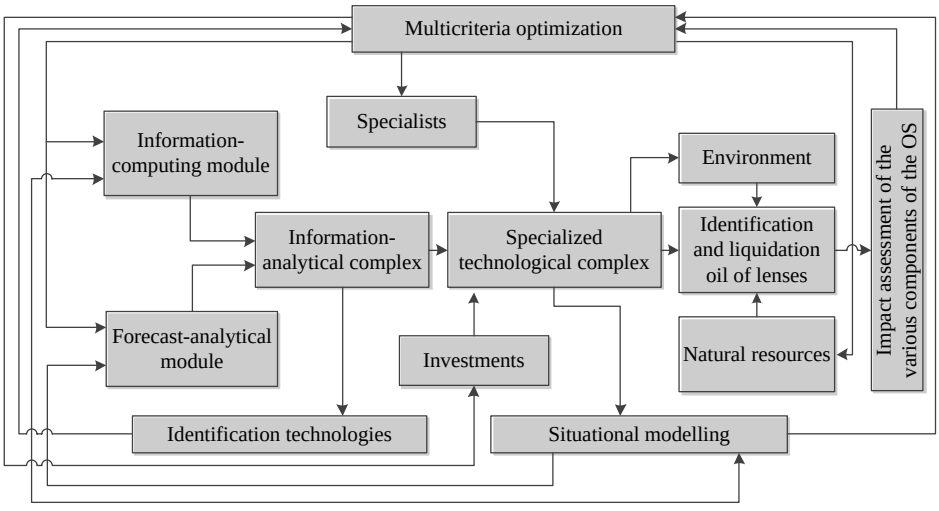
Abstract: Nowadays there are some sufficient preconditions for the implementation of informative direct and indirect methods of oil lenses identification. The combination of mapping and situational modeling of oil polluted geological environment includes physical and chemical oil transformations while infiltration.
In many cases, the difficulties of management decisions can be reduced to analysis of the prior information and expert data, the identification of quality indicators and the best alternative selection.
Environmental security systems integration in the technological cycles is based on multi-criteria hierarchical evaluation. Such principles as wastes inventory, the environmental impact assessment, hierarchical structuring of individual technological criteria, general criteria analysis, the best alternatives selection and summary assessment of hierarchy technological levels including climate patterns of the region are in the base of technological integration.
The procedure sequence of situational modeling helps to select and integrate identification technologies (extent area definition, reservoir thickness and "sticky fingers" formation) and oil lenses extraction with following remediation of contaminated lands.



Structural diagram of ecoengineering oil lenses extraction

Keywords: oil lenses, environmental security systems, situational modeling

ENVIRONMENTAL FLOWS MANAGEMENT AND SYSTEMS OF ENVIRONMENTAL-ECONOMIC ACCOUNTING

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Abstract: Modern global economy is developing on a base of market principles, and GDP is the main criterion of its effectiveness. Serious shortcoming is that GDP doesn't reflect a degradation of natural landscapes and the damage from pollution of natural environment. In this regard, transition to the ecological or "green" economy should be based on a comprehensive assessment of environmental effects of economic activity.
One of approaches in this field is the Systems of National Accounts (SNA). The London Group of Experts suggested to use environmental criteria of the economics, such as physical parameters of water resources quality and quantity. Further development of this idea will contribute to development of the system, accounting flows in natural landscapes as a criteria of changes in the environment resulting from economic development. Preliminary estimations of changes in natural landscapes were obtained in studies conducted in Baikal area in Russia. Environmental-economic accounting with attention to ecological services and intensity of energy flows in landscapes will contribute to more effective system of environmental management and economic development in the region.

Keywords: Environmental-Economic Accounting, Economic Growth, Environmental Management, Effectiveness, Baikal Area

1. INTRODUCTION

The effectiveness of environmental management is one of the most significant and complicated issues in modern environmental policy at national and regional levels. In the last decades many countries implemented policies aimed to reduce ecological impact while maintaining economic growth. As it is shown in [1], some of them managed to reduce GHG emissions in absolute terms within their territories, and others boosted their environmental performance parameters by using fewer raw materials today than 20 years ago. Unfortunately, life cycle emissions of final consumption, in fact, increased in many cases: production of emission-intensive goods has simply moved elsewhere. The key issue in this field is, probably, transfer of focus from production to consumption parameters. However, even these attempts to shift the focus do not reveal a real environmental impact of human activity due to approaches used to its evaluation.

Today many economists recognize that market principles forming a framework of evaluation of a global economy's effectiveness – and GDP as the main economic indicator of development – do not reflect degradation of natural landscapes and damage from pollution of natural environment. That's why it is necessary to elaborate a number of indicators reflecting changes (both positive and especially negative) in nature environment. One of the most relevant approaches is the System of Environmental-Economic Accounting (SEEA).

2. ENVIRONMENTAL-ECONOMIC ACCOUNTING AS AN APPROACH TO JUSTICE EVALUATION

The System was adopted as an international standard by the United Nations Statistical Commission (UNSC) in 2012. The Central Framework of SEEA is a multipurpose conceptual framework for understanding the interactions between the economy and the environment, and for describing stocks and changes in stocks of environmental assets [2]. This approach to assessing the economic development has become increasingly popular in recent decades. National economies across the world must be regularly inventoried on the transparency in resource use. These were some of the key recommendations of the World Resources Forum (WRF) 2013. In 2011 WRF had already called for the improvement of data and indicators, since "one cannot manage what one cannot measure" [1]. Measuring the ecological footprint as a base of economic effectiveness is a right step in correct direction.

Probably the most complicated part of these studies – accounting of ecological functions of the landscape. Identification of all types of materials and resources in a system of production and consumption should take into account such indicators as, for example, emissions of pollutants, and changes in the thermal balance of the territory, etc.

Transition to the principles of the System of Environmental-Economic Accounting based on the understanding of necessity to take into account not only individual benefits from resources extraction, but also social costs from environmental degradation. The costs of raw material extraction are often very low (for example, for natural timber resources), but accounting of losses of ecological functions gives a fundamentally different estimation of the effectiveness of such activities. According to recent scientific researches – both theoretical and applied works – value of ecological services of natural systems is comparable to a market value of natural resources [3, 4, 5]. Some authors [6, 7] conclude that benefits from conservation of natural ecosystems even greatly exceed the revenues from resource extraction – in most cases an excess depends only on the length of time perspective.

Such researches demonstrate relevance of a cost-benefit analysis for purposes of green growth on a regional level. In a case to define directions of green economic development, environmentally oriented activities, efficient from ecological point of view, must be priorities. Evaluation of effectiveness must be based on accounting of ecosystems services, including such indicators as intensity of energy flows in landscapes, carrying capacity of natural ecosystems, changes in terrestrial albedo coefficient due to land use structure and others. Unfortunately, all known approaches are based on measurement these ecological services in monetary terms. At the same time a notable trend of scientific publications in recent years is

an attention to non-monetary evaluation, focused on the physical indicators of systems development.

3. INSTITUTIONAL PREREQUISITES FOR GREENING RUSSIAN ECONOMY

Due to transition to a green economy, proclaimed as a priority of Russian modernization, relevant policy documents were adopted on regional and federal level. Among them: "Principles of the state policy in a field of environmental development of Russia until 2030" and the National Program "Environment Protection" of the Russian Federation on period of 2012-2020. According to the "eastern" and "arctic" vectors of modern Russian economy, principles of green economy are, first of all, crucial for regions of Siberia and Far East, as well as for the Russian Arctic – extremely important areas for further development. Environmental issues of these areas are particularly considered in the State Program of Development the Far East and Baikal Area up to 2025 and the Federal Target Program "Protection of the Lake Baikal and a social and economic development of the Baikal Natural Area on 2012-2020".

Despite the declared ideas, contemporary national economy has a raw orientation. Dependence on extraction of non-renewable resources increases environmental damage, measured in 4-6% of GDP annually [8]. At one of the first positions among "expected results" of the National Program "Environment Protection" there is "an effective system of state regulation and control in a field of environmental protection and ecological safety, encouraging a modernization of the economy, based on principles of a "green growth". Along with this, the Program focuses on conditions for an involvement of eco-efficient innovations, development of a market of environmental goods and services, and attention to environmental safety.

Achievement of the stated goals requires significant efforts, both in economy and environmental management. Currently a situation in Russian economy does not correspond to a line of greening. Economic growth is based on the use of fossil fuels with a low share of renewable sources, and development indicators are far from socially oriented ones. Declared rate of GDP growth was not met in last two years: instead 3.5% in 2012 the growth was fixed at the level of 3.4% (compared to 4.3% in 2011) [9]. The rate of GDP growth expected in 2013 was not also reached: a real rate was 2.4% instead 3.6% that were planned in a beginning of 2013. Due to political situation there is every reason to expect even more difficult economic situation in 2014: the real GDP rate could be 0.8% instead planned 2.5%. Thus, Russian economy is characterized by contradictory trends: a need for growth, as a prerequisite of social stability and rise of living standard, on the one hand, and a need to move towards a green economy – on the other. Experiences of developed countries show that these conflicting trends can be combined with each other. The situation can be even considered as an advantage, since it is possible to use innovative technologies, according to the latest trends. Innovative approaches should be developed also for estimation of effectiveness of economic development with attention to its environmental effect.

4. PERSPECTIVES OF EFFECTIVE ENVIRONMENTAL MANAGEMENT IN THE REPUBLIC OF BURYATIA

Current situation and perspectives of green economic development at one of the Eastern Siberia areas – the Republic of Buryatia – we studied during the field trips in years 2012-2014. Total area of the Republic, including water area, is 351.3 thousand km², which is comparable to the area of Germany (357 thousand km ²), or Finland (337 thousand km²). Number of population is 971.8 thousand people (2013), population density – 2.77 people per km². Analysis of current economic indicators proves a strong necessity of growth: GDP is 172.0 billion Russian roubles (RR) (2013) or $5.27 billion, per capita – 176.1 thousand RR or $5.2 thousand.

Table 1. Republic of Buryatia in economy of Russia (2013)

	Republic of Buryatia (RB)	Russian Federation (RF)	Share of RB in RF, [%]
Area, thousand km^2	351.3	17 098.2	2.0
Population, thousand people	971.8	142 009	0.7
GDP, billion RR	172.0	67 100.0	0.3
The volume of industrial production, bln RR (2010)	29.3	12 128.0	0.2

Source: Federal State Statistics Service

Development of a mineral resources sector and a tourism industry were specified by the government of the Republic of Buryatia as the development priorities. The most serious obstacles to development of the region are poor infrastructure along with harsh natural conditions. The overall level of gasification with liquefied gas is still very low (about 15%). Many parts of the area have no paved roads. Thus, a further economic development can be based on improved infrastructure of transportation and water and gas supply. Mining industry, based on rich polymetallic ore fields, is one of key sectors of further development, through which it is planned to raise GDP and living standards in Buryatia.

Despite a low rate of economic growth in Buryatia, there is a number of strong risk factors, affecting both on natural landscapes and their components, and on the Baikal water quality. Analysis of distribution of polluting emissions within the Baikal Natural Area (BNA) shows that the main volume of pollution comes from the territory of the Irkutsk region. Large number of industrial polluters are located at Angarsk and Irkutsk cities, and the strong environmental risk during many years was caused by Baikalsk' Pulp and Paper Mill (BPPM), located at the south western part of Baikal. Only in 2013 there was accepted the decision of the Russian Governance to stop the plant. A significant contribution to the pollution of the area make the industries of Buryatia, located in Ulan-Ude and Gusinoozersk: coal thermal power plants, machine-building plants, coal mining, etc. The main feature of the impact on environment in the area is a prevailing role of thermal power plant: they throw out about 50% of all air emissions. Fortunately, there are grounds to mark the trend of total emissions reducing: on 34% during period 2007-2011. Despite these encouraging findings, the total air emissions in the frame of

BNA in 2011 amounted to 375.4 thousand tons, discharges into water bodies - 400.4 million m^3, and the total volume of industrial waste has achieved 10,845.5 thousand tons [10].

Economic growth in the region planned to be reached through investments in a frame of public-private partnership. Development of one of the most ambitious projects, the mining project at "Ozernoye" field, includes plans for infrastructure improvement: local railways and roads, transmission and electricity supply facilities, system of water supply and sewage, etc. In the long term there can be formed a cluster, containing a number of mining and processing plants, forming a necessary base for the economic stability and population well-being. In a case of implementation of these plans, investment in the region could reach $ 3.3 billion [11]. At the same time, the Ozernoye field development will lead to formation of technogenic landscape and transformation of the natural material flows. Production process will cause emissions of NO_2, CO, soot and other air pollutants. Land disturbance will cause transformation of landscapes by changes in exogenous geological processes, parameters of hydrogeological and surface flows, increasing erosion processes, etc. Changes in a land use will result in declining of landscape capacity to absorb green-house gases (GHG), including CO_2. At the same time, the impact on the landscape will be of a local scale because of the land restoration as an obligatory part of works.

Taking into account changes in a land use we may conclude that the result of the area deforestation will be lost ecological functions, such as CO_2 sequestration. The total annual carbon storage by forests of the Republic of Buryatia is estimated at 12.5 million tons [12], and the larch forests make a largest contribution (about 35%) in this value. Since a larch is the main tree species in the Ozernoye field, there will be a significant reduction in the absorption of CO_2 from deforestation. Preliminary calculations made with account the average annual carbon sequestration of larch wood (0.43 t/ha) suggests that the costs of deforestation in the area will result in additional emissions of about 860 tons/year [5]. The same consequences are typical for other economic activities, developing now in Buryatia, such as tourism industry.

Specifics of this economy's sector in greater extent corresponds with the ideas of "green" economy. It can not only reduce ecological scarcities through saving environmental services of the unique natural landscapes and environmental risks by investing in a low-carbon economy, but also will result in improved human well-being and social equity through "green" employment. Studies in this field reveal that new technologies, including that in a renewable energy, are more labor-intensive than fossil fuel-based energy generation, and contribute to increasing high-qualified labor [13]. The key point for realisation plans of tourism development at the Republic of Buryatia is a Special Economic Zone (SEZ) "Baikal haven", which started to be built on the coast of the Lake Baikal in 2009. The basic principle of its development is a public-private partnership, in a frame of which it is planned to build transportation infrastructure, ski resorts and a number of hotels with modern systems of water supply and sewage systems, and other recreational facilities. SEZ development program aimed on creation of infrastructure that minimizes impact on the natural landscape and meet all the environmental restrictions: nature conservation in this case is a practical necessity. In this regard, SEZ development program widely use approaches to energy saving, resources efficiency, etc. In addition to strong energy-saving measures, there will be created more than 4 million of job places.

However, a tourism industry development will also result in a transformation of natural landscapes: construction the ski resort on the Mount Bych'a will lead to disturbance of the

landscape at the area of 2300 ha. In contrast to mining activity at the ore fields, changes in a land use in this case will not be so radical, and landscape's disturbance will be fragmentary, that allow to save partially forested landscapes. Social effect from realisation of this project, which can be measured by employment increase, will be 4.1 thousand job places, and a volume of services will reach 30.9 bln. RR, which is highest amount if compare with other clusters of SEZ. Undeniable advantage is that, in addition to the development of ski tourism, it is also planned to develop ethnographic and religious tourism, based on the authentic culture of the local population. This undoubtedly will attract special attention to preservation of a pristine nature of the region. It is widely known that tourism development, especially in a way of eco-tourism, is traditionally based on preservation of natural landscapes; therefore, development of this industry will contribute to a green development. As a whole, further development of the SEZ can be regarded as a successful example of economy, which meets "green" standards, i.e. is directed on increase of living standards and preserving ecosystems.

4. SYSTEMS OF NATIONAL ACCOUNTS AND ENVIRONMENTAL FLOWS

Reviewed case shows that new approaches to reflect adequately environmental effects of economic activities are needed. A number of comparative analyses, such as correlation of environmental pressures to GDP, Human Development Index (HDI), and others economic indicators of a region, must be made to get an adequate estimation of effectiveness of regional environmental management [1]. Preliminary analysis conducted for the Republic of Buryatia, shows that even the current low level of GDP is associated with high pressure on natural systems. In recent years, the GDP growth directly correlates with indicators of environmental degradation and depletion of resources (table 2).

Table 2. Environmental parameters' changes as a result of economic activity

Years	GRP, mln. RR	Water extraction, mln. м³	Lands covered by forests, thousand ha	Area of natural protected areas, thousand ha	Emissions to the air, thousand tons	Extraction of coal, thousand tons
2010	133 526	634.5	26943.2	2137.1	183.7	985
2011	154 678	594.9	26906.7	2093.3	164.4	1521
2012	167 038	646.3	26912.0	2093.3	~190.0	2280
2013	172 049	649.3	26912.0	2093.3	~212.0	2853

Source: Federal State Statistics Service

The value of GDP growth on 5 billion rubles equals consumption of 3 million m^3 of natural waters, extraction of 600 thousand tons of coal, 22 thousand tons of emissions to the air, etc. Consumption of territorial (land) resources requires clarification, as well as many other environmental indicators of economic activity. This calculation does not take into account indirect consequences for natural landscapes due to future changes.

However, these activities are necessary for the raising of living standard of the local population. In this regard, further researches on assessing the effectiveness of environmental management in the region are very actual. Important part of these researches – elaboration of

methodical approaches to evaluation, based on physical parameters of the environment. As it was shown in [2], the London group of experts on environmental-economic analysis has tested physical indicators for measuring water resources. Obviously, there are broad prospects for this approach to all other resources measurement. Preliminary framework was elaborated for biological resources, including aquatic resources, forest resources and some others.

Original solutions are offered in interdisciplinary researches, at the intersection of natural sciences and economics. Consideration of comparability of economic and ecological indicators through flows of energy in a landscape was proposed by A.M. Friend [14]. The idea of measuring the level of entropy in landscape, as a universal indicator of balanced development, can be quite productive. In case of elaboration and use of such indicators (or evaluation principles) can be also significantly changed the System of National Accounts (SNA). Environmental-economic indicators will contribute to proper accounting and fair distribution of resources between regions and generations. It is widely known that in a case of transformation of forest lands for non-forest purposes, the national accounts record only the expenditure incurred in clear-felling the forests and do not account for the loss to the society as a result of transfer [2].

New approach to SNA forming can be realized for: 1) balance of natural resources (as assets) in physical terms and changes of the national wealth (can be presented as the tables "costs-output"); 2) losses of natural resources (as a stock of energy) and deterioration of natural conditions can be considered as an indicator of inefficiency of the economy in the long perspective.

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PLANNING OF INTEGRATED/SUSTAINABLE SOLID WASTE MANAGEMENT (ISWM) – MODEL OF INTEGRATED SOLID WASTE MANAGEMENT IN REPUBLIKA SRPSKA/BIH

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Abstract: Municipal solid waste management (MSWM) has become an important issue for countries, regions and communities around the world. The challenges are particularly notable in developing and transitional countries reflected mainly in inappropriate management, insufficient and underdeveloped technology, an unfavorable economic situation and the lack of environmental awareness in the population, causing a tremendous environmental impact. Today, various deterministic and multi-objective models are applied to analyze solid waste management systems from the regional to the municipal levels. Understanding the mechanisms and factors that currently drive the development of solid waste management is a crucial step for moving forward and planning sustainable waste management systems. The main objective of this paper is to apply the ISWM model, which is based on the Life-Cycle approach and follows the analytical framework methodology, to the research region. The trans-disciplinary research framework was empirically tested and subsequently applied in the region Republika Srpska (a political entity in Bosnia and Herzegovina). Using the benchmark methodology, based on environmental, institutional and economical sustainability, the waste management is summarized in assessment profile. The model allows an indicator based classification in order to determine the stage development of waste management. The results of the conducted analyses and the application of the developed model can be used further as a basis for the proposal of further strategic, political and managerial changes and support decision makers, stakeholders and planners to handle waste in a cost-efficient and environmentally sound way.

Keywords: Bosnia and Herzegovina, Integrated/sustainable waste management, planning of WM, Republika Srpska, solid waste management.

1. INTRODUCTION

Increasing population, rapid urbanization and the growth of living standards have significantly accelerated the rate of waste generation in countries around the world. According to the World Bank's global review of solid waste management (SWM), in 2011 alone, urban areas in the world generated about 1.3 billion tonnes of municipal solid waste and that is expected to increase to approximately 2.2 billion tonnes annually by 2025. Expectations are that waste generation rates in developing countries will more than double over the next two decades [1]. These developing and transitional countries have significant problems in

managing solid waste. The reasons are numerous; notably limited resources (financial and social) and enforcement of relevant regulations especially affecting the quality of waste collection and the application of technologies for safe recycling, treatment and disposal [2]. Therefore, introduction of efficient solid waste management and its affordability will be one of the key challenges of the 21st century for developing countries, and one of the key responsibilities of local city and municipal governments [3].

The ISWM model, based on the Life-Cycle approach, recognizes three dimensions in analyzing, developing or changing a waste management system: Firstly, the **stakeholders -** a key element in sustainable development and the role of the legislation in the system; secondly, the **technical component** of integrated solid waste management system elements such as waste collection and transportation, waste recovery through sorting and recycling options, waste treatment, waste disposal and waste minimization; and thirdly **waste management sustainability aspects**. Hence, the development of waste management system depends on the successful interaction and integration of a diverse range of activities, processes, technologies and people. The main goal of the model is therefore to support decision-makers, stakeholders and planners to handle the system in an economically and environmentally sound way [11]. Through the last several years the concept of ISWM and its aspects has been further clarified and is gradually becoming the norm in discussion of solid waste management in developing countries [12,13,3,14,9]. However, one of the main challenges derived from the analysis has been the usage of various methodologies for data gathering. Moreover, this problem is especially emphasized when the different cities from different countries are compared. In order to solve and minimize those limitations the ISWM benchmarking indicators set was developed [3; 6, 15]. This set allows benchmarking of a city's performance in waste management, allowing consistent comparison of performance between cities either in developing countries or in the developed world and monitoring changes and progress over time. Topic (2014) research closely this thematic and develops a **Model of Integrative/Sustainable Solid Waste Management.**

A model (Figure 1) has been built around the analytical framework of UN-HABITAT benchmarking methodology [3,6,16], which is based on the concept of integrated and sustainable (solid) waste management, known as ISWM [11] and around the phase model of KLAMPFL-PERNOLD et al. [17,18]. The analytical framework combine relatively standard, quantitative indicators for the three main physical components – collection, treatment/disposal and recycling – with a corresponding, qualitative, composite indicator for the "quality" of service provision for each physical component, as well as five further qualitative, composite indicators which assess performance for the three main aspects of governance, namely inclusivity of stakeholders, financial sustainability and sound institutions & proactive policies. On the other hand the KLAMPFL-PERNOLD et al. [17,18] phase model allows an indicator-based classification of different countries or regions to determine the stage of waste management development. The classification of the development stage of waste management in a country or a region can be stated by using a few key parameters without large-scale, on-site surveys. The parameters are classified by using an economic, social, legal and ecological perspective. Depending on the waste management phase, certain waste management measures are appropriate and effective.

Figure 1: Model of sustainable solid waste management (TOPIC, 2014)

The ISWM from Topic (2014) model is composed of three dimensions representing the sustainability process. In order to achieve sustainability, all dimensions in the model have to be in motion and connected to each other. The first **green component** represents the environmental dimension of sustainability and focuses on key drivers for the development of waste management, which include the three key physical components: (1) public health, which depends on a good waste collection service; (2) environmental protection achieved by controlled waste treatment and disposal; and (3) resource management ("3 R's" – reduce, reuse, recycle), which leads to a recycling society and recognizes waste management as a source of raw material. The second, **blue element** characterizes the institutional and social sustainability aspect. To deliver a well-functioning system and to see contributions and benefits, full participation of all relevant stakeholders (both service users and service providers) have to be ensured.This aspect is considered from two perspectives: firstly, the active participation of the users of solid waste services, which describes how these stakeholders are included in the planning, policy formation and implementation processes. Secondly, the provider participation refers to the performance of the system, and the extent to which it serves all users equitably and according to their needs and preferences. The institutional/social component relies not only on effective stakeholder participation but also on the legal framework. Moreover, it focuses on the implemented legislation and regulation, institutions and legal requirements on the national level and on local institutions and their organizational structures and institutional capacity. The economic aspect is categorized as a **special component** and presented in red. Sustainability of the solid waste management system relies on the assurance that SWM services and activities are cost-effective and affordable. Moreover, without direct economic benefits, investment and subsidies, the waste management system is not sustainable. To achieve economic sustainability it is necessary to fulfill two different criteria: (1) the macro-economic indicators, which represent the overall economic situation of a country, region or a city and (2) specific economic waste management indicators, which give an overview of sustainability in waste management (e.g. cost accounting, system costs recovered from user fees and payments).

3. RESEARCH METHODOLOGY

The methodological basis for this paper includes an interdisciplinary approach which is based on the knowledge and experiences accumulated from environmental sciences, natural and technical geosciences and economic sciences. The waste management data was collected through comprehensive on-site research carried out in RS through the research project *"Waste Management in the Republic of Srpska"*. The project application was developed in cooperation with the Department of Geography and Regional Sciences (Austria) and the International Association of Scientists "AIS" in Banja Luka (BIH) and co-financed by the Environment Protection and Energy Efficiency Fund of Republika Srpska. The main aim of the project was to conduct systematic and critical research, using structured data collection, of the municipal solid waste management in RS, in order to detect, identify and solve the problems and challenges which this branch of the economy has to face. In addition, the study analyzed the generation, collection, transportation, recycling and disposal options in municipal solid waste management in RS [8]. The main part of the data was collected through questionnaires, delivered to municipalities (62) and waste management companies. The collected data was entered into a computer database and analyzed with the statistical program SPSS. In addition to the questionnaire and the literature review, the waste management data was also collected by conducting several structured interviews with decisions makers, communal enterprises and the civil sector. The interviews were addressed to wide range of active stakeholders within the system. For instance, representatives of the Government (Senior Associate for Waste Management at the Ministry of Spatial Planning, Civil Engineering and Ecology); representatives of local governments; service provider managers (technical directors at regional landfill company Ramici in Banja Luka and in Bijeljina; managers of several communal enterprises; managers of several waste management companies); NGO and CBO representatives and scientific researchers from Bosnia and Herzegovina and Serbia (University of Banja Luka; University of Sarajevo; University of Belgrade; University of Novi Sad; Union University).

Furthermore the methodology used in this paper follows the developed ISWM methodology [15], where the indicators and criteria have been identified, supplemented and designed around the three model components. The Model encompasses seven indicators which are selected according to a series of quantitative and qualitative criteria. The quantitative indicators are based on the original methodology (e.g. analytical framework) which is tested on numerous case studies around the world. For each of the criteria comprising a qualitative indicator, there is a device to allow the very different aspects of performance - each ideally being assessed by its own distinct and traceable criterion - to be combined into one indicator; that way, the resulting overall percentages can be converted back into a qualitative assessment. The model recognizes the five phases of waste management development. Each phase is color-coded using a "traffic light" system, to assist with a rapid visual assessment of the tabulated data. The color red indicates areas of the system requiring immediate observation and reformation.

The level of the environmental sustainability is analyzed by a set of qualitative and quantitative criteria. For instance, quantities criteria cover the percentage of the service

coverage in the tested region, either waste collection coverage, controlled waste disposal and treatment or share of the recycled waste. In addition, for each component tested there is the qualitative criterion. Qualitative criterion is composed of several questions measuring each indicator separately, for instance the quality of waste collection, the degree of environmental protection in waste treatment and disposal and evaluation of resource management.

Further, the sustainability processes in solid waste management cannot be achieved without the effective participation of relevant stakeholders and a legal framework. Therefore, the indicator of participation is analyzed from both sides: user and provider participation. The indicator for user participation is measured by the six qualitative criteria for determining the degree of user participation in the solid waste management system. The questions are related to user involvement in the planning, policy formation, implementation and evaluation of those services, existence of legal rules and regulations which require consultation with and participation of stakeholders outside the institutional structures, existence of user satisfaction measurements, the existence and use of public feedback mechanisms for SWM services, implementation of comprehensive, culturally appropriate public education, behavioral changes and/or awareness raising programs and level of involvement NGOs and CBOs dedicated to conservation and environmental protection. The second indicator is related to provider participation. It again encompasses a set of qualitative criteria measuring the degree to which economic niches in service delivery and recycling are open and accessible to non-state stakeholders and non-municipal service providers from the formal, private, community or "informal" sectors. The second indicator for measuring the institutional sustainability is built on two criteria: (1) adequacy of national frameworks for solid waste management (measures the existence and implementation of the waste management related legislation at national level) and (2) the degree of local institutional coherence (measures the strength of the local institutional capacities).

The level of economic sustainability is identified by two indicators: firstly, by the macro-economic indicators comprising three quantitative economic criteria: (1) gross domestic product (GDP), (2) unemployment rate and (3) inflation rate; secondly, by specific economic waste management indicators analyzed through a bundle of qualitative questions. The second indicator includes information related to investments, subsidies, cost accounting, affordability of user charges and charging policies.

The final result of the model analysis is the assessment profile consisting of a one-page summary of the benchmark indicators and supplementary background data. In addition to the set of indicators, the assessment profile is supplemented by background information (name of the researched region, population and the Human Development Index (HDI) and by key waste related data (waste generation per year (t/year), waste generation per capita per year (kg/year) and municipal solid waste composition with a focus on main components).

4. RESULTS AND DISCUSSION

The first step in planning sustainable solid waste management is to conduct comprehensive on-site research and obtain the essential data. Equally important is the

understanding of the mechanisms and factors that currently drive the development of solid waste management. This is a crucial step in moving forward and planning sustainable waste management systems. Therefore, the key for effective waste management analysis is a clear understanding of waste management data, such as data about the volumes, mass and nature of each type of waste produced; the collection and transportation system, and treatments and disposal methods.

Municipal solid waste (MSW) presents a significant problem in RS [8,15,19,20]. Current waste management systems do not follow modern waste management practices due to different historical, financial and social aspects. Fragmentation of solid waste collection and disposal systems; inadequate, technically and legally unapproved landfills; absence of treatment technologies or insufficient number of recycling centers have contributed to the present situation. The material flow diagram, presented in Figure 2, gives an overview of the municipal solid waste management in RS. As the MFD illustrates, the MSWM involves a wide range of stakeholders in the system, including decision-makers, service providers and service users.

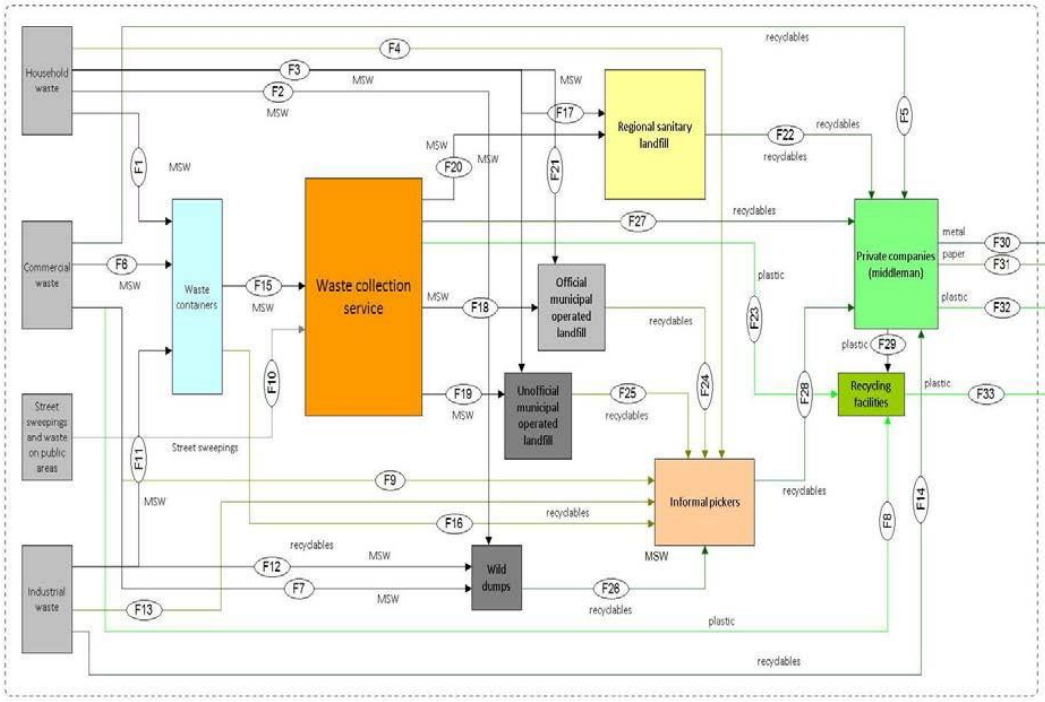

Figure 2: Material Flow Diagram for MSWM in Republika Srpska (Topic, 2014)

4.1. ASSESSMENT PROFILE

Solid Waste Management in RS is mostly spread between the medium/low and medium phases of development (Table: 1). Significant problems are represented by waste disposal, particularly the unregulated disposal in several municipalities as well as the appearance of a large number of wild dumps in rural areas, and should be rapidly solved in

order to reduce harmful effects on humans and the environment. Moreover, the difficult economic situation in the country is a major obstacle to rapid waste management development. The first steps in building a legal framework for environmental protection and waste management have been taken. Adoption of numerous rules and regulations in the country, in accordance with the EU directives, and adoption of procedures for setting up regional sanitary landfills, has facilitated a comprehensive approach to waste management. Despite the non- existent legislation in separate waste collection, there have been some positive improvements in waste recycling, mostly through the initiatives by private waste companies and the informal sector. However, the lack of data collection and incomplete knowledge about waste streams present a constructive challenge for further strategic planning. The existence of waste data is a prerequisite for steering the country towards advanced waste management. Waste recycling will have to become an essential part of waste management in RS, particularly when the country speeds up the process of approximation to the European Union, fulfills the demands made by EU policies and legislation, and notably EU directives, that impact directly on waste management options. These include requirements within the Landfill Directive to reduce dependency on landfill for biodegradable waste, and policies that support the waste management hierarchy of options and notably support waste reduction and recovery.

Table: 1: Assessment profile of MSWM in Republika Srpska. (TOPIC, 2014)

Assessment profile								
I.	**Background information**							
	Name of the country/region	Bosnia and Herzegovina/ Republika Srpska						
	Population	1,326,991						
	Human Development Index	0.733 → Health 0.78; living standard 0.62; education 0.72						
II.	**Key waste-related data**							
	Waste generation	376,438 tons (2012)						
	Waste per capita	263 kg/year						
	Waste composition (main components)	-						
III.	**Profile**							
No.	**ENVIRONMENTAL COMPONENT**	**INDICATOR NAME**	**LOW**	**LOW/ MEDIUM**	**MEDIUM**	**MEDIUM/ HIGH**	**HIGH**	
Environmental sustainability								
1.	Waste collection	Waste collection coverage						
1.Q		Quality of waste collection service						
2.	Waste treatment and disposal	Controlled treatment or disposal rate						
2.Q		Environmental quality of waste treatment and disposal						
3.	"3 R's" – reduce, reuse and recycle	Recycling rate						
3.Q		Quality of "3R's" provision						
Institutional/social sustainability								
4.	Participation	User participation						
		Provider participation						
5.	Legal framework	National level						
		Local level						
Economic sustainability								
6.	Macro-economic indicators	GDP						
		Unemployment rate						
		Inflation rate						
7.	WM indicators	Degree of financial sustainability						

5. CONCLUSIONS

The results of the current state analysis have showed that municipal solid waste management (MSWM) presents a significant problem in RS. Current waste management systems in RS do not follow modern waste management practices due to different historical, financial and social aspects. Fragmentation of solid waste collection and disposal systems; inadequate, technically and legally unapproved landfills; absence of treatment technologies or insufficient number of recycling centers have contributed to the present situation. Using the benchmark methodology, based on environmental, institutional and economical sustainability, the MSWM in the research region is analyzed and as result the assessment profile is presented. The results of the evaluation show that MSWM in RS is mostly spread between the medium/low and medium phases of development. Severe problems are identified in the waste disposal, particularly unregulated disposal in several municipalities as well as the appearance of a large number of wild dumps in rural areas. These problem areas should be dealt with urgently in order to reduce harmful effects on humans and the environment. One of the main obstacles for the further development lies in the difficult economic situation. However, positive steps toward sustainable development have already been taken. The building of a legal framework for environmental protection and waste management at national level is identified as medium/high. Numerous rules and regulations in the country, in accordance with the EU directives, have been adopted, creating the foundation for future planning. Furthermore, the positive improvements in waste recycling, mostly through the initiatives of private waste companies and the informal sector, show that the service providers have recognized the benefits to be gained from the raw materials market.
Furthermore, the model clearly illustrates the problem of poor legal enforcement. Although the basic environmental and waste management laws are implemented, the poor waste collection coverage and uncontrolled disposal are present in the region. The entity is deficient in capacity to manage complex arrangements with private investors. The private public partnerships (PPP) in the waste management sector are rare causing lack of new investments in new infrastructure and capacity. This is leading to a deficiency in the development of skilled labor, so that there is a critical need for training and transfer of know-how. Another problem area identified by model is the financial viability of communal enterprises which is impaired by inadequate cost accounting and low payment rate of provided service. The combination of these two factors produces a devastating effect on the economic viability of the waste management sector.

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SUSTAINABLE COMPETITIVENESS OF UNIVERSITIES IN TERMS OF GLOBALIZATION AND INTERNATIONALIZATION OF HIGHER EDUCATION

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Abstract: This article considers one of the most important modern tendencies - internationalization - in the field of higher education, its basic forms and characteristics such as mobility of students and lecturers, internationalization of curricular, setting up international networks of higher educational establishments, export of educational services and their influence on competitiveness of regions and countries.

Keywords: internationalization of higher education, students and lecturers' mobility, competitiveness

Nowadays one should notice the significance of changes occurring in all life spheres of the society and the importance of their consequences. One of similar changes concerns internationalization of higher education. As world experience shows today more and more countries consider their presence in the forming global educational field as one of priority strategies of their development. Russia is not an exception to this vector of changes. Thus, one of main parameters of the Concept of the long-term social and economic development of the Russian Federation till 2020 is getting revenues not less than 10 per cent of the amount of financing the educational system from foreign students studying at Russian higher educational establishments[1].

The development of business and economics internationalization in the field of higher education made society face new aims:

- training professional personnel capable to work effectively in the changed market conditions;
- increasing financial incomes through attracting foreign students to pay for their studying;
- expanding curricular and educating national students in foreign Universities - partners;
- extending regional networks of Universities for effective application of own resources;
- improving the quality of education and research due to participating both students and lecturers in the international process of knowledge exchange;
- organizing team research projects, different curricular both for lecturers and students, special curricularr for foreigners.

But first of all it's necessary to define "internationalization". According to Webster's desk dictionary "internationalization" implies "the principle of cooperation among nations for promoting their common goods" in general and educational services in particular [2]. Internationalization of higher education means the process where the mechanism and functions of educational services have an international character. Internationalization of higher education is directly connected with the state policy solving political, economic, social and national problems.

In other words, internationalization of education is the basis of the universal educational process taking place on two levels: internal (students and lecturers' mobility, partnership in research) and external (transcontinental education).

In many counties today contemporary educational systems are subjected to integration. The advantages of this process are evident and result in the following: increasing academic mobility, uniting resources, avoiding duplication in research, exchanging and improving curricularr, unifying teaching methods, expanding cultural horizons of national students and lecturers due to the presence of foreign ones, attracting additional investments, on-line education etc.

Besides, firstly, internationalization of higher education is vital for the countries that are leading in this field in order to sustain their status; secondly, it helps Universities to transform into new categories; thirdly, it is an object of state policy aimed at achieving economic and geopolitical goals.

Signing declarations in Sorbonne (1998), Bologna (1999) and Prague communiqué (2001) resulted in creating a single European higher educational area, increasing citizens' mobility, improving quality of education, placing graduates in jobs, raising potential competitiveness of higher vocational education and Universities, i.e. saying in one word, doing all that correspond to the requirements of global modern labour market. It's worth noticing that graduates' success in the worldwide educational market is directly connected with delivering lectures in foreign languages and including them in the universal research system.

The main aim of signing Bologna declaration was activity of the European higher education system on a global scale. The declaration points out the following clauses:

- accepting a system of comparable degrees including appendix to diplomas for providing a possibility to place European citizens in jobs and increasing international competitiveness of the European higher education system;
- launching two-cycle education: undergraduate and graduate. The first cycle lasts not less than three years, the second should finally result in magister or doctor degree;
- introducing a European system of transferring labour-consumption units for supporting large-scale students' mobility (credit system) that enables students to choose subjects. This system is based on a European credit transfer system working in the concept "all life studies";
- developing mobility of students, lecturers and other personnel taking into account the time period spent by them working in Europe;
- assisting European collaboration in controlling education quality that is aimed at working out comparable criteria and methods;

- introducing inside University systems of education quality control and attracting students and employers for external estimation of Universities' activity;
- assisting European paradigm of the higher education development in the field of the contests of curricular, mobility schemes and cooperation between Universities, practical training and conducting research [3].

1. Mutual understanding approach is based on long-term political, academic and cultural goals of the country's development. The main principle of this approach is international cooperation rather than competition. That's why realizing such an approach is possible through supporting students and academic mobility, allocating scholarships and realizing programmes of academic exchange as well as programmes aimed at creating international partnerships in the field of higher education.
2. Skilled migration approach is based on attracting elite and talented students to work in the accepting country as a means of providing the economic development and increasing the country's competitiveness in knowledge. This approach is connected with visas and migration legislation. That's why realizing such programmes occurs through special agencies and organizations.
3. Revenue-generating approach is based on two previous ones. But in this case educational services are given completely for money and allocating state subsidies is not taken into account. Foreign students bring additional revenues to the educational establishment, stimulating Universities realize entrepreneurial strategy in the international educational market. On the other hand, Universities get considerable autonomy, high reputation, good defense of foreign students for the part of the government.
4. Capacity building approach enables to get higher education abroad or at Universities giving foreign educational services. The main instruments of such an approach are curricular for supporting foreign mobility of lecturers, scientists, researches, students as well as providing foreign Universities, curricular and lecturers with favorable conditions for commercial educational activity in the country. Such an approach supports the creation of partnerships with local "suppliers of educational services" to transfer and exchange knowledge between national and international higher educational establishments [4].

All aforesaid emphasizes the fact that in modern life internationalization is becoming vital necessity for Universities and it's interconnected with the quality of received and given educational services. Besides, internationalization of higher education should become one of the ways of overcoming conflicts, distrust, developing cooperation between countries, i.e. intensifying the role of education as an instrument of the country's foreign policy.

Students' mobility is sure to be the most popular form of internationalization of higher education. It implies moving students to study abroad. According to the data of Organization of economic cooperation and development more than a million and a half foreign students annually study in all corners of the world. The majority of European countries have a regular and stable intake of students from their colonies, e.g. youth from Latin America strive to get their diplomas at Universities of Canada and the USA.

According to the data given by UNESCO the level of the international students' mobility has grown for the last 25 years by 300 per cent. To the experts' minds the number of students studying abroad was 2,8 million but by 2025 their number will be 4,9 million [5].

To confirm the role of internationalization of higher education it's worth representing opinions of foreign experts. E.g. D.Lain a co-supervisor of transnational research group in the field of higher education Olbany University (New York) considers that that there are two main reasons making governments control internationalization of education in their countries. The first one is economics development, such as export of educational services to Australia's economy is $15 bln. a year, in the USA it's $21bln,i.e. one fifth of all world incomes in this field. International education results in training competitive labour forces, "circulation of brains", helps attract international investments. The second reason is motivation.

The American expert concluded that governments should strive to focus on the development of international education; get interested in the situation occurring inside the whole educational sector rather than its separate institutes and come from the fact that the main mechanism of the countries' development is competition both economy and diplomacy rather than education [6].

The representative of the association of academic cooperation I. Ferenz (Belgium) accentuates the speed of internationalization of higher education and says that this phenomenon happens differently in various countries. Then he notices the a smaller part of the European countries have internationalization strategies on the national level (Norway, Denmark, Finland, Estonia, the Netherlands etc.) but in the majority of European countries many initiatives in the field of internationalization are supported on the EU level.

E.g. in 2009 the European educational market had about half "mobile" students of the world. However, there is a great difference between some European countries. Great Britain is considered to be the most popular country with foreign students for getting Ph.D. degrees. For exchange students prefer Spain. About half foreign entrants in Europe are representatives of non-European countries, though European students choose more and more countries inside the EU to get their degrees. In 2013 the EU planned to finish working out the internationalization strategy. It meant cooperation with the countries outside the EU. By 2020 about 20 per cent of European students plan their studying and training abroad.

The European Union offered special scholarships and curricular stimulating students to study outside their own countries. E.g. up to 80 per cent of all students in Great Britain, the USA and Canada are foreigners. Thus, in Cambridge their amount is above 15 per cent, in Oxford – 25 per cent, in the University College in London one third of all students are foreigners [5].

During the last decade demand for higher education has grown considerably in the world, its significance is rising and hence, competitiveness of Universities in offering unique educational services, training specialists of the international level, achieving Universities their strategic goals grows too. One of such wide spread and accessible ways to get higher education abroad is an on-line system.

The dynamic development of on-line education, modern IT made national boundaries between countries clear for getting and giving educational services. Besides, the global educational market that has already been formed and that is offering educational products and services to all students at once does not limit itself with the national boundaries either. To

prove this fact it's worth mentioning famous rankings: Financial Times, QS World University Ranking, THES, ARWU, Webometrics and others include today not only Universities form the USA but ones from Canada, Spain, France, Great Britain, Switzerland, Singapore, Japan, South Korea, Hong Kong, China, Australia, Germany, Belgium, the Netherlands, Sweden, Finland, Denmark, Ireland, South Africa, Taiwan, New Zealand, Norway, Israel, Turkey [7].

Employers in many European countries pay more and more attention to studying experience, life and work abroad of the applicants while employing them as it says of their adapting, skills, outlook and abilities to communicate with the representatives of different cultures.

In the opinion of experts from the Business Schools Association (Great Britain), the main factors for the students' choice of Universities are their reputation (42,2%), curricular (36%), career promotion (35,5%). These factors are the main and they let neglect the rest ones [5].

Similar processes take place in Russia too. E.g. international fairs of MBA curricular, target programmes of financial help of the leading European business schools working in terms of the international competition for Russian MBA students are held in Moscow and other cities. Such curricular as IRSE (Spain), INSEAD (France), LBS (Great Britain), ABN-AMRO (the Netherlands) work in Russia. One can't help mentioning many American, Dutch, English Universities and Business Schools either.

These Business Schools compete to attract Russian entrants not only with other Russian Universities but also with foreign ones and their mediators that offer their curricular in the Russian market. The more stable a situation in the political, economic, social, legal and other sectors in Russia is, the more interesting and attractive the Russian educational market for foreign Universities is and Russian Universities must also be ready for competing for the right to be chosen.

The chief member of staff of scientific of the Institute of the Far East of the Russian Academy of science N. Borevskaya thinks the attitude to internationalization in Russia is like the market that must be controlled and run. In her opinion, today Russia has rather weak positions in the field of internationalization but the reasons are not economic. E.g. China started this process from a very low level but it thoroughly worked out internationalization concepts, state strategy in this field and today progress in this country is evident. Though Russia is a member of Bologna process it is still intensifying its internationalization processes in the East, in this way it's Eurasia.

To the mind of the department Head of the global integration of the Ministry of science of the Russian Federation I. Prtotsenko, the measures Russia takes today to support internationalization of education are the following: forming main Universities (the whole amount of extra financing is 27 bln. rubles); preparing curricular of Russian citizens abroad; agencies for strategic initiatives; reforms in the fields of diploma admission of foreign Universities; transferring to qualification estimation; international cooperation of some Universities [6].

Such a vital problem in Russia can be solved by Federal Universities. They are nine today: Baltic Federal University named after I. Kant, Far-East Federal University, Kazan Federal University, North (Arctic) Federal University named after M.V.Lomonosov, North-East Federal University named after M.K. Ammosov, North-Caucasus Federal University, Siberian Federal University, South Federal University and Ural Federal University named after the first

President of Russia B.N.Yeltsin that is located in the capital of the Urals, the city of Yekaterinburg.

Ural Federal University was established to realize the concept of the long-term development of the Russian Federation as one of global leaders in education, research and innovations. It has agreements concerning collaboration with more than 345 Universities and organizations. Geography of its cooperation seizes the countries of all the continents: Europe, Asia, South and North America, Africa and Australia. The University has a more active cooperation with Universities from Germany, Austria, Italy, the Netherlands, East-European countries, the USA, Mongolia, South Korea, CIS countries.

The mission of the University is increasing competitiveness, forming personnel, scientific and technical potential, renewing traditional and developing industrial branches of economy of the Ural Federal district.

One of the main strategic goals of the University's development is internationalization of the educational process that includes attracting foreign students and lecturers; providing basic positions in international research and participating in many innovation directions. In future the University must become one of the leading intellectual centres, a centre of transferring technologies, a geopolitical factor of Russia's influence in the countries of Middle and South-East Asia.

Ural Federal University is well-known both in Russia and abroad that can be confirmed by the data of national and international University Rankings. E.g. according to the QS World University Ranking in 2011 Ural Federal University took a position that was 100 points higher than in a previous year. It was due to joining two biggest Universities in the region (Ural state University named after M. Gorky and Ural State technical University) and correctly chosen priority activity: uniting their educational, scientific and innovative potential in the interests of the Ural's development as one of the centres of global economy.

In 2012 the University confirmed its position in group 451-500 of QS Ranking that included 729 Universities. It occupied the leading place among Federal Universities and the sixth among all Russian ones following capital Universities. The main criteria of its competitiveness estimation are reputation in the academic field, quoting publications of its staff, employers' attitude towards graduates, correlation between students and lecturers, a number of foreign students and lecturers, i.e. all that concerns the problem of University internationalization.

Ural Federal University was also highly appreciated by national rankings. E.g. V. Potanin's charity fund makes its own ranking of leading national Universities by the results of work of Federal scholarship and grant programmes for young lecturers. The ranking results of 2012-2013 academic year show that Ural Federal University was one of three best national Universities. This ranking has been published annually since 2004 and is considered to be one of the best authoritative independent quality estimations of 58 Russian Universities.

In 2013 the University was one among 15 chosen by the Ministry of education and science of the Russian Federation by the results of public contest for getting subsidies to increase international competitiveness and get in Top-100 of global University rankings by 2020.

Ranking also concerned CIS countries. By results of this ranking conducted 01.03.2014 Ural Federal University took 18th place considering the following indicators: amount of students, conditions for getting qualitative education, a share of foreign students, research

activity etc. And by results of rankings conducted 05.06.2014 prepared by "Expert AA" agency that was held in Moscow Ural Federal University was included in top-10 of Russian Universities [8].

Better positions of Ural Federal University resulted from strengthening international integration. Its popularity with foreign students grew, financing for one student increased that was connected with joining University a group of higher educational establishments that get state subsidies to increase competitiveness.

Last years the number of foreign students and postgraduates studying at Ural Federal University is growing. It is shown in table 1.

Table 1. A number of foreign citizens studying at Ural Federal University

	2009/2010	2010/2011	2011/2012	2012/2013	2013/2014
In all:	564	800	1023	903	1016
Among them:					
Preparatory department	9	106	109	141	256
Students	551	682	907	750	745
Postgraduates and trainees	4	12	8	12	15
Among them:					
Free	66	64	86	121	134
Contract	392	597	637	515	611

According to the information offered by the International department of the University, in 2014 students from 43 countries study here in different forms: budget, contract, academic changes. In near future there are some backgrounds to suppose that this tendency will be kept and the incomes that University will get from teaching foreign students will increase.

Ural Federal University has already trained more than two thousand specialists for Asian, African and European countries. The majority of foreign students are from Uzbekistan (120), Kazakhstan (251), Tajikistan (118) Kirghizia, Abkhazia, Mongolia, China (176). Figure 1 shows the number of foreign students studying in Ural Federal University since 2011 till 2014.

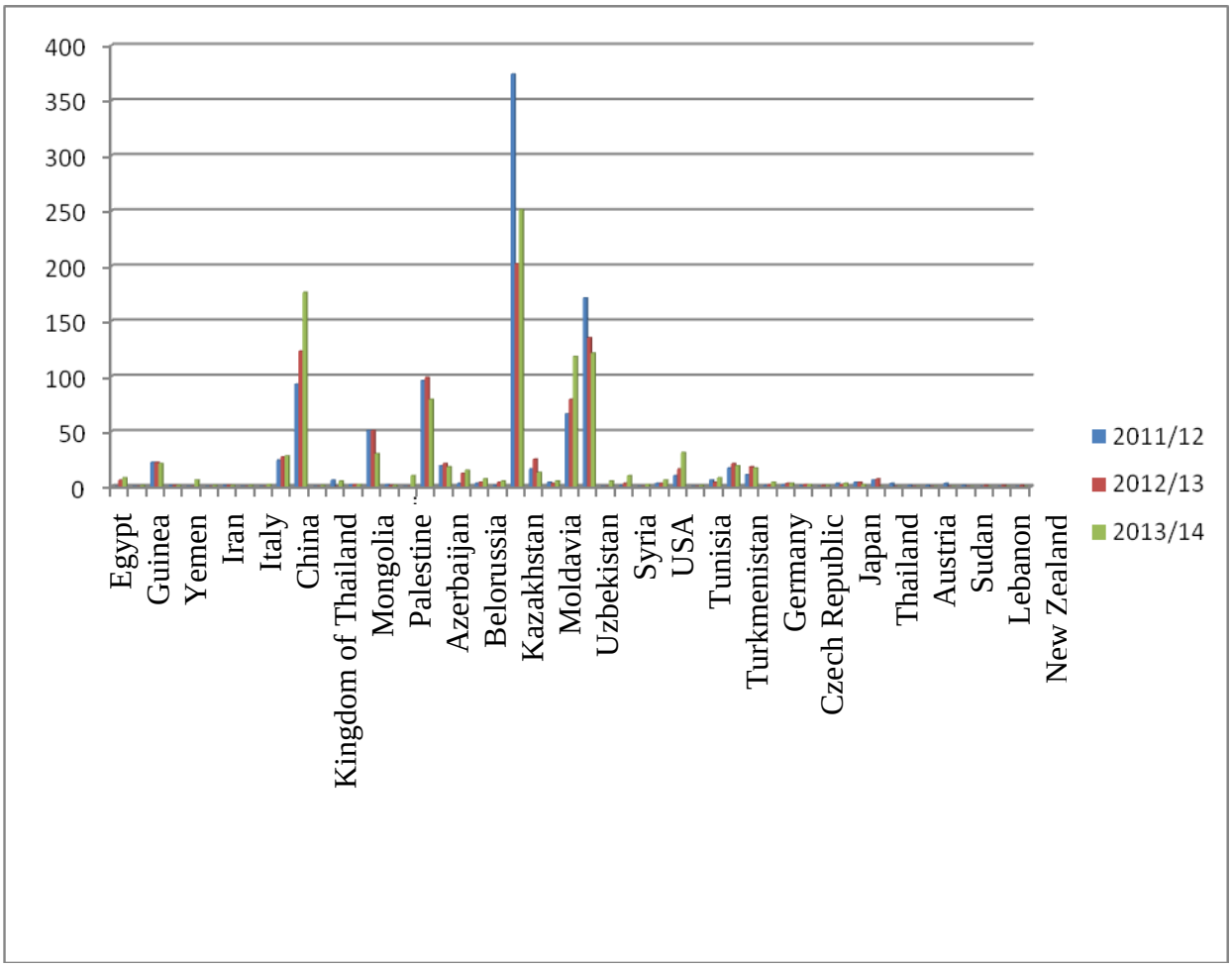

Figure 1. Number of foreign students studying at Ural Federal University 2011 - 2014

The majority of foreign students study at humanitarian institutes: Institute of Humanities and art, Institute of social and political sciences, Higher School of Economics and Management. A bit fewer foreign students prefer to study at technical institutes: Ural energetic institute, Radio Institute etc. [9].

One should notice that a great number of students from one country or region can result in definite difficulties for the University. E.g. some years ago there were a lot of students from China in Great Britain that resulted in the problems connected with epidemic of pneumonia so as a result, British Universities could not have had students at all.

In many countries Universities try to combine training foreign students and expanding their activity in the field of offering their own educational services in perspective markets establishing branches abroad. This tendency shows a shift in internationalization from demand to supply. If the country where the branch is located admits a foreign diploma thus students can study according to curricular of a foreign University from entering to graduating.

Similar acts are conducted by management of Ural Federal University. Nowadays it actively promotes University within the limits of internationalization of higher education in

the countries where there is demand for forming a system of engineering and technical education, research and educational activity. But it's worth mentioning that it takes about from ten to fifteen years to form a complete University branch network.

The main goals for making a branch of University networks are the following: expanding geography to offer educational services; developing a system of searching, recruiting, choosing talented entrants and students; making business contacts to exchange technologies and conduct team research. Thus, according to the Programme of the development of Ural Federal University named after the first President of Russia B.N.Yeltsin till 2020, it is planned to open Head University of Shanghai cooperation organization in limits of University networks in 2016 [10].

Branch networks in the countries with fast economic development must be built on the basis of University-partners. And in short-term period University should set up bilateral partnerships then form partnership networks in different fields of knowledge with leading Universities abroad. Such partnerships must provide the following: visits and lectures of famous professors, combined educational modules and courses; simplifying a procedure of students' exchange; programmes on team research etc.

Creating such networks are a good step towards internationalization of higher education though, on the other hand, similar branches can be considered by national educational establishments as interference into the national system of higher education and national policy as they offer curricular in foreign languages on materials of a different market and can be offered only to well-to-do students.

As a rule such a form of internationalization of curricular is typical for developing countries. E.g. a Dutch Institute of hotel management (Leeuwarden) made whole networks of its curricular called "global campus". Curricular of this Institute are offered in Qatar, Indonesia, Aruba and other countries practically without any changes. Ural Federal University make the same things in CIS countries, Abkhazia, South Ossetia.

According to the Programme of the development of Ural Federal University named after the first President of Russia B.N.Yeltsin till 2020, within limits of internationalization of higher education it is planned to set up global cooperation with foreign Universities that are strategic partners of Ural Federal University in the following main formats: working out and realizing inter-University curricular; conducting research on the international level; launching team venture projects etc. In 2016 students will get international (European) appendix to their University diplomas.

One can't help mentioning one interesting fact that conditions of entering Ural Federal University are different for foreigners. E.g. entrants from Turkmenistan enter the University via representatives of their country in Russia. As a rule students from such countries as Belorussia, Kazakhstan, Kirgizia, Tajikistan are children of management of companies and enterprises.

Students that come from abroad pay for their education. Entrants from Guinea have a contest called "100 scholarships of RUSAL". Annually about three thousand entrants are tested and only one hundred get a chance to study in Russia: 22 study at Ural Federal University, 22 enter Mining Academy in Yekaterinburg and the rest study in Moscow.

Only the best employees of different Mongolian enterprises who got a bachelor degree in their own country have a chance to come and study at magister courses at Ural Federal University. As a rule they are sent here by the Ministry of education.

Entrants from Africa (Egypt, Yemen and other countries) enter Ural Federal University on the basis on agreements concluded between countries. The Russian Ministry of education invite these entrants to study in Russia.

The majority of foreign students coming to study at Ural Federal University do it by recommendations of their friends and relatives. To attract more foreign students the University began cooperation with different recruiting agencies where it is actively advertised as well as its scientific, educational, cultural, sport and other forms of activity.

Speaking about the forms of internationalization one can't help saying about lecturers' mobility. It's a tradition that staff's mobility is connected with their research. Like students' mobility it has considerable differences in geography. On the one hand, there are countries that attract such personnel deliberately with the aim to expand their system of higher education, Hong Kong is an example. On the other hand, there are countries with a low level of staff's internationalization. As a rule these are the countries with a high level of national homogeneity, using only their native language in teaching and that experience some difficulties in finding specialists knowing foreign languages. Thus, the USA and Great Britain are main exporters of scientific personnel but at the same time the departments of Universities of these countries are very attractive for foreign specialists.

Ural Federal University is also very active in attracting foreign lecturers and researches. It can be confirmed by the following dynamics: in 2011 the number of foreign lecturers was ten. Those were specialists from Germany, Austria, Norway, France, Denmark, Italy. In 2012 the number increased to 138 and they represented 34 countries. The University also launched on-line technology of attracting foreign lecturers. The amount of specialists attracted in this way was ten.

Professors, lecturers, researches, experts of Ural Federal University intensively cooperate with Universities and research centres of Europe and the USA delivering lectures, conducting combined research and educational projects, setting up partner relations. Among such Universities one should pick out the following: Johannes Kepler (Austria), Federal University of Rio de Janeiro (Brazil), City University of London, Fredric Sheller University, Technical University in Munich (Germany), University of Delhi South Campus (India), University of Seville, University of Granada (Spain), University of Turin, Milan Polytechnic University (Italy), University of Western Ontario (Canada), Technologic University of Harbin, Beijing Technologic University (China), Seoul Cyber University, Korean Institute of science and technology (Korea), Higher school of business (Latvia), Kaunas technological University (Lithuania), Mongolian national University (Mongolia), State University of Erevan, Erevan state University of building and architecture (Armenia), Tajik technical University named after M.S.Osimi (Tajikistan), State University of Florida (USA), Donetsk national technical University (Ukraine), Technological University of Lappeenranta, Universities of applied science (Finland), Brnyansk technological University, Higher school of Economics (Czech Republic), University of Science and technology of Hanoi, National University of Hanoi (Vietnam) and many others [9].

Similar processes are directly connected with intellectual migration, i.e. migration of researchers and lecturers of high qualification who are really and potentially involved in working out and research. The main reasons of intellectual migration are the following: a possibility to get extra experience and do work that is not accessible in Russia.

There are two concepts of intellectual migration:

1. A brain exchange concept explains migration of people by searching for a new place of their being employed considering their qualification and experience. Both brain gain and brain drain are typical for all economies and suppose bilateral exchange of information about the situation in the country-exporter and the country-importer. This information can be about labour markets, finances, product markets, living conditions.
2. A brain waste concept considers intellectual emigration as net loss for overall labour force of the country-exporter. The outflow of qualified personnel is considered to worsen the ability of the country to develop in a social and economic way that finally results in decreasing life level there.

There are a lot of criteria to estimate internationalization of higher education. Good indicators of these criteria say about good University life and activity, about its competitiveness and future perspectives of development. One of the main criteria used for estimating higher educational establishments in the world rankings is quoting. By this indicator Ural Federal University takes a leading position among universities of Ural Federal district. During the last years staff of the University publish more than 1200 articles annually that are taken into account in the basis of Web of Science and Scopus [10].

It's worth emphasizing that by the majority of main characteristics Ural Federal University named after the first President of Russia B.N.Yeltsin today leaves considerably behind its competitors inside the country. Thus, according to the estimations of Universities and Scientific Associations internationalization indicators in this University are the best in the region. Representatives of these associations estimated ten Universities of Ural Federal district by the following criteria:

- Universities whose personnel are active in realizing team research projects with foreign Universities in the fields known to you;
- Universities whose students and postgraduates are active in participating in international scientific events, research, trainings in the fields known to you.

The result of this estimation was a comparative level of perception of the following Universities:

A - Ural Federal University named after the first President of Russia B.N.Yeltsin

B - Tumen State Oil and Gas University

C - Tumen State University

D - South - Ural Sate University

E - Perm National Research University
F - Ural State Medical Academy
G - Ufa State Oil technical University
H - Perm National Research polytechnic University
I - Chelyabinsk State University
J - Orenburg State University

Ranking Universities of Ural Federal district is shown in figure 2 [11].

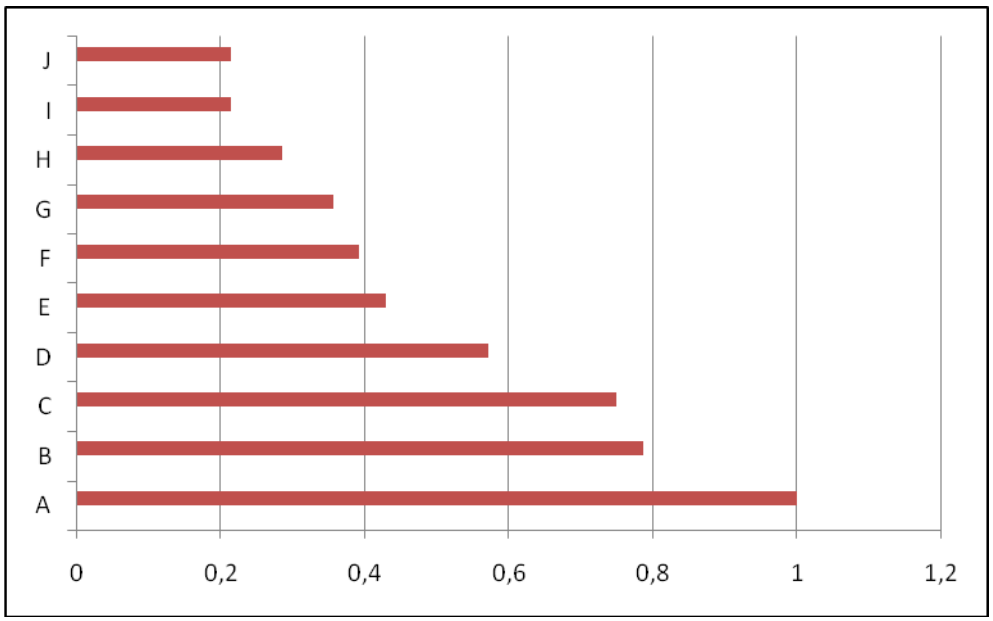

Figure 2. Ranking Universities of Ural Federal district

In conclusion it's important to say that every country works out its own internationalization strategy coming from its own economic and political possibilities taking into account sizes, geographical position, history, culture, quality and distinctive features of its system of higher education, the language role of the country in the world and experience in the sphere of international cooperation.

Internationalization of education is considered by countries both as an object and a subject of state purposeful policy aimed at solving definite national, political, social and economic problems. The international character of activity not only enriches educational process due to cooperation and "collision" of different cultures and traditions of management but also makes the specific environment of success for graduates whose business connections are spread and will be spread much further the boundaries of the Urals in particular and Russia on the whole.

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CHEMICAL TREATMENT OF WATER FOR STEAM BOILERS IN MINING POWER COMPLEX "OSLOMEJ" IN KICEVO

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Abstract: Mining power complex "Oslomej" in Kicevo is a thermal power plant that achieves an annual production of about 700 GW/h. Oslomej uses drinking water for operating of the steam boilers.. Since drinking water does not meet the required criteria for the working of steam boilers, it is necessary to be chemically treated. The chemical treatment is consisted of two different procedures: decarbonation and demineralization. Decarbonation is performed in quick concrete reactor - accelerator with a solution of $Ca(OH)_2$ and $FeCl_3$, and demineralization is performed using ion modifiers. As a result of the process of decarbonation, there is a partial water refill which reduces the conductivity. After applying the process of demineralization there is a complete removal of the mineral substances, so that the total water hardness is 0 degrees German (ºD), SiO_2 is less than 0,2 mg/L, and the conductivity (σ) is smaller than 0,5 μS/cm. Filtering is done using sand filters and the recommended intensity of the flow of filtered water is 40 - 60 m^3/h. The analyses of drinking, decarbonized and demineralized water are made daily. This paper describes the chemical treatment of water for steam boilers in "Oslomej". There are shown the results from the analysis of drinking, decarbonized and demineralized water in randomly selected days.

Keywords: decarbonation, demineralization, steam boilers, water

1. INTRODUCTION

About 96 % of the total domestic energy production in Macedonia is provided by AD ELEM. Power plants are used for production of approximately 5000 GW/h or 80 % of the total energy, while hydro plants contribute for about 1200 GW/h. The contribution of the mining - energy factories in Bitola and Kicevo is approximately 80 % of the total energy provided. These thermal plants use coal as primary fuel. The average calorific value is 7660 KJ/kg. "Oslomej", mining – energy plant in Kicevo, has installed capacity of 125 MW, and the net annual production is 700 GW/h [1].

This power plant uses drinking water for the steam boiler operating. According to its chemical composition, this water does not match the steam boilers needs. It contains ingredients that create a residue in boiler plants, cause corrosion of the boiler material and cause water foaming [2]. Therefore comes to lower utilization, higher costs and less job

security using steam boilers. Precipitate in boiler plants is due to the presence of soluble salts of calcium and magnesium in the water [3]. The solid crystalline precipitate which occurs on the heated surface of the walls of the boiler is called boiler stone and colloidal irregular precipitate is called boiler mud.

The water used for steam boilers need to meet the following conditions:

- Must not contain iron and copper, because the presence of hydrogen and oxygen causes corrosion
- Water fortress of low pressure steam boilers has to be <0,05 ºD, and for high pressure boilers <0,02 ºD
- The content of O2 has to be <0,02 mg/L because of caused corrosion of boiler
- Do not have to contain organic materials, because they cause water foaming and the level of water could not properly be controlled
- Free H_2CO_3 should not be included, because of the number of changes in pH
- H_4SiO_4 should not be included, because it creates a solid stone
- The most suitable pH for high pressure water boilers is 9,6

There is a need of physical and chemical treatments to remove the unnecessary components from water or to reduce their amounts to the minimum acceptable value. Physical treatment comprises the processes of deposition and filtration, while the chemical treatment consists of two different procedures: decarbonation and demineralization [4-7]. Decarbonation is a process that removes carbonate salts. Decarbonized water can´t be used for steam boilers, because the value of the hardness is 0,3 to 1 ºD. It can be used in the technological and the process of cooling. Its usage in steam boilers should be followed by the process of demineralization, or removal of all salts, carbonates and non carbonates.

Decarbonation can be made using different chemical elements: Na_2CO_3, NaOH, Na_2CO_3 and NaOH, Na_3PO_4, $Ca(OH)_2$, Na_3PO_4 and $Ca(OH)_2$, $Ca(OH)_2$ and $FeCl_3$ etc. Demineralization is performed using ion modifiers, which may be cationic and anionic. Cationic modifiers exchange the cations, while anionic modifiers exchange the anions [8,9].

2. MATERIALS AND METHODS

Mining - energy plant "Bitola" uses drinking water from the source "Studencica" as raw water. This water does not meet the required criteria for steam boilers and therefore is chemically treated [10]. The water is first collected in a concrete reservoir with a volume of 1000 m^3. This reservoir is located above the Mining Energy Plant "Oslomej" and because of the gravity there is a movement of the water from the reservoir to the accelerator. The accelerator is a fast concrete reactor in which is performed the process of decarbonation. The capacity of the accelerator is 380-480 m^3/h. The speed which changes the capacity of the accelerator should not be higher than 20 - 40 m^3/h. If this speed is higher than 40 m^3/h, the deposition will not be successful and the water that comes out will occur greater amount of non-precipitated particles.

The process of decarbonation is performed using $Ca(OH)_2$ and $FeCl_3$ as coagulants. The solution of $Ca(OH)_2$ is prepared in separate tanks and its concentration is about 3,6 %. The density of this solution is approximately 1,055 g/cm^3. The accelerator solution of $Ca(OH)_2$ is transferred by pumps from these tanks. Prepared solution of $Ca(OH)_2$ should always be mixed using special blenders. For 24 hours it is spent around 700-1300 kg solution of $Ca(OH)_2$. The greatest amount of $Ca(OH)_2$ is consumed in summer and the lowest in winter. The reason is that in summer is consumed the highest amount of decarbonated water for cooling the plants in " Oslomej". Dosing the solution of $Ca(OH)_2$ in the accelerator must be carried out continuously. Changing the amount of solution of $Ca(OH)_2$ depends on the change of the capacity of the accelerator. Dosage amount of solution of $Ca(OH)_2$ in the accelerator depends on the value of alkalinity "p" and alkalinity "m" of the water in the accelerator, which is constantly monitored. Alkalinity "p" of the water in level 1 should range from 0,2 - 0,4 mVal/dm^3. When 2p = m, the decarbonation is properly executed and $Ca(OH)_2$ is exactly balanced. When $Ca(OH)_2$ is added in excess, 2p> m, and when 2p <m, there is added a smaller amount of $Ca(OH)_2$ than necessary. Under the condition of excess of $Ca(OH)_2$ there is a reaction between $Ca(OH)_2$ and atmospheric CO_2, which creates CaCO3. When 2p <m, or $Ca(OH)_2$ is added less than necessary, decarbonation is incomplete and follows a process of salt precipitation in the condenser, thus reducing thermal alteration. Using the process of decarbonation there is mainly a removal of calcium and magnesium bicarbonates, according to the following reactions:

$$Ca(HCO)_2 + Ca(OH)_2 = 2CaCO_3 + 2H_2O$$
$$Mg(HCO_3)_2 + Ca(OH)_2 = CaCO_3 + MgCO_3 + 2H_2O$$
$$MgCO_3 + Ca(OH)_2 = Mg(OH)_2 + CaCO_3$$
$$CO_2 + Ca(OH)_2 = CaCO_3 + H_2O$$

$FeCl_3$ is a coagulant and it should be added continuously. If you stop adding $FeCl_3$, the outlet water from the accelerator will skyrocket the amount of sediment. If decarbonation is done correctly, the water that comes out of the accelerator is clear and its fortress is less than 3,5 ^oD. $FeCl_3$ is prepared in the form of a solution with a density of 1,006 g/cm^3. For 1 m^3 raw water it is spent 20-30 g $FeCl_3$ as coagulant. For 24 hours, depending on the quality of raw water, it is consumed about 75-90 kg coagulant. Sludge removing is performed in every 4 hours. The precipitate is removed simultaneously from both holes and is collected in two reservoirs. The volume of one tank is 30 m^3. Piping after removing sludge should be rinsed using decarbonized water to avoid their blockage. To reduce the water losses there is a need the clear water reservoir to be turned back to the accelerator after sludge removing. Sediment from the bottom of the tank is discharged.

Purification of water by mechanical impurities is done by sand filters. The capacity of the filter depends on the consumption of water. Sand filters are filled by gravel which granulation is 2,0-3,0 mm, and the amount of sand filtration is 1,4 m. When water passes through the sand filter, mechanical impurities are retained between sand grains. If the water contains more impurities impedes the passage of water through the filter. Therefore it is necessary to rinse

the filter. The filter is rinsed by decarbonized water that is worn by the pump from the decarbonized water tank. The recommended intensity of the water flow is 40-60 m^3/h.

The demineralization is performed using ion modifiers. There are used various types of cationic and anionic modifiers. Over the period of the analysis, it is used the cationic modifier K-1 filled by ionic modification table LEVATIT S-100 and anionic modifier A-1 filled by ionic modification table VOFATIT SBK. The height of cationic modifier is 1 m, and the amount is 0,8 m^3. The height of the anion modifier is 1 m and the amount is 1,1 m^3. Ion modifiers are regenerated, cationic are regenerated by concentrated HCl, and the anionic are regenerated by concentrated NaOH [11].

3. RESULTS AND DISCUSSION

The Mining - energy Plant "Oslomej" daily performs analysis of raw, demineralized and decarbonized water. Raw water is drinking water that is collected in concrete tanks over mining - energy Plant "Oslomej". There is an analysis of the following parameters: σ, pH, alkalinity "p" and "m", total hardness (TH), calcium hardness (CaH), magnesium hardness (MgH), carbonate hardness (KH), Fe^{3+}, Cl^-, SO_4^{2-}, SiO_2, $KMnO_4$ etc. table 1 shows the values of the important parameters in rough water.

Table 1. Important parameters in raw water

date	σ (μs/cm)	pH	TH (°D)	p/m (mVal/L)	SiO_2 (mg/L)
28.12.2012	157	8,1	6,2	0,00/2,14	2,70
13.02.2013	144	8,0	6,3	0,00/2,2	2,95
28.03.2013	135	7,8	5,2	0,00/2,1	3,19

In table 1 is shown that the raw water from 28.03.2013 has the highest value for SiO_2, and the lowest for σ, pH, TH and p/m for the three analyzed waters. It is because at this time of the year there is a greatest rainfall and snow melting, which increases the amount of water in the sources. Raw water is taken in accelerators where the process of decarboxylation is performed. The process of decarbonation is taking samples for analysis in every 2 hours. The sample is collected from three different places: level 1, level 2 and level 3. Level 1 is the lowest level, and level 3 is the highest level of the accelerator. In every 2 hours there are monitored these parameters for all the 3 levels: σ, pH, p/m and TH. The process of decarbonation follows these parameters to be accurately dosed $Ca(OH)_2$ and $FeCl_3$. Apart from these parameters, once in the month there are made analyzes of decarbonation water just like those for the raw water. Table 2 provides the results of measurements of decarbonized water in three different days and different times of the day.

Table 2. Important parameters in decarbonized water

Levels in the accelerator	Important parameters measured on 27.01.2012 in 13 ^{30} hour			
	σ (μs/cm)	pH	TH (ºD)	p/m (mVal/L)
Level 1	68,2	10,4	2,5	0,35/0,5
Level 2	69,3	10,5	2,5	0,3/0,5
Level 3	69,0	10,4	2,9	0,35/0,5
	Important parameters measured on 10.02.2013 in 11 hour			
	σ (μs/cm)	pH	TH (ºD)	p/m (mVal/L)
Level 1	65,1	10,2	2,9	0,35/0,5
Level 2	64,2	10,4	2,7	0,35/0,5
Level 3	63,7	10,3	2,8	0,35/0,5
	Important parameters measured on 07.03.2013 in 11 hour			
	σ (μs/cm)	pH	TH (ºD)	p/m (mVal/L)
Level 1	61,5	9,7	3,2	0,3/0,6
Level 2	60,6	9,67	2,7	0,4/0,9
Level 3	61,7	9,5	2,5	0,3/0,65

When the decarbonation is properly executed, 2p=m. Table 2 shows that on 27.01.2012 and 10.02.2013, 2p> m, which means that $Ca(OH)_2$ was added in excess or there was not enough coagulant $FeCl_3$. In this case $FeCl_3$ coagulant is added to get the required terms of p and m. On 07.03.2013 at 11 am, just in the first level, 2p=m, while in the second and third level 2p <m. The relationship between p and m in this case is corrected by adding $Ca(OH)_2$. Because of this, we monitor the basic parameters in every 2 hours.

In table 3 are given the values of p/m and TH at different times of the day. These values are exactly the same for all 3 levels.

Table 3. p/m and TH of decarbonized water at different times of the day

hour	05.02.2013		06.02.2013		08.02.2013	
	p/m (mVal/L)	TH (ºD)	p/m (mVal/L)	TH (ºD)	p/m (mVal/L)	TH (ºD)
7^{00}	0,30/0,60	2,5	0,35/0,70	2,4	0,45/0,90	2,5
9^{00}	0,35/0,70	1,5	0,30/0,60	1,9	0,40/0,80	2,4
11^{00}	0,35/0,70	1,4	0,30/0,60	1,7	0,30/0,60	2,2

In all the three selected days, at different times of the day 2p=m, which means decarbonization is properly executed and there are not necessary any adjustments by adding $Ca(OH)_2$ or $FeCl_3$. In table 3 is shown TH value that over time which is constantly declining for the three days. Although TH in decarbonizated water is much smaller than TH in the rough water, this is not enough to be used for "Oslomej" steam boilers. It is therefore necessary to perform demineralization that will remove all mineral materials and TH will be 0.

Table 4 shows the values of σ, pH, p/m, TH and SiO_2.

Table 4. Important parameters in raw, dacarbonized and demineralized water

Type of water	Important parameters measured on 28.12.2012					
	σ (μs/cm)	pH	TH (ºD)	p/m (mVal/L)	SiO_2(μg/L)	σ (μs/cm)
Raw	157	8,1	6,2	0,00/2,14	2 700	157
Decarbonized	70	10,2	1,5	0,25/0,5	2 080	70
Demineralized	0,8	7,2	0,000	0,00/0,05	<10	0,8
	Important parameters measured on 13.02.2013					
	σ (μs/cm)	pH	TH (ºD)	p/m (mVal/L)	SiO_2(μg/L)	σ (μs/cm)
Raw	144	8,0	6,3	0,00/2,2	2 900	144
Decarbonized	61,7	9,9	2,1	0,25/0,5	2560	61,7
Demineralized	0,3	7,8	0,000	0,00/0,05	<10	0,3
	Important parameters measured on 28.03.2013					
	σ (μs/cm)	pH	TH (ºD)	p/m (mVal/L)	SiO_2(μg/L)	σ (μs/cm)
Raw	135	7,8	5,2	0,00/2,1	3190	135
Decarbonized	60	9,6	2,0	0,2/0,4	2628	60
Demineralized	0,5	7,7	0.000	0,00/0,05	<10	0,5

Table 4 shows that the conductivity of the water is greatly reduced during the processes of decarbonation and demineralization. Raw water's conductivity is about 140 μs/cm and it is reduced by more than a half of its value, to the value of around 60 μs/cm. After the process of demineralization, σ value is less than 0,5 μs/cm. The conductivity decreases because many ions and many salts are removed by the processes of dekacarbonation and demineralization. Besides conductivity, reducing salts affect the overall hardness of the water. Raw water's total hardness is 5,2- 6,3 ºD. This value for the decarbonation water varies from 1,5 to 2,5 ºD, and for demineralization water is equal to 0,00 ºD. The amount of SiO_2 is slightly reduced during the decarbonation and it is almost completely removed in the process of demineralization.

4. CONCLUSIONS

Steam boilers in "Oslomej" mining - energy plant are using drinking water. This water is chemically treated before using, because it does not fulfill the required criteria. Chemical treatment is comprised of decarbonation and demineralization. Decarbonation is performed by $Ca(OH)_2$ and $FeCl_3$. In every 2 hours there is a monitoring of parameters "p" and "m" to see whether these assets are properly dosed. When 2p> m, there should be added $Ca(OH)_2$, and when 2p <m, $Ca(OH)_2$ is in excess and there should be added $FeCl_3$. The ion modifiers are used for the process of demineralization which removes all mineral material. The chemical treatment is carried out continuously and therefore we perform daily analyzes of crude, decarbonation and demineralization water. The daily monitor is important for the parameters σ, pH, TH and p /m, while there is once a month monitoring for analyzing all parameters in the water. The results show that σ is the largest in the rough water. In the process of decarbonation this value is almost halved, while the demineralization water gives the smallest

and has negligible value in terms of raw water. The total hardness of water is the most important parameter of the water for its use in steam boilers. TH value in the raw water is around 6ºD, in decarbonation water this value is around 2ºD, and in demineralization water it is 0ºD. The results show that the amount of SiO_2 is extremely reduced in the process of demineralization while in the process of decarbonation the reduction is very small.

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COMPARISON OF HANDLING WITH SECONDARY RAW MATERIALS IN GERMANY AND BOSNIA AND HERZEGOVINA ON THE EXAMPLE FROM WASTE PAPER COLLECTING

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Abstract: Any mode of organization from waste paper collecting is adapted of concrete, local respectively regional, conditions. We can distinguish three basic units as functional part from operating system of collecting: collecting, transport and sorting.
Waste paper Collectors in Bosnia and Herzegovina act generally of small collecting space, limited of specific location or municipality. Colectors, which perform their activities in the area of whole Bosnia and Herzegovina are exception.
In this study are compared and analized data about waste paper collecting in Bosnia and Herzegovina from local colectors in the area of Zenica (year 2005) with comprehensive data about waste collecting in Germany, from Association of utility companies for waste transport and city cleaning (VKS , year 1995).
When data comparing is obviously the difference in each part of activities. Despite difference initial conditions Waste paper are collected ewerywhere.
Market value and constant market demand for waste paper, including environmentally motivated reason for handling with waste paper, enable solutions for reuse from waste paper as raw material for the produktions of many paper and cardboard category.

Keywords: waste paper, collecting, transport, sorting.

1. COLLECTING

Waste paper, that mean paper for reuse, have to fullfill technical and economic requirements as row material for paper production. It is usefull waste paper (recovered paper and board) by producer or consumer separately to collect, and should in principle be supplied free of unusable materials. Consist of any foreign matter in the recovered paper and board may cause interruptions to production or may reduce the value of the finished product, such as: metal, plastic, glass, textiles, wood, sand and building materials, syntetic materials, syntetic papers.

1.1. COLLECTING PLACE

General data about collecting place refers to two differently big and differently populated territory. Population of < 100 pop./km^2 is rural less populated, and population of > 200 pop./km^2 is rural highly populated, which is common in the German rural village.

Table 1. General data

general data	VKS	Zenica
population	20.388.804	565.333
average population	210 pop./km^2	96 op./km^2

1.2. TYPE OF WASTE PAPER COLLECTION

We can distinguish the following collecting systems of usable materials:

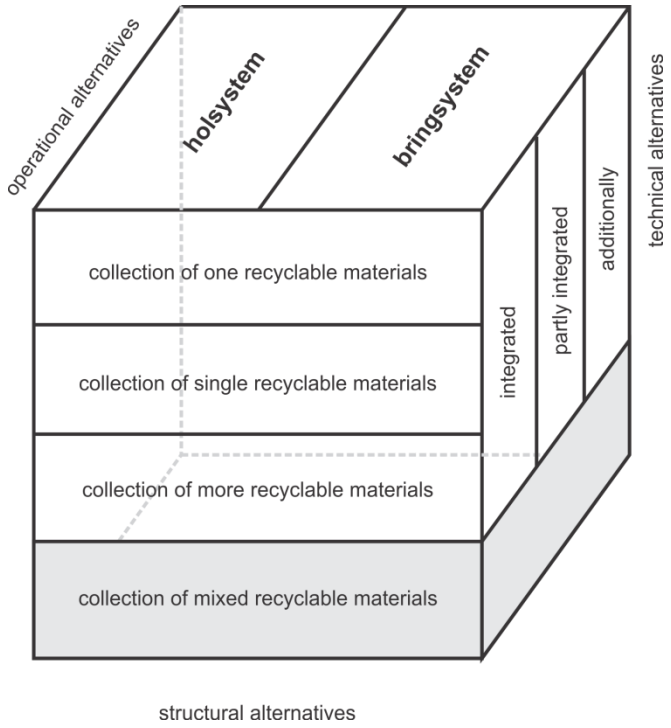

Figure 1. collecting systems [3]

Separately collecting of waste paper is proven correct way for providing raw materials for paper mill. Basically have two systems for separately waste paper collecting:

1. Paper collecting in firms – holsystem /pick-up system/ (Collector picks waste paper by the waste paper producers)

2. Collecting in public places – bring system (Waste paper producers bring waste paper to the collecting place)

Holsystem and bringsystem provide users complet different service/conformity.

Waste paper collecting is different organised in observed areas. In Bosnia and Herzegowina is participation in the system of waste paper collecting voluntary and in Germany forced. Holsystem is in Bosnia Herzegowina much more prevelant as Bringsystem. Collector picks waste paper on the place of its origin, from its own container, transported it to the sorting plant, sorted and press, than transported to the paper mill.

Table 2. Type of collecting

waste paper collecting	VKS	Zenica
holsystem	26,0 %	9,1 %
holsystem	28,0 %	90,9 %
mix system	46,0 %	
forced participation	52,1 %	
voluntary participation	47,9 %	100,0 %

In Germany with the implementation of adopted legislation about waste, especially Regulation on Packaging (Year 1991) inclusive with waste paper is waste paper collecting individualized. Containers from 120 l to 1100 l used for waste paper collecting in hausholds. Waste paper collecting in Bosnia and Herzegovina indicate typically use of big container, what suggesting of board packaging in shops, storages and production plants.

Table 3. container for collecting

nr.	container size /l/	VKS		Zenica	
		number /%/	volume /%/	number /%/	volume /%/
1.	35 – 80	0	0,0	81,7	16,2
2.	120	16,6	7,3		
3.	240	77,3	68,4	9,2	6,3
4.	660	0,2	0,5		
5.	770	0,1	0,4		
6.	1100	5,8	23,4	3,9	12,1
7.	3000			2,1	17,6
8.	5000			1,0	14,3
9.	5600			2,1	33,5

Data about specific gravity from waste paper in containers are important, as indicator of its use and efficiency.

Table 4. specific gravity from waste paper in container [4]

Grade	Waste paper	Container 240 (0,24 m³)	Container 1100 (1,1 m³)	Big container (5,5 m³)
		[t/m³]	[t/m³]	[t/m³]
1.11	Deinking	0,3-0,35	0,20-0,25	0,15-0,20
1.04	Board	0,04-0,08	0,03-0,05	0,02-0,04
1.01	Mixed paper	0,15-0,30	0,10-0,20	0,05-0,15

In Bosnia and Herzegovina data on waste paper collection shows that typically use larger containers, indicating collecting cartons from stores, storage and manufacturing plants. From the above it is evident and crucial differences in collecting between two existing systems. The VKS-in is mostly a collection of sales (primary) packaging, which is a result of the application and implementation of the Regulation on Packaging, while in Zenica collects mainly storage (secondary) and transport (tertiary) packaging.

The Regulation on Packaging in Germany in the period of 6 years led to the utilization of packaging waste paper 90% more than in 1997-the year. [6]

In the Federation of Bosnia and Herzegovina and the Serbian Republic's 2011-year adopted Regulation or regulation on the management of packaging and packaging waste, which is one of preconditions to increase the percentage of collected waste paper from its packaging in Bosnia and Herzegovina. The introduction of statutory quotas collection and recycling of materials from containers , National targets in the European practice, proved to be a prerequisite for the introduction of separate collection of packaging or to the establishment of a dual system.

3. TRANSPORT

Transports are the most important link in the chain of exploitation-disposal of waste paper. There are different types of transportation systems in relation to the way of consideration, elaborate technical or structural. The choice of transport system is determined by local conditions-restrictions.

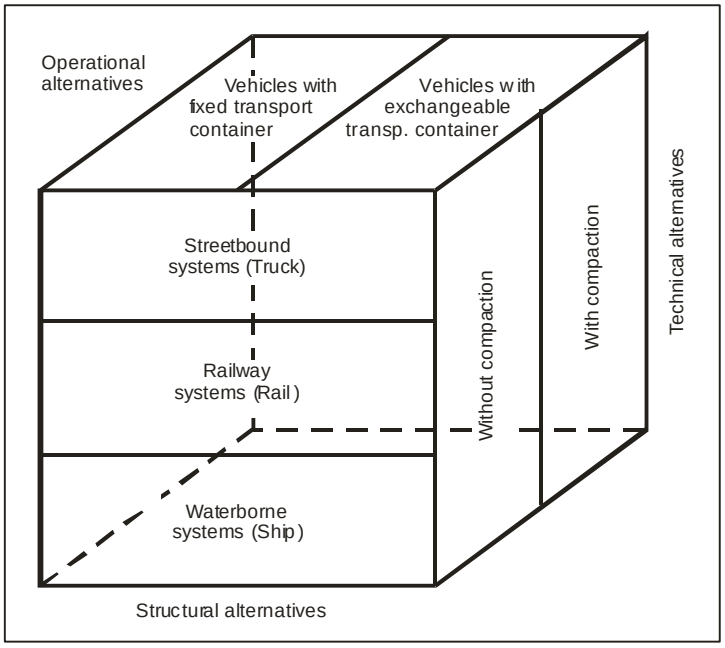

Figure 2. Transport systems [3]

In Bosnia and Herzegovina is available for an extensive road network, while the railway network is limited to two lines Samac - Ploče, running north-south and Dvor na Uni-Doboj-Tuzla-Brcko, west to east. Waterway is only the Sava River along the northern border with the Croatian. The relatively small amount of collected waste paper, the need for faster rates of turnover and logistical requirements, storage, handling and transfer complication and increase the cost of transport waterway and rail through and lead to only use road transport system.

Map 1. roads in Bosnia and Herzegovina [7]

Map 2. Road and rail networks in BiH

Loading waste paper into vehicles is done by hand or by mechanical means, depending on whether the loaded bulk, compacted or baled waste paper. For mechanical loading used fork-lift trucks, cranes, hydraulic load-systems, "tossing" containers (lifter) or "tugging" containers (Hookloader roll containers) or emptying containers in the truck with upgrades for compacting materials. Distance of origin of waste paper to the collector and the collector of waste paper to paper factory is different and depends on local specificities.

We distinguish between the primary transport from the collecting place to the collection sites (warehouse collectors), and secondary transport, from the collecting sites to the paper factory.

3.1. PRIMARY TRANSPORT

The primary transport are significant per smaller quantities and collecting on a number of locations in a relatively short distances between them. The place of origin of small quantities of waste paper is practiced loading by hand, especially when the place of origin-loading is in the narrow streets and poor solved driveway, which stipulate the use of smaller vehicles.

In the following table are primarily for primary transportation shown usual combinations collection containers and transport vehicles.

Table 6. Data about transport – primary transport

Vehicle	Container	Loading
van	bundle, carton	by hand
truck with compression	bin 240l, container 1100l or 5000l	hydraulics Rollover
self loader	mesh metal cage	crane
self loader	igloo	crane
hookloader	press container, roll-off container	hydraulic hook
self loader, truck	bale	crane or forklift

3.2. SEKUNDARY TRANSPORT

Secondary freight transport characterized by larger weights collected materials generally at greater distances than from the primary transport.
Transportation is with the distance demanding and orients itself towards larger amounts, or large shipments of waste paper, which is achieved major transportation units.

Table 7. Data about transport – sekundary transport

	paper	distance	transport unit	capacity	remark
1.*	loose	short (<70km)	hookloader with trailer, roll-off containers 40 m^3	up to 15t	loading with loader
2.	bale	all	truck with trailer	up to 24t	permissible total weight 40t
3.	bale	all	train	50 t per wagon	greater weight and distances

*) Old paper when loading presses with a shovel of the loader, to be squeezed and achieve greater specific gravity of loaded weight (kg/m^3)

An important indicator for evaluating the transport is definitely capacity and capacity utilization of used vehicles for the transport of waste paper, which can be determined by analyzing the data presented in the tables below.

Table 8. Data about transport – comparative Data VKS - Zenica

Transport Data	VKS	Zenica
average distance sorting / collecting place	16 km (min. 2 km, max. 60 km)	14 km (min. 3km, max. 80 km)
number of tour sorting / collecting place	2,1 per day	4,1 per day
average daily distance per vehicle	97,1km (min. 17 km, max. 290 km)	153,7 km (min. 75 km, max. 210 km)
average daily weight per vehicle	12,8 t/day 6,1 t/tour	3,9t/day 0,95 t/tour

In Germany are used vehicles with more payload and their carrying capacity is better utilized. Better utilization of capacity of the vehicle is achieved using a mechanized loading, using Press containers and vehicles with upgrades for compacting bulk cargo, which actually allows greater utilization of payload vehicle.

Table 9. types of vehicles

Number	Truck in use	VKS	Zenica
1.	two axis with compression	41,4 %	6,3 %
2.	two axis with tarpaulin	10,0 %	50,0 %
3.	two axis		31,1 %
4.	three-axis with compression	43,0 %	6,3 %
5.	three-axis with tarpaulin	3,6 %	6,3 %
6.	three-axis	2,0 %	

3.3. INTERVALS DISCHARGE

For the success of separate collection is of great importance the available volume (container) per inhabitant and year. This feathure can be determined by the number of containers or frequency of their discharge.

In Germany is usual large density from collecting places und short distance between them. In Southeast Europe is generally less density from collecting places, but with high frequency discharge sometimes with daily discharge.

The reason for this approach to the organization of separate collection of waste paper is often high population density in urban areas with difficult traffic conditions, conditioned by narrow streets, which in practice limits the density of the collection.

The absence of individualized system of separate collection of waste paper accompanying with undeveloped system of compensation, is resulting in a lack of necessary investments for the purchase of an appropriate number of collection containers. High transport costs incurred due to frequent discharges further limit the efficiency and capacity of the collection system.

Table 5. Frequency discharge

Number	Rhythm discharge	yearly	VKS	Zenica
1.	more times a month	>52 x year	8,1 %	61,0 %
2.	weekly	52 x year	22,6 %	31,0 %
3.	twice a month	26 x year	16,1 %	6,0 %
4.	monthly	13 x year	41,1 %	2,0 %
5.	others	<13 x year	12,1 %	

Increased frequency discharge in Zenica indicates a lower volume available for the collection of waste paper per user (citizen). The smaller volume of available containers directly leads to increased frequency of emptying them.

4. SORTING

The soring means separation of separately collected waste paper qualitatively different grades of recovered paper and board. Stationary systems for sorting work mostly as a combination of mechanical and manual sorting.

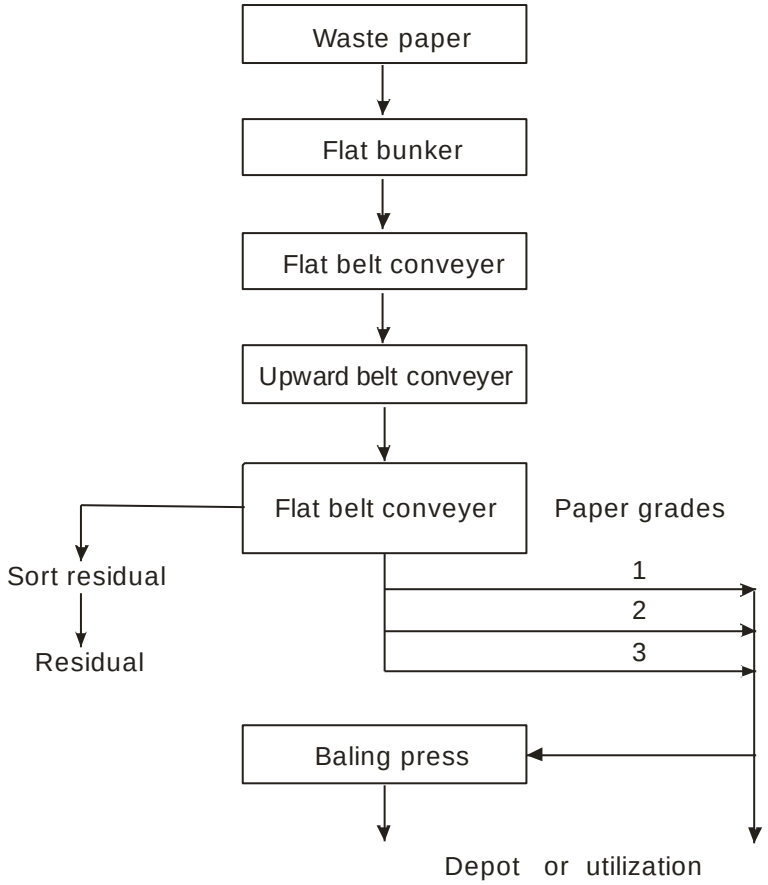

Figure 3. Sorting the waste paper [8]

When sorting distinguish :

a. positive sorting
b. negative sorting

Pozitive sorting – off conveyor belt for sorting to take different kinds of waste paper and inserted into a separate container (bunkers). Impurities and wastes remain on the band and end up in the waste container. Separated grades of recovered paper and board are pressed for transport to paper mill.

Negativ sorting – off conveyor belt are removed dirty paper and other impurities and inclusions, and clean paper is most often directly leads to the press for paper.

Negative sorting applied where the collected waste paper is homogeneous and good quality. In this case additional sorting is not necessary. (e.g. waste paper from shopping centers)

4.1. SORTING COSTS

For sorting and sorting costs are in addition to the monthly amount also important:

- a homogeneous of waste paper
- the type and quantity of inclusions
- the difference in price of certain types of waste paper
- sorting costs (depreciation, energy, labor, maintance)

Sorting as an activity and the cost can be economically justified by the increased surrender value of collected waste paper, which is sorted by grades. In Bosnia and Herzegovina is the most present packaging waste paper, while the share of "expensive" grades of of recovered paper and board rather small.

Table 6. Percentage composition of waste paper in BiH, price from 2009

(source EUWID)

Nr.	Grades	Description	Share	Price	Share in tone
1.	1.04.	Supermarket corrugated paper and board	90,0 %	26,1 €/t	23,5 €/t
2.	1.11.	Sorted graphic paper for deinking	2,5 %	49,2 €/t	1,2 €/t
3.	2.01.	Newspapers	2,5 %	56,7 €/t	1,4 €/t
4.	2.06.	Coloured letters	5,0 %	19,2 €/t	1,0 €/t
average value of tone waste paper					27,1 €/t

Qualitative is significantly different composition of the collected waste paper in Bosnia and Herzegovina and Germany. The expanded system of collecting waste paper in Germany, which is usually individualized, as a result of a higher proportion of valuable grades of waste paper, after sorting. In the following table is visible "increase" the value of the collected papers after its sort.

Table 7. Percentage composition of waste paper in Germany, price from 2009 (source EUWID)

Nr.	Grades	description	Share	Price	Share in tone
1.	1.01.	Mixed paper and board unsorted	100,0 %	19,2 €/t	19,2 €/t
2.	1.02.	Mixed papers and boards (sorted)	25,0 %	56,7 €/t	14,2 €/t
3.	1.04.	Supermarket corrugated paper and board	15,0 %	26,1 €/t	3,9 €/t
4.	1.11.	Sorted graphic paper for deinking	60,0 %	49,2 €/t	29,5 €/t
average value of tone waste paper					47,6 €/t

Although it can be expected to increase valuable paper in volume of collected waste paper from the above table (6), it is evident now that the expected increase in value of waste paper due to sorting is insufficient to justify an investment in waste paper sorting and its work.

5. CONCLUSION

Way of dealing with waste paper in Germany is an example of how legislation, technical capabilities and behavior of the population can increase the amount of collected and re-used waste paper, to present indicators of over 90%. [6]

The prerequisite for this is a comprehensive, optimized, collection system extended to the entire area of the state, which is due to the Regulation of Packaging is not based exclusively on market principles, but relies on the participation of all sectors of society, as economic entities and natural persons. System utilization of waste paper, as secondary raw materials should be adapted to the circumstances: the demand for and consumption of paper, amount of paper in the places of its appearance, habits and customs of the population, economic situation, traffic conditions and transportation options,

Looking at the way of dealing with waste paper in Bosnia and Herzegovina, we can compare it with the handling of the paper in Germany some 20 years ago. Of course a major influence in addition to legislation and social behavior has economic situation, gross national income or standard of living. In both middle as environmentally and economically justified way of collecting paper proved separate collection of paper, if possible, by grade of waste paper.

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UNIQUE LANDSCAPE VALUES OF SOUTH BALATON REGION, HUNGARY

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Abstract: Unique landscape values are those natural formations or man-made values which represents natural, historical, cultural, scientific or/and aesthetic significance for the local societies of particular villages and settlements. These values are not protected by national law. Surveying and management of the unique landscape values is regulated by the Hungarian Standard. Although every local authority is obliged to make the cadastre in his jurisdiction, around a third of the Hungarian municipalities have no cadastres of their unique landscape values. The launching of unique landscape values database in Hungary allowed the possibility of recording particular values, without making full cadastres. The South Balaton region includes 62 settlements, all of them having recorded unique landscape values. Up to the present a number of 2161 unique landscape values have been recorded in this area. The data sheets of these values are extremely heterogeneous varying from the very detailed to the 'symbolic filled'. As expected, higher numbers of values were registered in biggest localities of the region like Siófok, Marcali and Fonyód, but interestingly some small settlements like Kéthely, Buzsák or Táska have also high number of values. In many other small settlements only a few data sheets were completed. The majority of the unique landscape values registered have historical or religious interest, but the number of different buildings is high, too. The most unrepresented are the natural formations, mainly old trees, bird nesting places and remains of native habitats. As a conclusion, the situation of South Balaton region referring to unique landscape value surveying is optimal, but it needs revision and completion in the future.

Keywords: Unique landscape values, cadastres, South Balaton

LIFE CYCLE ASSESSMENT OF POLYESTER FABRIC - ITALIAN CASE STUDY

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Abstract: The purpose of this study was to increase awareness of the environmental impacts associated to fabrics for home. The textile industry is a complicated manufacturing industry because it is a fragmented and heterogeneous sector dominated by small and medium-sized enterprises. The inventory (LCI) has been obtained by considering a tissue in PET (from cradle to grave) produced by an Italian company, some processes occur in other companies in Italy and abroad. The environmental impact has been studied by applying the principles of life cycle assessment (LCA) methodology. Life cycle assessments provide useful information on quantities of energy and resources consumed and emissions associated with the production systems. The calculations have shown that the consumption of energy is the most critical point, then, improvement interventions need to be made here. The environmental impact of each process was analyzed by the method RECIPE. The dyeing process uses so greater the water resource, while the process with high environmental load in general is the production of yarn PET.

Keywords: life cycle assessment, textile industry, environmental impact, RECIPE

ENVIRONMENTALLY FRIENDLY COMPLEX SULPHIDE-BARITE ORE TREATMENT BY LEACHING IN FERRIC CHLORIDE SOLUTION

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Abstract: The results of research on the leaching process of complex sulphide-barite ore were presented in this paper. The leaching process was carried out in a laboratory autoclave by ferric chloride solution. Considering that those minerals are represented in complex structural-textural relationships, it is not possible to extract lead, zinc and copper minerals from ore by flotation methods. The obtained results confirmed possibility of the ore processing directly, by chemical methods.
The effect of temperature, time and oxygen partial pressure on the lead, zinc and copper dissolution was studied. The maximal leaching degree was achieved at 100 °C and amount of 91.5 % for Pb, 96.1 % for Zn and 60.7 % for Cu). Leaching at temperatures above 100 °C is impractical.

Keywords: autoclave, ferric chloride, leaching, sulphide-barite ore

1. INTRODUCTION

Non-ferrous metals and iron usually appears in a form of sulphide complex ores. The large deposits of complex ores may contain chalcopyrite, sphalerite, galena and pyrite in disseminated form with complex mineralogical composition and fine grained structures. These minerals are generally separated from each other by flotation and treated by conventional pyrometallurgical processes. Sometimes, when it is difficult to prepare flotation concentrates of the individual minerals, then it is easier to prepare bulk concentrates [1].

Hydrometallurgical processes offer great potential for treating complex sulphide concentrates, resulting in increased metal recoveries and reduced air pollution hazards. Ferric and cupric ions, bacteria, oxygen, and other oxidants have been used as leaching agents of sulphide in sulphate and chloride media under atmospheric or pressure leaching conditions [2-18].

Ferric chloride is one of the most important oxidative agents in leaching process. The oxidation potential of ferric chloride leaching system results in elemental sulphur as one of

the major by-products, a form generally more acceptable environmentally than the sulphur dioxide from pyrometallurgy. The leaching of metal sulphide minerals in chloride media is a subject of interest and many articles have been published [10-16]. This studied indicated that the ferric chloride solutions could rapidly, but unselectively leach valuable metals such as copper, zinc and lead from sulphide minerals, leaving the bulk of the pyrite and sulphur. The reaction mechanism of complex copper-zinc-lead sulphide concentrate leaching in ferric chloride solution may be described by (1)

$$MeS + 2FeCl_3 = MeCl_2 + 2FeCl_2 + S° \quad (1)$$

where Me is Cu, Zn or Pb. Oxidizing agents such O_2 or H_2O_2 may be used for oxidation of ferrous ions formed through reaction (1) [17,18].

The leaching of sulphides by ferric chloride is governed by parabolic kinetics caused by progressive formation of a compact layer of elemental sulphur on the solid/liquid interface. The leaching process is slow under normal temperature and pressure. Previous results showed that after an initially rapid reaction period the dissolution rate decreases and reaches a steady state. During this steady period the development of a porous layer of elemental sulphur at the surface limits the reaction.

Besides the genesis of sulphide minerals and reaction conditions, the kinetic parameters of leaching are also dependent on the morphology and compactness of the sulphur layer [11]. The determination of the optimal leaching speed is thus tha major object in this study, because the values of leaching rate published in different paper and especially those obtained by investigations with natural concentrates exhibit great scatter. Dutrizac [14] observed significant differences ~ 50% in leaching rates of eleven chalcopyrites from different localities under various leaching conditions. The scattering results can be mainly attributed to admixtures and impurities as well as to the influence of real structure of the investigated material.

The purpose of this study is to investigate possibility of complex sulphide ore leaching by ferric chloride solutions in autoclave.

2. EXPERIMENTS

The leaching study was conducted in a five-liter stainless steel autoclave, which enabled maximal working temperature of 250°C and pressure of 5.5 MPa (figure 1). Also, this apparatus provided hermetic conditions, heating at constant temperature, addition of oxygen and mechanical mixing.

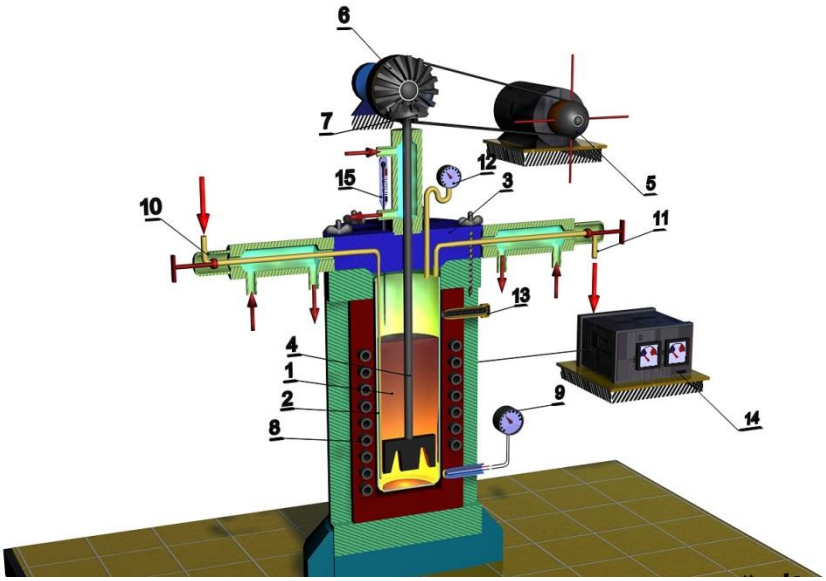

Figure 1. Schematic of the experimental set up for the high-pressure leaching: 1-chamber, 2-pressure vessel, 3-reactor cover, 4-agitator, 5-electromotor, 6-pulley, 7-gear wheel, 8-heater, 9-thermoragulator, 10 and 11-valves, 12-pressure gauge, 13-pressure relief valve, 14-control panel, 15-thermometer

The calculated volume of $FeCl_3$ and the solid sample of the ore were put into the reactor. Then, the autoclave was closed up, and heated up to the selected temperature. When the temperature was reached, the stirrer was turned on and that moment was taken for beginning of leaching. At the expiration of definite leaching time, the autoclave was turned off, cooled off, opened and solution sample was taken for chemical analysis, which was carried out with AAS (Type PERKIN ELMER).

3. RESULTS AND DISCUSSION

3.1 CHARACTERIZATION OF COMPLEX SULPHIDE-BARITE ORE

In order to investigate in detail the characteristics of the ore, its chemical and mineral composition and particle size were determined.

For experimental studying of leaching process, the complex sulphide –barite ore from the "Bobija" deposit was used, and comminuted to 75 μm particles. Chemical composition of the ore is presented in table 1.

Table 1. Results of chemical analysis of complex sulphide-barite ore

Element	Fe	Zn	Pb	Cu	Ba
WT, %	26,84	4,57	4,95	0,84	4,34

The mineralogical researches included both, qualitative and quantitative mineralogical analysis. Correction of quantitative mineralogical analysis was performed using results of chemical analysis. Participation of the most dominant minerals in the ore mas is presented in table 2.

Table 2. Quantitative mineral composition of the complex sulphide-barite ore

Minerals	WT, %
Pyrite	57,52
Sphalerite	6,82
Galena	5,72
Tetrahedrite	1,84
Barite	7,38
Quartz	17,90
Others	2,80

The microscopic tests were carried out using a Carl-Zeiss Jena, JENAPOL-U, reflected- and transmitted-light microscope, and the "OZARIA 2.5" microphotography and quantitative mineralogical analysis program. The results are shown in figure 2 and figure 3.

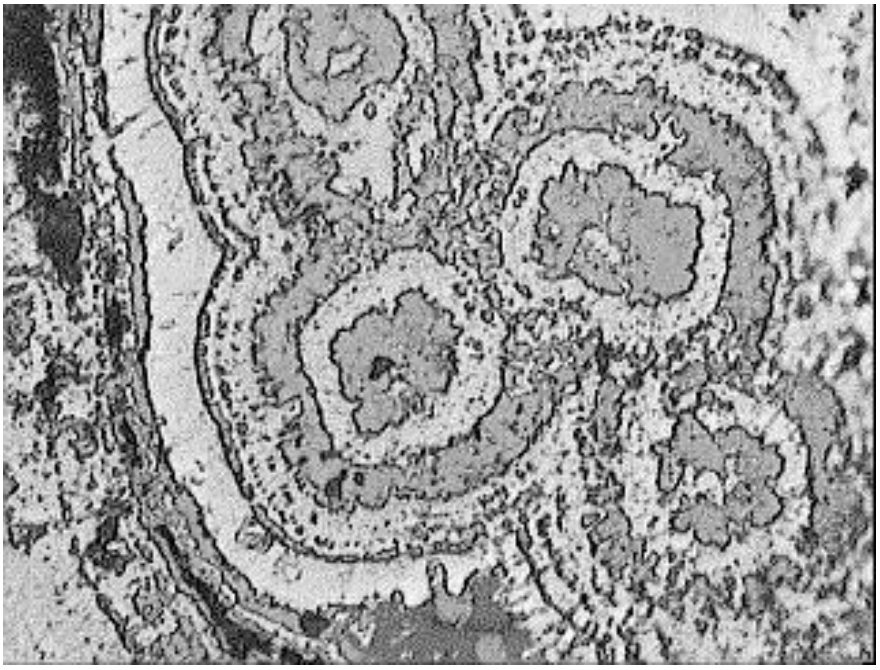

Figure 2. Compact pyrite ore, with rhythmic colloform textures cemented by galena (gray) and sphalerite (dark gray).

[On air, 50x, N II]

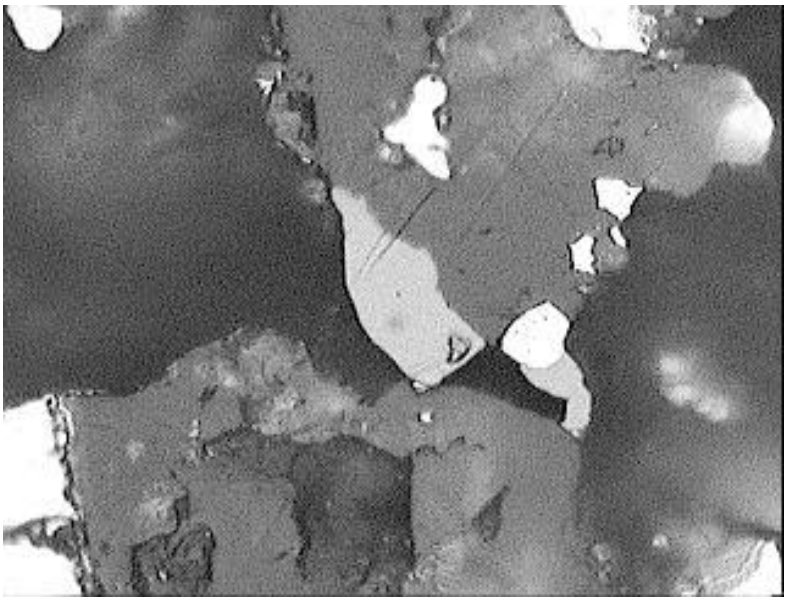

Figure 3. Aggregates of sphalerite (grey) with tetrahedrite (light grey), galena (white - soft) and pyrite (white - hard) in barite base (dark grey). [In oil, 100x, N II]

The obtained microphotographs confirm the presence of the following minerals: pyrite, sphalerite, galena, tetrahedrite, barite and quartz. Pyrite, being the most prevailing mineral of the sulphide ore, is intergrown with all other mineral components. Therefore, it is not possible to extract lead, zinc and copper minerals from complex sulphide-barite ore by flotation process.

3.2 LEACHING TESTS

In all experiments, the following conditions were constant: phase ratio (S/L) 150 g ore/dm^3, 1.0 mol/dm^3 Fe^{3+} and stirring speed 400 min^{-1}.

The influence of temperature, time and oxygen partial pressure on the leaching degree of lead, zinc and copper, was studied. These parameters varied as following:

- temperature (°C): 80, 100, 120 and 150;
- time (min): 60 and 120;
- oxygen partial pressure (MPa): 0.0 and 1.1.

3.2.1 Effect of temperature

The influence of temperature on the leaching degree of lead, zinc and copper, was determined in a temperature range from 80 to 150 °C, under constant all other parameters. Obtained results are shown in table 3.

Table 3. Effect of temperature on leaching of lead, zinc and copper

Temp., °C	$[Fe^{3+}]$, mol/dm^3	Time, min	$P(O_2)$, MPa	Leaching degree, %		
				Pb	Zn	Cu
80	1.0	60	0.0	86.3	91.5	52.3
100	1.0	60	0.0	91.5	96.1	60.7
120	1.0	60	0.0	75.5	83.6	54.3
150	1.0	60	0.0	82.2	82.9	59.4

Experimental results (table 3) show that the quantity of leached lead, zinc and copper increases when the temperature is increased from 80 to 100 °C, reaches a maximum at 100 °C, thereafter it falls. The reason for leaching decrease at higher temperatures is melting of elemental sulphur, which is formed during the leaching (1) and melts at 119 °C. The molten sulphur generates a viscous layer, surrounding the ore particle, which is the limiting factor for diffusion of leaching reagent.

Leaching at temperatures above 100 °C does not have practical importance.

3.2.2 Effect of leaching time

The effect of time on the leaching degree of the particular components was studied at 120 °C. The experimental results are given in table 4, where it can be seen that the increase in time does not affect significantly the transition of lead, zinc and copper from the ore to the solution. Therefore, it is not necessarily for leaching to last more than 60 min.

Table 4. Dependence of leaching degree on time

Time, min	Temp., °C	$[Fe^{3+}]$, mol/dm^3	$P(O_2)$, MPa	Leaching degree, %		
				Pb	Zn	Cu
60	120	1.0	0,0	75.5	83.6	54.3
120	120	1.0	0,0	78.2	84.5	56.9

3.2.3 Effect of oxygen partial pressure

The influence of oxygen on the leaching degree was studied by increase of oxygen partial pressure from 0.0 to 1.1 MPa. The results obtained at 120 °C are shown in table 5.

Table 5. Effect of gaseous oxygen on leaching of lead, zinc and copper

$P(O_2)$, MPa	Temp., °C	$[Fe^{3+}]$, mol/dm^3	Time, min	Leaching degree, %		
				Pb	Zn	Cu
0,0	120	1.0	60	75.5	83.6	54.3
1,1	120	1.0	60	85.6	90.7	60.3

The injection of oxygen into the autoclave, favorably affects the leaching of lead, zinc and copper (table 5). It can be explained by Fe^{2+}-ions oxidation with oxygen to Fe^{3+}-ions. In this way, the regeneration of Fe^{2+}-ions is achieved, what contributes the leaching.

4. CONCLUSIONS

Mineralogical researches of the complex sulphide-barite ore showed the presence of the following minerals: pyrite, sphalerite, galena, tetrahedrite, barite and quartz. The most dominant mineral component is pyrite. The individual minerals present in the ore are very fine-grained and intergrown. The complex structural-textural relationships of the useful minerals do not make possible the classical flotation of this ore, or some other concentration.

The obtained results in this investigation demonstrate the possibility of the sulphide-barite ore processing by leaching with ferric chloride solutions, because of the significant leaching degree achievements, especially for zinc and lead.

The effect of temperature was studied in the temperature range from 80 to 150 °C. The maximal leaching degree was achieved at 100 °C (91.5 %Pb, 96.1 %Zn and 60.7 %Cu). Leaching at temperatures above 100 °C is impractical.

The influence of time on the leaching degree of lead, zinc and copper is weak.

The injection of oxygen into the autoclave is favourable, i.e. intensifies dissolution of lead, zinc and copper.

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NETWORKING SMES FOR THE ENVIRONMENT – THE ROLE AND SIGNIFICANCE OF SUSTAINABLE DISTRICT LOGISTICS APPROACH

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Abstract: The sustainable technologies, i.e. novel solutions in the field of environmentally friendly product and process design, are crucial for operationalization of the sustainable development concept. However, organizational issues, coupled with societal concern and based on sound economy, are of no less importance in attempt to reach sustainability goals. Designing eco-industrial networks is a demanding endeavor that requires integration of many fields of structural and social design as well as responsible decision-making. To reduce the intensity of material flows and achieve sustainable use of resources, some sort of complex integration would be necessary. Foreign experiences reveal close relationships between logistics issues and several policy fields, such as: spatial planning, formation, employment, social services, environmental protection and corporate responsibility. Environmental clusters of Small and Medium Enterprises (SMEs) are particularly significant as a units that might become carriers of eco-industrial networking concept. However, all regional incentives must rely on proper logistics that should also take into account all the elements of sustainability concept. Achieving the objectives of sustainable development require simultaneous advancement in societal development, economy and environmental protection. One such approach, Sustainable District Logistics (SDL), known for almost a decade but not widely recognized in the West Balkans area, might provide significant support in attempt to sustainably integrate often geographically scattered SMEs into functional eco-industrial units. This paper strives to highlight the role, significance and procedure of implementation of the SDL approach in the context of eco-industrial networking for sustainability.

Keywords: Environmental Networks, LCA, SMEs, Sustainable District Logistics

1. INTRODUCTION

So called linear model of industrial development has proven to be in conflict with very concept of sustainability which is supposed to assure fulfillment of societal requirements without compromising the ability of future generations to meet their own needs. The results of ever increasing industrial activities are depleting of natural resources, pollution and waste buildup. Population growth boosts consumption and, consequently, enhance production of consumer goods and energy use. In the last couple of decades, several paradigms, frameworks, strategies and tools have been developed in order to meet sustainability goals,

one of which is Zero emission model. Inspired by the nature, it envisages closed loop material flows at reduced emission, with minimal consumption of material and energy. It seems that Zero emission concept is the appropriate answer to sustainability challenge. However, it requires substantial changes in technologies, organization, logistics and consumption models.

Sustainable technologies should require less energy, fewer limited resources, favor reuse and recyclability, operate with reduced emissions and decreased environmental impact trough all phases of their life cycle. However, in order to achieve and maintain sustainable performance, it is essential to have established an appropriate management system [1]. In addition, environmental risk assessment should be performed before and during implementation of every significant technological advancement. Appropriate legislation is of crucial importance since it can support and accelerate the process of sustainable development in industrial sectors. Technology aspects of sustainability comprise (but are not limited to) waste minimization, effective energy usage, pollution prevention, waste treatment, recycling, solid waste management and renewable energy harvesting. The renewable energy plays an important role in supporting sustainable technologies and sustainability in general. A sustainable society as a whole, must be energy efficient and have to rely on sustainable industry driven by sustainable technologies.

The problem of waste management and reduction, has been handled by three chronologically developed concepts: End-of-Pipe Pollution Control, Cleaner Production and the Zero Emission concept. The first one, End-of-Pipe (i.e. treatment or control of already generated wastes and/or emissions) is considered obsolete and without capacity to adequately address sustainability goals. Cleaner Production concept comprises strategies, methods and tools to decrease waste generation and recover material along production lines, which provide more efficient use of resources at reduced pollution. The Zero Emission concept, however, plead to be the final solution to waste management and pollution control issues. It obviously comprise the previous two concepts, especially Cleaner Production one and, therefore, clear distinction between the two latter is not always possible. Also, there are several similar, overlapping or complementary concepts and strategies to Zero Emission, such as: eco-industrial clusters, eco-industrial parks (eco-industrial networks), industrial symbiosis and circular economy [2]. While each of them possess certain specifics, the common denominator is attempt to meet sustainability goals by targeting environmental issues at the source.

The Zero emission model, presupposes that the amount of generated wastes approaches technological minimum, because almost all material flows are diverted toward complementary processes. The concept relies on assumption that environmental protection could be achieved at no extra costs, but with economic benefit for the eco-friendly industries. The resources should be provided locally/regionally wherever possible, and those should be used efficiently.

The vast majority of technological processes are energy intensive. Reducing energy consumption while protecting the environment and reducing the waste, have become imperative to every environmentally conscious manufacturer. Increased energy efficiency, rational energy use and recovery of excessive energy from the process are three the most important ways to reduce operational costs. Utilization of a portion of waste stream as secondary fuel and applying renewable sources are the two common approaches that help to reduce costs and to preserve the environment. Energy efficiency increase require

comprehensive energy consumption analysis that rely on material and energy balances. The savings can be achieved by optimal use of each individual device or at system level as a whole. Therefore, it is necessary to explore each production unit, and to detect sources of potential losses. Heating, cooling, air conditioning, insulation and lighting systems are widely present in almost every industrial sector. However, there are also certain industry specific operations, some of which significantly contribute to consumption and pollution performance of an industrial unit.

The sustainable technologies, i.e. novel solutions in the field of environmentally friendly product and process design, are crucial for operationalization of the sustainable development concept. However, organizational issues, coupled with societal concern and based on sound economy, are of no less importance in attempt to reach sustainability goals. Designing eco-industrial networks is a demanding endeavor that requires integration of many fields of structural and social design as well as responsible decision-making.

2. SUSTAINABLE LOGISTICS AND ENVIRONMENTAL NETWORKS

To reduce the intensity of material flows and achieve sustainable use of resources, some sort of complex integration would be necessary. This ambitious goal could be reached by several diverse strategies and array of coherent activities, such as:

- promoting new models of production and consumption and favoring local networks and supply chains
- promoting and supporting the reuse and recycling of materials
- extending the longevity of consumer goods
- dematerialization (substituting the use of material goods by services)
- providing alternative ways to access goods and services (trough e-commerce instead of physical access)
- fostering territorial perspective in attempt to build industrial symbiosis through clusters, bundling and other forms of co-operation

Foreign experiences reveal close relationships between logistics issues and several policy fields, such as: spatial planning, rural development, formation, employment, social services, corporate responsibility, etc [3]. There is a wide range of relationships that might exist between the participants in an e.g. cross-border territorial area or an extended production chain. Different interests, but also different expertise and professional capacities should be put together for synergetic effects.

The environmental issues that affect and/or are affected by the regional logistics and supply chain logistics (figure 1) are as follows:

- the resources use (energy consumption; waste generation; waste treatment facilities and available technologies allocation; energy produced by renewable sources; the investments for the environmental protection and site remediation)

- the land use (concentration of industrial, urban, rural and protected areas; population density; *km* of rail/road infrastructure in the region)
- the environmental impact (concentration of greenhouse gases and other pollutants, exposure to noise, accidental spill outs of chemicals)

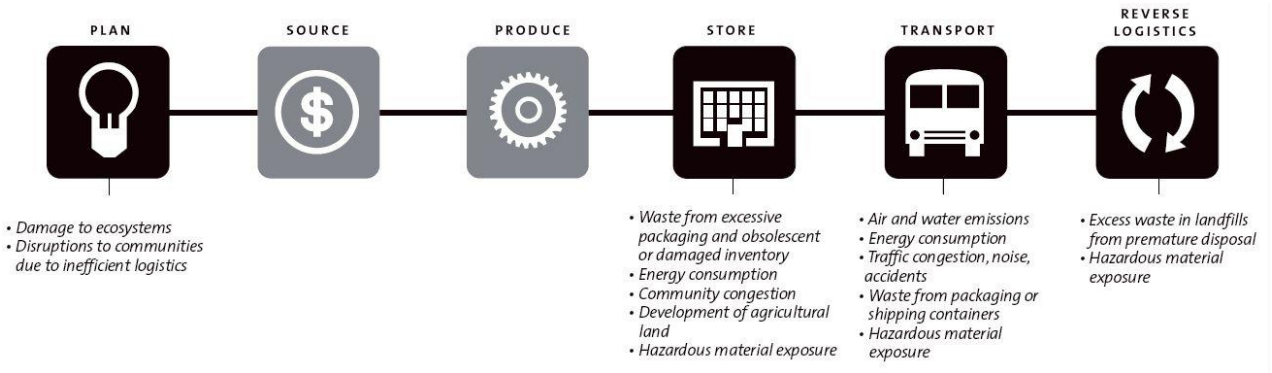

Figure 1. Environmental and Social Impacts of SCL Activities (Model adapted from SCOR, the Supply Chain Council's Supply Chain Operations Reference model) [4]

Sustainable logistics face similar external pressures as Green Supply Chain does. Paquette claims that "supply chains must respond to environmental pressures from four sources. Resource availability and regulatory pressures place physical, legal and economic constraints on supply chain management, while consumer demands and the ethical responsibilities of corporations define desirable behavior in the market and within those constraints..." [5]

Sustainable District Logistics (SDL) defined as "the integrated management of materials, energy and information flows in a cohesive territorial system to improve access to goods, services, people and places, maintaining and renewing the available resources (human-made, human and natural)" [6]. Regional aspect emphasized in this approach have been denoted as a change in paradigm from some previous, yet significant definition of logistics, as the one by the Council of Logistics Management (ECMT/OECD, 1997) which describe it as a "process of planning, implementing and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory from point-of-origin to point-of consumption for the purpose of conforming to customer requirements".

In 2004, the European Network for Sustainable District Logistics (ENSDL), an international non-profit association, has been established with the aim to promote the Sustainable District Logistics (SDL) approach and tools in the analysis and improvement of the logistic of a specific region, with a particular consideration to the burdens associated with logistics operations from an environmental, social and economic aspect.

Companies taking part in an eco-industrial networking (EIN) initiative recognize residuals and wastes as products they have no idea how to use themselves or sell on open market, but that might be used by some compatible manufacturer or business elsewhere. As a business community joined in an EIN they couple their manufacturing and creative powers to optimize use of materials thus minimizing the wastes. The by-products that can't be treated on the spot

could be warehoused and when collected in tradable quantities shipped to some external customers. That way an EIN becomes part of a regional scale by-product exchange [1].

There is no fast recipe on how to manage the Sustainable District Logistics (SDL) methods and tools in order to carry out a region-specific projects of industrial symbiosis. However, general instructions and recommendations considering the specific issues should be put in the local context, and applied accordingly. There are numerous questions to be answered in order to facilitate network integration, such as:

- How to combine different interests and points of view?
- How to tackle local initiatives, territorial aspects and local context in attempt to formulate appropriate actions?
- How to monitor and measure material flows, logistic and business performances at a regional level?
- Where to place nods and hubs to optimize material collection and flow inside the network?
- Which collaborative instrument to apply for supporting evaluations and decisions?

There are numerous aspects of design that should address several areas of concern that spreads from protection of natural systems, energy efficiency, industrial metabolism (i.e. flow of material, energy and fluids trough the system), all the way to issues of integration into local community. Basic presumption is that an industrial network should fit into its natural surrounding in such a way that environmental impacts are minimized while operational costs decrease as a consequence of progressive system design.

Sustainable District Logistic comprises: a coherent method to analyze and identify the local stakeholders to be involved; an iterative process for the design of innovative actions that regard territorial and business planning; an approach to carry out the initial design activities; a set of indicators that can be usefully adapted to a regional specifics; a series of procedures to identify the district logistics flows and business performances (questionnaires, data processing, estimations and benchmarking); a methodology to perform workshops that help the local stakeholders to arrive at a common expectations of the future. The logistics within quality cycle is a recurrent procedure that comprise a number of environmental concerns, as described in the figure 2:

Local stakeholders should be both among initiators and the main beneficiaries of the creation of a new territorial pact based on partnerships, common decision making processes and a sustainable district logistics strategy that integrates the environmental, economic and societal resources of a region. An analysis of the local stakeholders should be made at the beginning of a SDL based industrial symbiosis project, to reveal different interests and points of view. The lists of stakeholders should comprise:

- the public sector (local governments and regional authorities),
- the industrial sector (manufacturers and suppliers, SMEs, larger companies and logistics operators),

- environmental organizations, social service providers and representatives of the civil society

As for stakeholder involvement in the project, the following recommendations apply:

- a wide spectrum of stakeholders must be addressed when the purposes of a SDL project concerns a relationships between logistics issues and policy fields of territorial planning
- a core group of stakeholders should be identified when a SDL project needs to be carried out in a short time,
- alliance with public authorities is always desirable, since it should help to overcome obstacles.
- it is necessary to combine different expertise, professional roles and interests

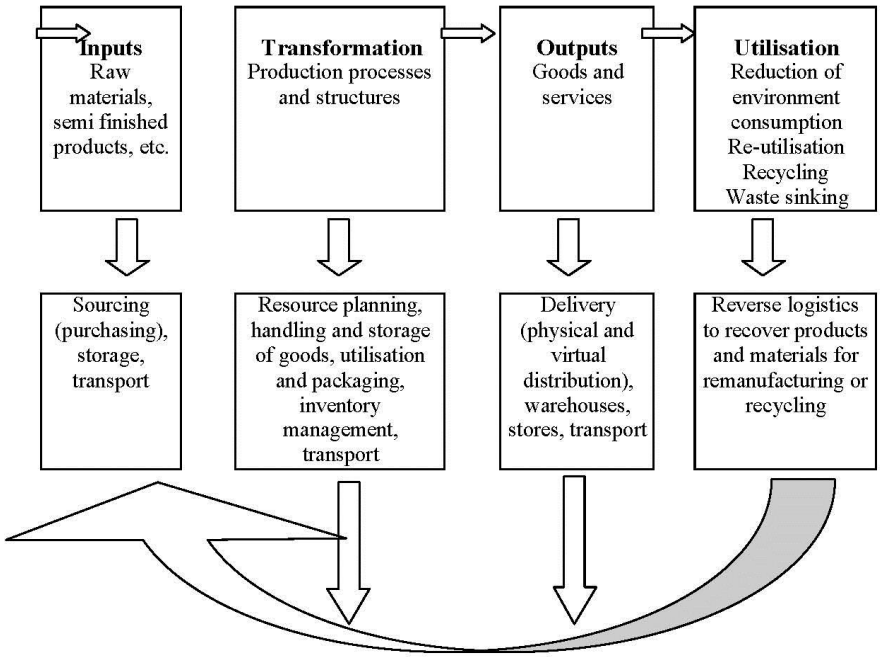

Figure 2. Logistics within Quality Cycle, Source: INNESTO Project [6]

Eco-industrial network integrators should guarantee a fair access of all it's participants to all the services and the instruments existing in the system, and they should:

- facilitate stakeholders participation in the project
- improve capacity and awareness of all participants/stakeholders to carry out required tasks and roles.

- favor exchange of best practices and experiences among participants inside and outside the network
- favor solidarity among participants and local communities
- adjust services and instruments according to local needs and distinctive territorial characteristics
- provide training and consultancy to develop the capacity of all the participants to utilize available instruments and tools
- disseminate the industrial symbiosis approach through the activities of the network

3. THE SDL APPROACH

There are three recognizable phases in preparing a SDL based project:

- Local Context Analysis – it provides hypotheses of innovative options to improve the regional logistics system
- District Logistics Analysis - integration of the hypotheses from the previous step with those concerning analyzed logistics flows and local business performances
- Local Scenario Workshop - final integration and validation of the LCA and DLA hypotheses through a coherent vision of the future developments

The Local Context Analysis (LCA) aims to reveal the possible interrelationships between the current players and logistics, the expected trends of logistics and other significant features of each regional system (environmental, societal and economic).

In the District Logistics Analysis (DLA), flows (material, energy, information, human resources) are explored alongside business performance (logistics costs, organizational networks). DLA elaborates and integrates results that are correlated with the LCA hypotheses by using data collection techniques such as questionnaires [3, 6]. Questionnaires should be tailor made according to the particular features of the explored local context, but most of them should include:

- The flows (materials, products, energy, information, human resources)
- Logistics management and related costs:
  - Inputs (sourcing, storage, transport)
  - Transformation (handling, storage, use, packaging, transport)
  - Outputs (distribution; warehousing; transport)
  - Use of products (discharge of waste and auxiliary materials during the life cycle of a product, all the way to reduction, reutilization, or recycle of its remains)
- Business organization and costs (performance, economic assets and liabilities)

It is noticeable that logistic management, if based on sustainability principles, closely follows the Life Cycle Stages, as applied in product environmental impact analyses. This observation gives impression that both the personnel and channels for disseminating Life Cycle Management (LCM) concept might be suitable to deal with dissemination of SDL approach.

Diverse aspects are taken into consideration while applying SDL approach and they regard the readiness and capacity to foster a new social and territorial deal towards SDL. Those are clustered in three groups:

- Human Resources (the individuals and their knowledge, skills and competencies, entrepreneurial creativity, perception of new circumstances and opportunities, integration of social and technical skills, etc.)
- Social Capital (networks, associations, social cohesion, multiculturalism, capacity to adopt common vision of local development)
- Institutional Capital (organizational capacities, autonomy in decision-making processes, effectiveness of support services, distribution of responsibilities, access to information, competences, collaboration)

The SDL approach and tools are flexibly adaptable to different local contexts since the main goal is to establish synergy and unity of diverse players and aspects (economic, societal and environmental). Some of the typical fields of action in the framework of SDL are:

- making sustainable accessibility plan
- building virtual networks for increasing transport efficiency in a region
- developing regional and local logistics among small and medium sized enterprises
- providing logistics related to renewable energy production and supply
- establishing cross-border cooperation between public and private actors in a regions, where applicable.

Very important issue is level of integration into the local community. Eco-industrial network (EIN) could provide a portion of its utility services to neighboring communities, support educational system by providing professional training and courses, support housing of employees and others from local community, etc. A successfully developed EIN could also act as a business incubator, to support new business initiatives or expansion of existing ones. While some of the local companies might opt to join EIN, others could provide services to member companies, from catering to parcel delivery or maintenance. Thus, EINs provide great opportunity for development of public–private partnerships (PPP) inside and outside the network [1]. This is particularly important since the PPP is considered the most promising business organization model for transition countries of WB.

4. THE SCOPE AND SIGNIFICANCE OF THE LOGISTICS AS PERCEIVED BY THE SMES

Most of the SMEs do not seem to be aware of the importance of the logistics, let alone its impact on the environment and sustainable development issues. A part of the problem might be in their inability to comprehend the scope of the logistics. Due to limited body of literature related to sustainable logistics of SMEs in WB area, there are no scientific evidences for this observation based exclusively on authors' experience.

Most of the researches did not examine the logistics interpretation of the small and medium-sized enterprises [7]. However, 90% of SMEs examined by Vízhányó [2006] believed that logistics meant exclusively transportation and warehousing; 55% of them regarded purchasing as the start of the process and delivery to the customer as its end [8].

Certain researches explored the level of significance of the logistics as perceived by the companies. In most cases, respondents considered logistics important, and they assigned it great significance [8]. The Finish survey of 2006 revealed that medium-sized and smaller enterprises were aware of the relevance of logistics [9]. In another Finnish research from 2008, large companies and medium-sized enterprises considered the role of logistics more important than their micro- and small counterparts. The reason was found to be growing complexity of the supply change concurrent with the increase in company size. The biggest difference was found among large companies and micro enterprises in terms of the profitability effect of logistics [10] Gritsch noticed that "the company sets out to deal with logistics when the external circumstances force it to do so or when the size of the company creates the possibility of cost reduction by logistics" [11]. However, the surveys did not provide a clear answer on the company size above which the small and medium-sized enterprises started to reflect on logistics [8,11].

5. RISKS WITH DEVELOPMENT OF AN EIN

Designing an eco-industrial network is a demanding endeavor that requires integration of many fields of structural and social design as well as responsible decision-making. Success depends upon achieved level of collaboration among all the players. Lack of ability to overcome focus on narrow interests within these groups and between them is a major risk, especially in vulnerable economies of WB [2].

The main obstacle is the fact that some of benefits that come out of an EIN may only become noticeable when savings are calculated in a longer time frame. Projects with a longer payback period are usually less likely to appear attractive for investors, and thus require extra effort when explaining the overall benefits. It is always advisable to involve in development process some public entity supported by local government. Public investors usually possess instruments to handle additional costs and to justify slower payback period by long term societal benefits that are expected from an eco-industrial establishment [1].

SMEs in the region of West Balkans are not used to share facilities and services. Therefore they might be hesitant to rely on interdependence that involvement in an

environmental network creates. Even more difficult might be to establish collaboration between companies headquartered in different countries with very different cultures of doing business. It could be the issue if logistic analyses show that cross-border cooperation is the most favorable solution in terms of economy and environmental protection.

6. CONCLUSIONS

The most industrial networks include several small and medium enterprises (SMEs). In most of the cases they get together to benefit from shared resources, logistics, services and infrastructure, but they are usually unable to invest in new technologies that might improve their environmental performance. Therefore, providing adequate financial support and strategies is necessary for a dynamic development of operations.

Development of regional eco-industrial initiatives has been recognized as promising approach to deal with environmental issues in transition societies of Western Balkans. There is a threat that irresponsible technology transfer might provoke giving advantage to end-of-pipe technologies instead of creating sustainable front-end solutions for environmental burden. In such a circumstances, creation of eco-industrial networks that consist mainly of SMEs would be compromised. However, there are reasons to believe that preventive and comprehensive solutions such as Industrial Ecology, Cleaner Production and Sustainable Manufacturing and Logistics would prevail. Common environmental legislation of EU would most probably curb obsolete strategies that confront establishing EIN in WB transition countries.

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INSURANCE AND ENVIRONMENTAL PROTECTION

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Abstract: Respecting human rights is often connected with environmental protection. This is mostly true for human rights to life and health, as well as all other human rights of the social, economic, cultural and political fields. All human rights can be fully protected only in a healthy environment. Insurance is a business, service business that protects the individual and his property as a result of the events of many dangers, It is an institution which compensated the damage caused in the society, its economy or in humans, due to the effects of destructive natural disaster or accident. The paper points the importance of timely implementation of preventive and quality of insurance and reinsurance in the field of environmental protection as a key issue of social development.

Keywords: environmental protection, human rights, insurance

A COMPARATIVE REVIEW OF PYROMETALLURGICAL AND HYDROMETALLURGICAL PROCESSES OF COPPER PRODUCTION FROM E-WASTE BASED ON ENVIRONMENTAL AND ECONOMIC PARAMETERS

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Abstract: A comparative review of the main characteristic of pyrometallurgical and hydrometallurgical copper production from electronic waste was given in this paper. These processes were compared according to following environmental and economic factors: gass emission, solid waste generation, wastewater discharge, energy consumption and mass balance, and production costs. Based on these parameters, it was concluded which copper production process will be more acceptable process in the future. Taking into account all the facts which favour hydrometallurgical processes, it can be concluded that hydrometallurgy will displace inefficient pyrometallurgical processes for obtaining copper from electronic scrap in future.

Keywords: copper production, environment, comparation, process

1. INTRODUCTION

During the seventies and mid-eighties of the last century, the main method for metal recovery from the e-waste was melting in furnaces for melting metals in existing smelters, copper or lead. Since the mid-eighties, this trend is changing in favor of the hydrometallurgical treatment of electronic waste [1-3].

Metal recovery from the electronic waste has three main phases [4]: (a) *selection* (selective dismantling and separation of hazardous or valuable components for special processing is a necessary step in the recycling of electronic waste); (b) *enrichment* (the application of mechanical and / or metallurgical treatment in order to increase the content of useful components and prepare materials for the refining process); and (c) *refinement* (re-obtained materials were purified metallurgical adequate procedures to regain its original use value).

The metal fractions separated from e-waste during preprocessing can be further processed using hydrometallurgical, pyrometallurgical, electrometallurgical, biometallurgical processes, and their combinations. The hydrometallurgical and pyrometallurgical processes are the major routes for processing of e-waste. These routes may be followed by

electrometallurgical/electrochemical processes (for example electrorefining or electrowinning) for selected metal separation and recovery. Currently, there are only limited laboratory studies for e-waste processing through biometallurgical routes, e.g., bioleaching of metals from e-waste. Nevertheless, this route has a potential for further development [5].

Pyrometallurgy, or the use of heat for the treatment, includes smelting and roasting. It involves heating in a furnace at temperatures above 1500°C to convert waste to a form that can be refined. The oxide waste is heated with a reducing agent, such as carbon in the form of coke or coal; the oxygen of the metal combines with the carbon and is removed in carbon dioxide gas. The waste material in e-waste (non-metallic parts) is called gangue; it is removed by means of a substance called a flux which, when heated, combines with it to form a molten mass called slag. Being lighter than the metal, the slag floats on it and can be skimmed or drawn off [6,7].

Hydrometallurgy, sometimes called leaching, involves the selective dissolution of metals from their waste. It involves the use of aqueous chemicals and much lower temperatures to separate metal. Metal is recovered by electrolysis of the solution. If metal obtained from waste still contains impurities, special refining processes are required. The decision whether to use hydrometallurgy or pyrometallurgy can be seen from various concerns including environment and economy. Low waste technology solutions provide a real answer to the increasing requirements of environmental legislation. Instead of waste treatment and waste disposal, new technologies for waste avoidance are a challenge today. Such technologies should meet the demand for economical use of raw materials and an energy poor future and contribute to efficiency in industry [8-10].

Environmental regulations will be more restrictive in the future. The expenditure for waste disposal and water use as well as energy, materials and labour will increase and internal recycling processes will become indispensable tools for successful industrial operations. A low waste technology solution should always be preferred as it minimizes the threat of environmental legislation [11-12].

Low waste technology solutions can be directed towards material recycling and heat recovery which contributes to economy. Chemical treatments improve on minimizing impurity build-up, and toxic compounds may be substitutable for less harmful constituents.

2 EMVIRONMENTAL PARAMETERS

2.1 GASS EMISSION

The basic operation is the direct introduction of e-waste into a furnace mixed with a reducer and smelting agent. This operation is accompanied with strong gas emissions including: CO_2/CO coming from oxidation of carbon used as the reducer, dust of scrap metals and other components, green house effect gases like SO_2, Cl_2, HCl and NO_x, organic volatile compounds and dioxins.

The burning of waste in the presence of oxygen, especially waste with plastic and other organic material content generate toxic gases such as furans and dioxins. Such gases are carcinogenic andincrease the risk of contracting respiratory disease. Incinerators have been

found to be the largest producers of dioxins and furans. Incineration produces ash with concentrated amounts of heavy metals, such as lead, arsenic and cadmium. These chemicals are well known to cause birth defects, cancer, respiratory ailments and reproductive dysfunction among people who live near incineration plants. Beside this, incomplete combustion may generate carbon monoxide and also volatile compounds, including formaldehyde and acetaldehyde. The treatment of these gases involves large capital investments in advanced technologies and equipment.

The amount of sulfur dioxide released depends:

1. On the characteristics of the type of waste - complex ones may contain lead, zinc and nickel
2. Whether facilities are in place for capturing and converting the sulfur dioxide.

SO_2 emissions may range from less than 4 kg/t of copper to 2000 kg/t of copper. Particulate emissions can range from 0.1 kg/t of copper to as high as 20 kg/t of copper. Fugitive emissions occur at furnace openings and from launders, casting molds, and ladles carrying molten materials. Additional fugitive particulate emissions occur from materials handling and transport of ores and concentrates. The smelting furnace will generate process gas streams with SO_2 concentrations ranging from 0.5% to 80%, depending on the process used. Vapors of arsenic and mercury are also present at high gas temperatures, which required additional scrubbing for removal. Modern plants using good industrial practices should set as targets total dust releases of 0.5–1.0 kg/t of copper and SO_2 discharges of 25 kg/t of copper.

Hydrometallurgy generates some hazardous gases such as chlorine, noxious and hydrogen cyanidegases which is possible to be treated by a simple 1-3 stage scrubber system with a chemical scrubbing solution. In contrast to a furnace process, chemical process also generates wastewater. However, as the treatment of these gases and wastewater utilizes common established technology, its efficiency can be justified with much lower capital investment. No gases can escape and solvents are fully trapped atroom temperature, where it is not in position to produce dioxins or other greenhouse effects. Hydrometallurgy is more environmentally friendly, also as sulphur is presented as either a stable sulphate or elemental sulphur rather than sulphur dioxide emissions.

There are global environmental concerns to smelting activities, which spew extremely harmful pollutants into the atmosphere. Smelting with pollution control equipment is extremely expensive, which contributes directly to the high cost.

2.2 SOLID WASTE GENERATION

In pyrometallurgy, almost all waste content is burnt to ashes or carbon and leaving behind also a mixture of heavy metals. Useful materials such as plastics, which might otherwise be further recycled into re-engineering plastic are also being burnt (this is in the event that feed materials did not go through initial mechanical separation stage). Other lesser important content such as paper, ceramics, glass and fibers which could also be reused as filler or flux in certain products are also non-recoverable. It is estimated that for every three tonnes of waste that is incinerated, one ton of ash is generated. The main portion of the solid waste is

discarded slag from the smelter. This ash is very toxic, containing concentrated amounts of heavy metals and dioxins which, when buried, will eventually leach into the soil, potentially polluting groundwater.

The end product of ashes or carbon eventually ends up in landfill, while the mixture of heavy metals undergoes further segregation and refining via chemical process or smelting process. The heavy metals mixture recovered may be covered or trapped within carbon residue, which makes it more complicatedfor downstream refining. Slag requires special treatment, e.g., slow cooling, grinding, and flotation or treatment in an electric furnace to recover its copper content which represents a heavy recycling load.

By using hydrometallurgy, almost all waste components (not only heavy metals) could be segregated and recovered for further recycling or re-use. Each component refining stage could be accomplished in one process, without the need for diversion to another process. Leaching processes produce residues, while effluent treatment results in sludges which can be sent for metals recovery.

2.3 WASTEWATER DISCHARGE

Wastewater from primary copper production contains dissolved and suspended solids that may include concentrations of copper, lead, cadmium, zinc, arsenic, and mercury and residues from mold release agents (lime or aluminum oxides). Fluoride may also be present, and the effluent may have a low pH.

Normally there is no liquid effluent from the smelter other than cooling water; wastewaters do originate in scrubbers (if used), wet electrostatic precipitators, cooling of copper cathodes, and so on. In the electrolytic refining process, by-products such as gold and silver are collected as slimes that are subsequently recovered. Sources of wastewater include spent electrolytic baths, slimes recovery, spent acid from hydrometallurgy processes, cooling water, air scrubbers, washdowns, stormwater, and sludges from wastewater treatment processes that require reuse/recovery or appropriate disposal.

2.4 ENERGY CONSUMPTION AND MASS BALANCE

In terms of mass balance, smelting leads to higher loss of metals as compared to hydrometallurgy.

The main factors are: loss of metals into the slag, loss of metals on the refractories, loss of dust and high volatile products. Large amounts of fuel are required for the melting process. The route for production of cathode copper requires large amounts of energy per ton of copper: 30–40 million British thermal units (Btu) per ton of cathode copper. In terms of energy use, there is no doubt that smelting = high energy consumption.

Hydrometallurgy leads to a higher recovery rate due to relative ease in leaching of product and the possibility of cascading – re-circulating solid waste to the next step and achieving a high recovery rate with chemical precipitation of electro-winning. Compared to pyrometallurgy, direct fuel consumption of hydrometallurgy is almost negligible. On the other hand, it should be noted that to produce a ton of copper cathode, this process requires around 315400 kWh. This means that, if the present fuel mix in electricity generation remains

constant, indirect emissions due to hydrometallurgy production in the year 2001 would probably attain 3.6 x 106 ton of CO_2, considering unit emissions of 0.68 kg CO_2/kWh and a production of 1.56 million tons of cathodes. Hydrometallurgical routes have become more popular to research because: energy costs are lower; more pollution-conscious communities require "zero discharge" type conditions; whether for air or water, as smelting processes are made "leak proof" the impurities become more of a problem in concentrating copper; hydrometallurgical processes by contrast can separate impurities better and operating temperatures are much lower making plants easier to operate.

3. CONCLUSIONS

Hydrometallurgy allows a real sustainable growth process considering the following aspects, given in summarized table 1:

Table 1. Pyrometallurgy vs. hydrometallurgy compared by various issues

Issue	Pyrometallurgy	Hydrometallurgy
Gass emission	High, varies from CO_2, greenhouse gaseous, volatile organic carbon	Low (room temperature) and easy to treat
Dioxin potential	High	No dioxins
Dust potential	High, during material handling and transport	Low, dissolve in solution or taken care off by pollution control equipment
Economics	Huge investment capital and low job creation	High job creation as processes involved are labour intensive
Social acceptance	Low, due to high environmental liabilities	High, cleaner environment with highly effective and mature pollution control methodology
Energy	High (up to 1200°C)	Low (room temperature)
Recovery rate	Low (only fraction of metals), useful non-metals are incinerated and impossible to recover	High recovery, clean separation of material types enable individual effective recovery
Final residue	High. (slag and dusts), potential metal trapped to reduce recovery effectiveness	Low. Only mixed plastics, which could be recycled into engineered plastic
Work place conditions	Hard conditions around furnaces	Clean condition

Taking into account all the facts which favour hydrometallurgical processes, it can be concluded that hydrometallurgy will displace inefficient pyrometallurgical processes for obtaining copper from electronic scrap in future. There are at least two examples which bear witness to this: a) Zinc was produced for over 400 years by a fully pyrometallurgical route. Since 1980, a fully hydrometallurgical process was invented (Sherritt autoclave process) and four plants are now in operation using this technology; b) Alumina was first produced by a high temperature sintering process was replaced by Bayer's hydrometallurgical process in 1892 - the process used today worldwide. Hydrometallurgy has also broadened the metal extraction options, as a more obvious extraction options compared to pyrometallurgy.

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DRY PROCESSES OF RECOVERY OF THE METAL AND PRODUCTION OF CONSTRUCTION MATERIAL FROM STEEL AND FERROCHROMIUM SLAG

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Abstract: Slag processing can have two goals: either to produce commercially viable materials and to resolve environmental issues. In terms of the growing demand for resources and the increasing of the shortage of the water supply, application of dry separation processes of the slags and raw materials are raised. This paper discuss: processes of fine grinding and dry separation of the slags, metal recovery from the slags, and production of high value construction materials and possibility of its using in civil industry. Also, results from laboratory and pilot testing will be presented.

Keywords: Slag, dry separation processes, metal recovery

FILTRATING SECTION WASTEWATER OF THE COPPER MINE IN MAJDANPEK AND ITS INFLUENCE ON THE RIVER VELIKI PEK

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Abstract: This work provides the analysis of average annual values of heavy metal ion concentration, and of average annual values of total dry residue and suspended solids, as well as of pH values of the wastewater released by the Copper mine in Majdanpek and its influence on the River Veliki Pek in the period 2008-2012. The analysis has shown that particular results in particular intervals of time exceed the allowed upper concentration values which are defined in the legislation of the Republic of Serbia. The final results have been compared to the allowed upper concentration values recomended by the World Health Organization Policy and the European Union Directive 98/83/EC.

Keywords: wastewater, heavy metal, dry residue, suspended solids, Copper mine Majdanpek, Veliki Pek

1. INTRODUCTION

20th century technological development and a dynamic industrial development have caused a permanent increase of the amount of wastewaters. Due to the expansion of industrial production, there is a wide scale pollution detected in the wastewaters. The wastewater composition is complex and encompasses different kinds of pollution. Classification is done on the basis of wastewater origin: ~~municipal~~ urban wastewater, industrial wastewater and agro-complex wastewater. This work considers the industrial wastewater and its polluters. Concentration and type of a pollutant depend on the kind of a technological process, raw material kind and products. Many processes, being discontinuous, lead to a different regime of producing and releasing wastewaters in different types of production. The dynamics of sampling, the type of a sample, a particular analyzing period during a month or a year are defined on the basis of a production technology, while the situational polluter plan presents the number of releases, the location of releases and the place of sampling.

All kinds of water already used up for some purpose, either in homes, industry or agriculture, are to be collected as wastewaters, processed properly and conducted to the receivers without harmful effects on the environment and without damaging the natural water cycle. The receivers of wastewaters may be natural waters – rivers, lakes, seas, but in some cases most of wastewater, if processed adequately, may be reused for initial or some other

processes. Due to the differences in wastewater composition, different materials are used in construction of a drainage system for different types of wastewaters.

Wastewater characteristics can be defined by the use of physical, chemical and biological indicators. Physical indicators related to the quality of sampled waters are: suspended particles, dissolved solids, total dry residue, etc. Suspended particles may be either of organic or non-organic origin. Deposited in calm waters, they endanger the living creatures at the bottom of watercourses and decrease the transparency of water. Ions and other solid molecules are adsorbed onto them. Dry residue forms dissolved colloidal and molecularly dispersed admixtures, without dissolved gasses, and is expressed in mg/dm3.

Chemical indicators of the quality of sampled waters are: pH values, water hardness and alkalinity. In natural waters, pH value is primarily a function of carbon system that is made of carbon dioxide (CO_2), carbonic acid (H_2CO_3), bicarbonates (HCO_3^-) and carbonates (CO_3^{2-}). Measuring pH values is very important because of the influence of pH on chemical and biological characteristics of water. Practically based, pH of a water solution is defined as a negative decimal logarithm of the concentration of hydrogen ions (the activity of hydrogen ions). Water hardness is caused by dissolved salts of calcium and magnesium in it. The concentration of calcium is the highest, due to its presence in the Earth's crust in the shape of a mineral calcite, dolomite etc. Alkalinity is caused by hydroxides, carbonates and bicarbonates of alkaline and alkaline earth metals, mostly by calcium, magnesium, natrium and potassium. Alkalinity value also includes borates, phosphates and silicates, if they are present. The alkalinity of water is expressed as the content of $CaCO_3$ in mg/dm^3 of water. Heavy metal ions like iron, lead, copper, zinc and others are present in the wastewater of the filtrating section.

According to the Water Classification Statute of the Republic of Serbia, the River Veliki Pek belongs to the third class of waters. The World Health Organization Policy and the European Union Directive 98/83/EC prescribe limited values related to the presence of polluters in wastewaters. This work deals with the testing of physico-chemical purity of the River Veliki Pek before the inflow of filtrating section wastewater, and of the filtrating section wastewater itself, as well as of the River Veliki Pek after the inflow of filtrating section wastewater, and then the final results are compared to the values prescribed in formerly mentioned policies and directives.

2. WATER SAMPLING AND ANALYSIS

Copper ore was found in Majdanpek at the end of 1953, when the reserves containing about 85 million tons with an average content of 0.83% Cu were confirmed to exist at the site "Južni revir". Taking these reserves of copper ore into account and assuming further exploration, the Federal Executive Council decided on founding a company "Rudnik bakra Majdanpek", or Copper Mine Majdanpek (16.04.1954.). In July 1957, the funds for constructing a mine were granted, and the construction work began at the end of 1957.

Production process of Copper Mine Majdanpek can be mostly viewed through several phases: the excavation of muck or ore, fragmentation and flotation of ore. What is interesting for this work to be mentioned is a technological procedure "trituration" that takes place in the

flotation department. During the process of trituration water, calx and reagents necessary for flotation are being dosed and put into the mills (fragmentation up to the 20 mm size). The pulp which has been got that way goes into hydrocyclones where separation takes place on overflow which is further exposed to the flotation process and on the underflow which is brought back into the ball mill. The product of grinding goes into the conditioner, then into the pulp separator, from which it is evenly distributed into the flotation machines. Flotation as a whole consists of a basic flotation and three purification processes.

On the right from the bank of the River Veliki Pek, in the vicinity of the village of Debeli Lug, a filtrating section was built. During the processing of flotation concentration, two products are got – concentrate consisting of about 20% of solid phase and flotation muck consisting of 12-18% of solid phase. Copper concentrate is brought into thickeners where the solid phase content is increased up to 50 %. Thickened product is gravitationally transported through a 3270m long tunnel to the filtrating section in Debeli Lug, where a collector tank receives it, and from where it is further transported by the use of the pumps to the vacuum filters. The cake from the vacuum filters drops onto the assembly conveyors, and then into the railway wagons. Fluid phase is transported from the vacuum filters into the thickener and then into the precipitator, where gravitational purification of the filtrate representing wastewater of the filtration process takes place. Thus gravitationally purified, wastewater is released from the precipitator into the recipient, the River Veliki Pek [1,9].

Filtrating section wastewater purification system was constructed in 1970 and it consists of a thickener and precipitator. The thickener is a concrete pool of a circular shape whose diameter is 28m long. Its surface of 630m^2 provides the mechanical ability of the thickener to thicken even greater masses than those regularly dealt with during the production process. Overflow is released from the thickener into the precipitator where further mechanical wastewater purification takes place.

Reinforced concrete was used for building the precipitator consisting of two chambers whose dimensions are 8x38 and depth 2.5m. Each chamber can be filled or emptied alternatively and individually. Currently, both gravitational precipitators are functioning properly providing the increased efficiency of wastewater purification due to a longer period of retention in the precipitator itself. After gravitational purification in the precipitator, wastewater is taken away through the land channel to the River Veliki Pek. The land channel is 1.5-3.0 wide, 1.4-1.6 deep and 600m long (1,9).

In order to achieve the best possible results of copper concentrate thickening and filtrating, wastewater pre-purification takes place in the thickeners whose diameters are 28 and 10m. The water released into the River Veliki Pek is examined three or four times a year, as well as the quality of the River Veliki Pek before and after the release of filtrating section wastewater. The quality of water is examined by an accredited institution, National Institute of Public Health ''Timok'' Zaječar (10, 11). After that, wastewater is directed into the precipitators, from where it is released into the recipient, rivers. Picture 1 presents a satellite's view of the Copper mine Majdanpek filtrating section, along with the places of sampling and the course of the River Veliki Pek.

Figure 1. satellite's view of the Copper mine Majdanpek filtrating section, along with the places of sampling and the course of the River Veliki Pek: (I) The River Veliki Pek before wastewater inflow, (II) Filtrating section wastewater, (III) The River Veliki Pek after wastewater inflow (1)

Dry residue is examined in laboratory (gravimetric method) by evaporating a measured volume of filtered water and drying the residue at 110 C, until constant weight of residue is reached. In order to get measurable quantities of dry residue, 10 dm3 of condensate is evaporated.

pH scale ranges from 0 to 14 (very acid-very alkaline). The value of pH 7 is related to a neutral environment at 289.16 K (25^{o}C). PH value is determined by pH-meter. The method of atomic absorption spectrophotometry (AAS) was used for measuring heavy metal ion concentration in the wastewater. Complexometric method was used for determining the hardness of water. Alkalinity was measured by titration of water using Sulphuric acid solution and indicators as phenolphthalein and methylorange.

3. DISCUSSION AND RESULTS

This work is related to the results gathered from three sampling sites in the period 2008-2012. The results are presented in Table 1, as well as maximal values of indicator concentration (MDK) prescribed for the third class of water, to which the River Veliki Pek belongs.

Table 2. The results of the analysis from three sampling places in the period 2008-2012

Indicators	Parameter	Mesto uzorkovanja		
		I	II	III
pH value	Min	7.38	7.68	7.53
	Max	8.81	**13.05**	**9.20**
	Average Value	7.95	**10.24**	8.49
	MDK	6.0−9.0		
Overall Cu, mg/ dm^3	Min	0.008	0.672	0.035
	Max	**4.412**	**7.552**	**0.884**
	Average Value	0.313	3.24	0.278
	MDK	0.1		
Overall Fe , mg/ dm^3	Min	0.092	0.736	0.137
	Max	**5.090**	**6.576**	**4.810**
	Average Value	**1.071**	**2.989**	0.966
	MDK	1.0		
Overall Pb, mg/ dm^3	Min	0.01	0.01	0.01
	Max	**0.333**	**2.255**	**0.126**
	Average Value	0.036	**0.562**	0.027
	MDK	0.1		
Overall dry residue mg/ dm^3	Min	200	**1980**	180
	Max	748	**3840**	888
	Average Value	395	**2547**	491
	MDK	1500		
Suspended particles mg/ dm^3	Min	0	21.2	0.2
	Max	47.4	**184.6**	18.2
	Average Value	6.76	64.68	7.31
	MDK	80		
Overall Cr, mg/ dm^3	Min	0.002	0.002	0.002
	Max	0.025	0.026	0.091
	Average Value	0.0051	0.0068	0.00906
	MDK	0.1		
Sulphates SO_4^{2-}, mg/ dm^3	Min	76.3	106,2	59,58
	Max	472.3	1864,2	373,4
	Average Value	174.82	906,55	147,74
	MDK	/		
As, mg/ dm^3	Min	0.001	0,001	0,001
	Max	0.01	0,029	0,007
	Average Value	0.0029	0,0099	0,0032
	MDK	0.05		
Mn mg/ dm^3	Min	0.015	0,01	0,019
	Max	0.088	0,132	2.442
	Average Value	0.054	0,047	0,195
	MDK	/		
Cd mg/ dm^3	Min	0.001	0,001	0,001
	Max	0.005	0,004	0,004
	Average Value	0.00213	0,002	0,0021
	MDK			0.01
Zn, mg/ dm^3	Min	0.025	0,082	0,049
	Max	0.651	**1,162**	0,727
	Average Value	0.082	0,316	0,126
	MDK			1.0
Overall phosphates PO_4^{3-} mg/ dm^3	Min	0.10	0,03	0,07
	Max	0.49	0,4	1,17
	Average Value	0.25	0,32	0,22
	MDK	/		
Dissolved oxygen mg/ dm^3 O_2	Min	**2**	**2,7**	8,4
	Max	16.7	11,73	13,6
	Average Value	11.77	8,53	11,81
	MDK	At least 4		
$KmnO_4$ consumption mg/ dm^3	Min	6.6	3,1	3,4
	Max	20.3	178,6	20,9
	Average Value	9.37	64,66	10,14
	MDK	/		
Fluoride mg/ dm^3	Min	0.01	0,01	0,01
	Max	0.29	0,46	0,68
	Average Value	0.08	0,17	0,14
	MDK	/		
Anion detergents mg/ dm^3	Min	0.01	0,01	0,01
	Max	**2.2**	**0,41**	**0,3**
	Average Value	**0.173**	0.097	0.061
	MDK	1.0		

Table 1. shows that minimal pH value of samples taken from three sampling places ranges 7.38-7.68, and that maximal pH value overcomes the maximal prescribed indicator concentration values (MDK) in samples taken from II and III sampling site (9.02-13.05). Maximal prescribed copper ion concentration value is surpassed even in the samples with minimal concentration, while maximal copper ion concentration value goes up to 7.552 mg/dm^3, as it is measured in the filtrating section wastewater sample. It is also obvious that iron ion and lead ion concentration values are higher in the samples taken from the second sampling site, and that after filtrating section processing of wastewater these values are higher than prescribed in the samples taken from the third sampling site. All the other indicators of the samples are under legally prescribed maximal values.

4. CONCLUSION

Based on the analysis of the results related to the quality of the Copper mine Majdanpek filtrating section wastewater and the River Veliki Pek, it is evident that annual average pH value in the River Veliki Pek after the inflow of filtrating section wastewater overcomes maximal prescribed indicator concentration values.

The presented results lead to a conclusion that the parameter values widely ranged in the period 2008-2012. In earlier years the influence was greater, but gradually decreased through years. By practicing the prescribed legislation, as well as decreasing the impact it has had on the environment (in this case on waterways), the Copper mine Majdanpek has done a lot of work to contribute to improvement of the quality of wastewaters, diminishing the pollution of the River Veliki Pek in the same time. Rubber curtains increasing gravitational precipitation were placed in the 30m long precipitators in order to improve gravitational purification.

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SUSTAINABLE DEVELOPMENT IN MACEDONIAN ORGANISATIONS

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Abstract:
Purpose: The purpose of this paper is to examine the current situation in Macedonian organisations and their awareness of sustainability and incorporating sustainable actions in everyday activities and strategic planning.
Design/methodology/approach: Desk research will be conducted analysing the websites of top organisations in Macedonia, focusing on sustainable development actions in their strategy and everyday activities. Also, we will conduct an interview with top managers assessing the awareness they have on sustainable development, measures taken so far, as well as their future commitment.
Some of the questions that we have in this study are: Is there any awareness and activities regarding sustainable development in Macedonian organisations?; What type of activities are currently conducted or planned in the future?; Is there a correlation with corporate social responsibility activities and their strategic plans?; Do they communicate their sustainable activities externally and internally?; What are the obstacles preventing Macedonian organisations to be more involved in sustainable development actions?.
Findings: The results from the study will help answer the questions concerning sustainable development in Macedonian organisations and guiding and supporting managerial decisions in creating sustainable organisations, as well as policy making.
Research limitations/implications: There is a literature gap in the area of sustainable development in Macedonia and Macedonian organisations.
Practical implications: This study will increase the understanding and awareness about sustainable development, as well as the influence it has on stakeholders. This study can help in future policy making and further research in this area.
Originality/value: This research contributes to the field by offering support and new findings. This study adds to the body of literature in what is considered relatively new and unexplored area of study. The survey conducted among Macedonian organisations contributes a lot for the knowledge about sustainable development in Macedonia.

Keywords: Sustainable Development, Strategy, Policy Making, Corporate Social Responsibility, Organizations, Macedonia.

1. INTRODUCTION

Sustainable development was defined in the 1987 report titled 'Our Common Future', by the United Nations (UN) world commission on the environment and development. [1] The focus of this report was on the "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

However, the concept of sustainable development didn't obtain international recognition until 1992 when the UN held a conference on environment and development in Rio de Janeiro, Brazil. [2] Now, under the principles of the UN charter, the millennium declaration identified principles and treaties on sustainable development, including economic development, social development and environmental protection. [3]

Ultimately, sustainable development should address the issues of scarce resources, production, technology, expanding scales of economic activities and environmental pressures. Therefore, the ultimate purpose of sustainable development is to find ways and methods to transparently and ethically address these issues, with responsibility for the wellbeing of current and future generations. It is a multi-dimensional concept and should be approached and researched in trans-disciplinary manner.

In this paper, we are studying the behaviour of organisations and the activities that are being conducted around sustainable development. The importance of this theme is the inter-connections between business organisations, the community and the environment.

Today in the global world there is a lot of research that has and continues to be conducted on this topic. Therefore, there is awareness of this theme in the global business world, but most organisations have not gone the extra step of creating actual strategies and activities for this. Or if they have, they have not measured the impact of their business decisions on the environment and sustainable development.

It is important to note that the goal of this paper is to assess the current situation in the Republic of Macedonia.

1.1 THE IMPORTANCE OF SUSTAINABLE DEVELOPMENT

Organisations around the world (including Macedonia) are facing high levels of criticism for their limited role in a number of social, environmental and economic issues. However, the issues of climate change, social inequity and the recent economic recession motivated a lot of organisations to take more responsible actions towards sustainable development.

Another important business issue that is increasingly impacting business decisions is that of environmental and the broader sustainability performance. There is a compelling financial, regulatory, and market place opportunity to evolve an organisation's activities so that they mitigate environmental risks and enhance opportunities. [4]

Overall, the three pillars of sustainability are economy, society and the environment. [5] However, we also need to be aware that the current and future challenges of organisations are to ensure profitability through these pillars.

If this is achieved, then organisations will pursue new business models, organisational structures and transformational leadership that will support this process of change. The business values will also change, and new priorities and policies will be implemented.

2. SUSTAINABLE BUSINESS PRACTICES

The European Union's (EU) definition for CSR and on the contribution of CSR to sustainable development is towards a concept whereby organisations integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis. The activities reflect the welfare for society and should be considered as management strategies. The EU also considers CSR to be inherently linked to sustainable development, which is the integration of all three aspects of environmental, social and economic impacts into the EU's analysis and decision-making. [7]

Recently, the UN Global Compact called for global attention at the Rio+20 conference of June 2012. [8] Also, The International Organization for Standardization (ISO) launched a number of CSR guidelines that have achieved international popularity. The ISO14000 series of 1996 deals with environmental management and the recent ISO26000 series of 2010 deals with social responsibilities. [9]

The number of organisations that are working proactively and are setting their priorities towards sustainability is growing daily. They are communicating this through the media and the progress of implementing their action plans on sustainability and the measurements done in this field. The analysis shows that organisations are changing and developing business values adequate to the new era of development.

3. RESEARCH METHODOLOGY

Research Problem

- How can organisations be motivated to lower their environmental impact and translate this into practice?
- Which factors are driving environmental and sustainable decisions for organisations?
- The environmental considerations are very often perceived as barriers to profitability. Therefore, the costs of regulations are rarely considered as part of the business strategy.
- How many organisations have a proactive attitude towards sustainable development and integrate and implement responsible actions?

The purpose of this paper is to explore the research questions:

- Is there any awareness or activities regarding sustainable development in organisations operating in Macedonia?

- What types of activities are currently conducted or planned in the future?
- Is there are correlation with corporate social responsibility activities and their strategic plans?
- Do organisations communicate their sustainable activities externally and internally?

Based on the research problems and theories, the following hypothesis has been formulated.

- The current situation of organisations in Macedonia in terms of sustainable development is on a very low level.
- Only a small number of organisations have sustainability activities and have a proactive role in mitigating environmental risks.
- Only a few organisations operating in Macedonia recognise the importance of sustainability and have implemented this into their business strategy - Vision, Mission and Goals.

3.1. SAMPLE

The sample group consisted of the top 100 organisations operating in Macedonia, which were the most profitable in 2013 according to The Kapital Magazine. Most of these organisations are located in the capital city, Skopje and a smaller number of organisations are located in other towns in Macedonia (Figure 1).

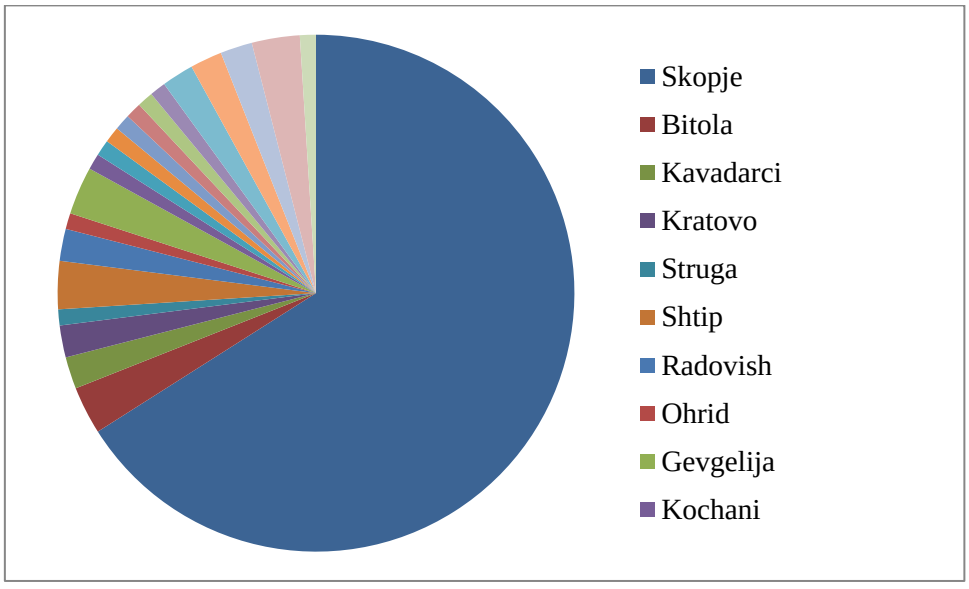

Figure 1. Locations of the top 100 organisations operating in Macedonia

The industries in which these organisations operate in have been grouped into the following categories: trade, telecommunications and IT, civil engineering, medicine and

pharmacy, media and TV, manufacturing, oil and gas, mining, energy, services and logistics and transport (Figure 2).

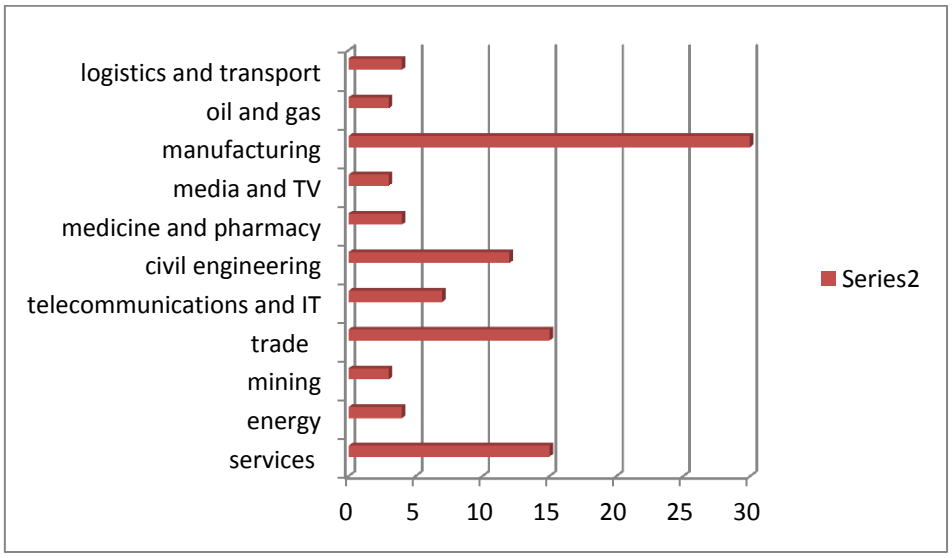

Figure 2. Industry categories of the top 100 organisations operating in Macedonia

The revenue of these organisations in 2013 was between 1.4 million euros to 54 million euros, and they employed between 1 and 2,257 personnel in the same year.

3.2. DATA COLLECTION

Within these past two months, we collected data by analysing the websites of the top 100 organisations operating in Macedonia and investigated the media reports and news available for these organisations.

3.3. MEASUREMENT OF VARIABLES

The desk research was focused on measuring and analysing the variables, including the organisations vision, mission, goals, action plan for sustainability, activities in sustainability, corporate social responsibility, and the UN global compact.

We also cross-referenced their social corporate responsibilities and action plans with activities for sustainability.

3.4. DATA ANALYSIS AND HYPOTHESIS TESTING

Descriptive statistics for all the variables are presented in the following tables. In Table 1, the frequency and percentage of an organisations use of the word "sustainability" in their mission statement are presented.

Table 1. Frequency and percentage of organisations use of sustainability in mission statements

Organisations use of sustainability in mission statement	Yes	No	No data
Number of organisations	18	51	31
Percentage	18%	51%	31%

In Table 1, it can be clearly seen that less than 20% of the organisations have mentioned the word "sustainability" in their mission statements.

In Table 2, the frequency and percentage of organisations use of the word "sustainability" in their vision statement are presented.

Table 2. Frequency and percentage of organisations use of sustainability in vision statements

Organisations use of sustainability in vision statement	Yes	No	No data
Number of organisations	16	53	31
Percentage	16%	53%	31%

In Table 2, it can be clearly seen that only 16% of the organisations have mentioned the word "sustainability" in their vision statements.

In Table 3, the frequency and percentage of organisations use of the word "sustainability" in their goals are presented.

Table 3. Frequency and percentage of organisations use of sustainability in goals

Organisations' goals and sustainability	Yes	No	No data
Number of organisations	20	49	31
Percentage	20%	49%	31%

In Table 3, the data shows that almost half of the organisations have not mentioned the word "sustainability" in their goals.

In Table 4, the frequency and percentage of organisations that have or don't have action plans for sustainability are presented.

Table 4. Frequency and percentage of organisations that have action plans for sustainability

Organisations action plans for sustainability	Yes	No	No data
Number of organisations	13	56	31
Percentage	13%	56%	31%

In Table 4, the data shows an alarming drop (less than 13%) in organisations that have developed action plans for sustainability, and communicated this plan through the media.

In Table 5, the frequency and percentage of organisations that have or don't have activities focused on sustainability, such as environmental protection.

Table 5. Frequency and percentage of organisations activities focused on sustainability

Organisations activities focused on sustainability	Yes	No	No data
Number of organisations	25	44	31
Percentage	25%	44%	31%

In Table 5, it can be noted that the percentage of organisations that have corporate social responsibility (CSR) activities is slightly higher – 25 %.

In Table 6, the frequency and percentage of organisations that have or don't have CSR activities are presented.

Table 6. Frequency and percentage of organisations CSR activities

Organisations CSR activities	Yes	No	No data
Number of organisations	25	44	31
Percentage	25%	44%	31%

In Table 6, it can be noted that the percentage of organisations that have CSR activities is slightly higher – 25 %.

In Table 7, the frequency and percentage of whether or not organisations they have implemented the UN Global Compact.

Table 7. Frequency and percentage of organisations implemented the UN Global Compact

Organisations implementation of UN Global Compact	Yes	No	No data
Number of organisations	2	66	31
Percentage	2%	66%	31%

In Table 7, it can be seen that only 2% of the organisations have signed the UN Global Compact initiative and are communicating on the principles to the media.

We also cross-referenced the organisations social corporate responsibility and action plans with their activities for sustainability. The results are as follows:

In Table 8, the frequency and percentage of organisations that have or don't have CSR and activities in sustainability are presented.

Table 8. Frequency and percentage of organisations that have CSR and action plans on sustainability

Organisations CSR and sustainability action plans	Yes	No	No data
Number of organisations	21	48	31
Percentage	21%	48%	31%

In Table 8, it can be seen that only 21% of the organisations have CSR activities and have developed action plans on sustainability.

In Table 9, the frequency and percentage of organisations that have or do not have CSR activities, action plans on sustainability and sustainable activities.

Table 9. Frequency and percentage of organisations CSR activities, sustainability action plans, and sustainability activities

Organisations CSR activities, sustainable action plans and sustainability activities	Yes	No	No data
Number of organisations	9	60	31
Percentage	9%	60%	31%

In Table 9, it can be clearly seen that only 9% of the organisations have CSR activities, have developed action plans on sustainability and are implementing activities in sustainability (like waste management, environmental protection, energy efficiency actions etc.).

4. CONCLUSION

Based on the results, we expected to find the hypotheses listed above. We can therefore conclude that this sample of organisations operating in Macedonia do not invest their resources and/or capital in developing sustainable strategies, actions, activities and solutions.

Further evidence supporting this claim include:

- less than 20 per cent of organisations are aware of the importance of sustainability and have mentioned this in their vision, mission, goals etc.
- only 13 per cent of this sample have developed action plans for sustainability and are pro-active in this field.
- approximately 25 per cent of the organisations have completed activities in sustainability, specifically for environmental protection, energy efficiency and utilising eco-friendly resources. However, we did not find any data regarding activities that deal with climate change.
- Only 25 per cent of the sample reported activities based around corporate social responsibility. Organisations operating in Macedonia (predominately the foreign investments) have started to recognise the importance of CSR and implementing this in their activities. However, these activities are more focused on helping the community such as donations, sponsorships and scholarships.
- In regards to the UN global compact, we can conclude that 98 out of the 100 organisations in this sample have not signed this initiative and nor have they established any other standard for corporate social responsibility.
- 21 organisations have corporate social responsibility activities regarding environmental protection and sustainable development. With further analysis, we concluded that only 5 organisations are Macedonian owned companies.

- 9 organisations have action plans for sustainability and are currently doing social responsibility activities.

Note that for 31 organisations, we could not even find relevant data to comment on.

Implications for future theory and research

This research provided an initial examination of the current situation for sustainable development in the top 100 organisation that operate in Macedonia, and has sparked numerous additional questions that need to be addressed by future research studies.

Research such as this one are rare in Macedonia, and therefore, it would be best to replicate the same study on other organisation samples so that it can provide more data about organisations operating in Macedonia and their focus and activities regarding sustainability.

Additional research questions can include the following:

- Attitudes towards sustainable development
- Sustainable business priorities
- Factors driving sustainable decisions
- Correlation between business values and sustainable development
- Corporate social responsibility actions
- Measuring the impact or business decisions about sustainability

Further studies should also investigate whether these activities are more towards driving marketing activities or whether they are actual investments in this field.

Such studies will also enhance the organisations and the educational system to take the additional steps that are needed in educating and creating greater awareness about these topics in Macedonia.

Implications for Practice

The implications of the findings presented in this study are also important from a practical perspective, as the information can assist management to discuss the relevance of the topic and become more aware of the importance and impact of their behaviour on sustainability.

This research also provides practical implications in several areas such as: discussion on the subject, new approaches in decision making, implementation of proactive strategies, mitigating environmental risks, dialogue between public and private institutions, creating and implementing policies on sustainable development, promoting awareness through media campaigns on the importance of sustainable business practices and provide education for sustainable development.

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INNOVATIVE APPROACH TO DEVELOPMENT OF NEW GOLD-BASED ECO SOLDER ALLOY

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Abstract: The resuts of development of new gold-based eco solder alloy are presented in this paper. Eco alloys of quaternary system Au-Ga-In-Sb are one of the potencional material, which can be used in electronics, like new, ecological lead-free solders. For this reason it is necessary to understand the different characteristics of these alloys. The results of experimental investigation of some thermal, structural, mechanical and electrical properties of selected alloy in the In-Ga70Au10Sb20 cross section of Au-Ga-In-Sb system are presented in this paper. Applied experimental techniques included: differential scanning calorimetry, light optical microscopy, scanning electron microscopy with energy dispersive spectroscopy, hardness, micro hardness and electrical conductivity measurements.

Keywords: Au-Ga-In-Sb, differential scanning calorimetry, lead-free solder alloy, scanning electron microscopy with energy dispersive spectroscopy, hardness

1. INTRODUCTION

Global electronics industry uses large amounts of lead-based solders. However, because of its toxicity, lead is a major environmental threat. At the beginning of the last decade of the last century, the United States Congress has launched an initiative to replace lead with other, less harmful metals [1]. In Europe and Japan, this idea is not only accepted, but also expanded. According to WEEE directive [2], in Europe, lead, cadmium and other toxic substances should be removed from use until 2008. Because of this it is present great need for development of new solder materials that do not contain toxic elements and at the same time meet the many requirements in terms of mechanical and electrical properties, corrosion resistance and economic viability.

Gold and its alloys are widely used in modern branches of technology and electronics, space and aeronautic technology, chemistry, and medicine. Electronics industry is the largest user of gold and its alloys. Gold alloy used for the realization of electrical contacts for making conductors and resistors in the measuring technique and computer because they possess good

mechanical and electrical properties, and corrosion resistance to oxidation and other harsh environments. Almost 90% of the applied gold and gold alloys are used as solders for electrical contacts at normal pressures and vacuum [3].

System Au-Ga-In-Sb belongs to a group of alloys based on gold and indium, which are possible alternative to traditional lead-based solders. The purpose of this paper is to presents results of development of new solder alloy from this quaternary system which can be used as new eco solder alloy.

2. EXPERIMENTAL

The samples used for the investigations were prepared using metals – gold, gallium, indium and antimony of 99.99% purity.

DSC experiments were carried out on the device SDT Q600 (TA Instruments), which works in a temperature range from room temperature to 1500 ° C, with a maximum vacuum to 7 Pa and the heating rate of 0.1 to 100 ° C / min. The precision of measurement was ± 2%.

Microstructural analysis of investigated samples was performed by light optical microscopy (LOM), using a Reichert MeF2 microscope (magnification up to 500x) and by Scanning-electron microscopy (SEM) with Energy dispersive spectroscopy (EDX) analysis performed on electronic microscope JEOL JSM-6610LV with resolution of 10 nm on 20keV, accelerating voltage of 0.2-30 kV and magnification up to 300000x. Prior to metallographic analysis, surfaces of the polished samples were etched with HNO_3 (1:1) solution to reveal the structure of the investigated alloys.

Hardness measurements were done using standard procedure according to Brinell, with ball diameter of 2.5 mm and load of 15.6 kP. Microhardness was measured using instrument PTM-3 with 50 - 150 grams load, depending on a phase.

Electrical conductivity of investigated materials was measured using SIGMATEST 2.069 (Foerster) eddy current instrument for measurements of electrical conductivity of non-ferromagnetic metals based on complex impedance of the measuring probe with 8mm probe diameter.

3. RESULTS AND DISCUSSION

Technology of production of selected solder included the following phases: the preparation of master alloys, the construction of certain dimensions profiles, analysis of the required parameters molding and defining the appropriate technology solutions, definition of cover assets and the dynamics of alloying, defining the minimum required amount of molten wires for the process of plastic deformation, semi-industrial experiment, testing cast ingots and profiles (chemical, metallographic, mechanical, physical and technological), the definition of thermomechanic regime of plastic deformation and selection of machines, testing of finished products, analyzing the results and repeating the experiment with a possible correction of identified deficiencies. Master alloys of selected compositions are made from pure metals (99.99%), by melting in an electric furnace. Samples of a given alloy composition are then produced by melting master alloys in an induction furnace, in air atmosphere, at

873K. The resulting samples were then annealed at a temperature of 473K for an hour and cooled at a cooling rate of 5K / min. In order to protect samples from oxidation, charcoal covering was used in all cases.

The prepared samples were subjected to by thermal, structural, mechanical and electrical tests.

The characteristic temperatures of phase transformations in the investigated samples, obtained using differential scanning calorimetry (DSC), are presented in Table 1.

Table 1. The characteristic temperatures of phase transformations in alloys Au6Ga30In24Sb40

Alloy	**Temperature (°C)**	
	Phase transformation	**Liquidus**
Au6Ga30In24Sb40	85, 475	647

Analysis of samples microstructure was performed using optical microscopy. Developing microstructures in multicomponent alloys was carried out by various means of etching, depending on the composition. Recording of microstructures was carried out using an optical microscope with magnification of 200 times. The microstructure of the samples is presented in Figure 1.

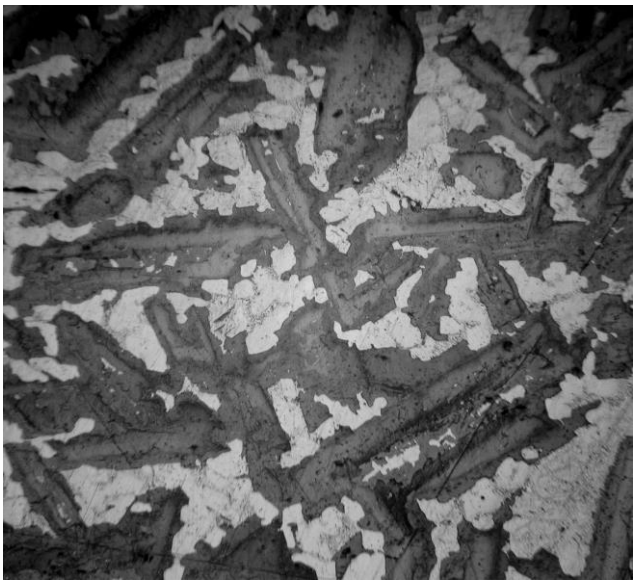

Figure 1. Mikrostrukture of Au6Ga30In24Sb40 alloy

Figure 2 shows the structure of the Au6Ga30In24Sb40 alloy obtained by scanning electron microscope. In Table 2 are presented results of EDX analysis of the same alloy, confirming the structural composition of investigated alloy - the alloy consist from Ga, In (Sb) solid solution with presence of Au_7In_3.

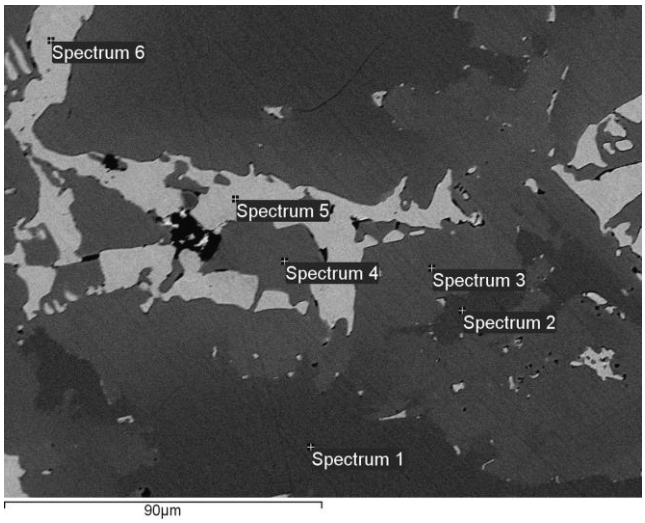

Figure 2. SEM pfotograph of Au6Ga30In24Sb40 alloy

Table 2. Results of Au6Ga30In24Sb40 alloy EDX analysis (at %)

Alloy / Spectrum	Au6Ga30In24Sb40			
	Au	**Ga**	**In**	**Sb**
Spectrum 1	0.00	40.07	8.83	51.11
Spectrum 2	0.00	39.43	9.17	51.40
Spectrum 3	0.00	25.09	25.40	49.51
Spectrum 4	0.00	21.36	28.50	50.14
Spectrum 5	66.40	3.99	29.61	0.00
Spectrum 6	68.06	2.54	29.40	0.00

As an additional method of characterization were used hardness measurements according to Brinell and result obtained for the alloy are presented in table 3.

Table 3. Hardness according to Brinell

Alloy	**HB**
Au6Ga30In24Sb40	140

The results of microhardness measurements for investigated alloys are presented in Table 4.

Table 4 Results of microhardness measurements

Alloy	H_μ	
	Light phase	***Draki phase***
Au6Ga30In24Sb40	363.8	166.9

Electricity conductivity is measured using standard apparatus - SIGMATEST 2069 (Foerster) instrument for measuring the electrical conductivity of metals that do not have ferromagnetic properties. Diameter probe measurement was 8 mm. Performed three sets of measurements and a mean value of the electrical conductivity of 0.784 MS / m.

4. CONCLUSION

Development and application of new materials is not limited just by to their characteristics and the impact on the environment, but also by their price. The content of gold in proposed new eco lead-free solder alloy is limited primarily by economic considerations, rather than structural, mechanical and other properties of the material. Taking this fact into account, content of gold in alloy was minimal, insuring that economic costs of solder production are not too extreme and in addition, that melting temperature of material does not become too high, making it impossible for a practical application. Although indium is also expensive, his price is not in range of gold, and this metal demonstrates many positive effects in solder alloys (lower crack propagation, improved thermal fatigue performance, and reduction of gold scavenging), which justifies higher content of indium in proposed solder alloy. New developed Au6Ga30In24Sb40 alloy is possible alternative to lead-based solders which need to be replaced with eco-friendly materials because protection of our environment needs to be one of primary goal to every scientist.

ACKNOWLEDGEMENTS

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TRENDWATCHING AS AN EFFECTIVE TOOL FOR SUSTAINABLE ENTREPRENEURSHIP

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Abstract:
Introductions: The article deals with *trendwatching* as a method of successful managing entrepreneurship projects in a frame of "volatile market processes", global political and economic changes. It is important for any start-up project or entrepreneur who wants to establish international business as well. Through the research was shown that all the successful examples\ways of doing business who becomes a new trends all over the world do not depends on geographic location or industry segment. That fact, allows to entrepreneurs to use trendwatching instruments for to reach sustainable business success.
Research problem: Today's world market – is really difficult structure, where the linear methods of analysis do not work successfully anymore, because doesn't allow to entrepreneur to predict the future trends and market niche. That's why the number of articles and the research about the synergetic business models, nonlinear methods in sociology and economics, increasing for the last couple years [1, 2]. But for the entrepreneurs who work in a world of fast and rapid changes it becomes very important to find out the most effective way how to make their business sustainable and minimize the risks. So, the key idea of this research paper conducted with the needs to find out the most effective instruments for to rise up investment attractiveness of the start-up projects and sustainable entrepreneurship via technology of trendwatching.
Objective/research goal: to investigate how to apply the actual methods and technology of trendwatching in entrepreneurship activity, including:
Systematization of last scientific concepts and trends in marketing research
Analysis of international best entrepreneurship practice
Benchmarking of successful experience
Analysis of companies report and internet resources of information
The research was designed at the Department of Marketing of The Russian Presidential Academy of National Economy and Public Administration at June-September 2014.
The results of the research shows the most actual methods and principals for developing sustainable enterprises and start-up projects through economical and social changes on a base of trendwatching.

Keywords: trendwatching, synergetic method, sustainable entrepreneurship, Eco-efficiency

WATER QUALITY ANALYSIS OF MORAVA RIVER, SERBIA

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Abstract: Water quality monitoring is one of the most important aspects of the overall water quality management. The well planned and well managed water quality monitoring system is required to signal, control or predict changes or trends of changes in the quality of a particular water body. However, a long-term survey and monitoring programs produce large and complicated data sets, which are difficult to analyze and interpret and they are not fully explored. Multivariate analysis techniques help in reducing the complexity of a large-scale data sets and are currently widely used in environmental impact studies.
The aim of this study is to observe the Morava River water quality. The extensive data sets were processed by multivariate techniques in order to identify similarities and differences between monitoring periods and locations.

Keywords: Water quality, Multivariate statistical techniques, Morava River System, Serbia

MULTI-CRITERIA OPTIMIZATION OF BATCH COMPOSITION FOR THE HYDROMETALLURGICAL PROCESS OF ZINC PRODUCTION

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Abstract: This paper presents the results of multi-criteria optimization of batch composition mathematical modeling for the hydrometallurgical process of zinc production from sulphide concentrates. Ten different zinc concentrates with 17 elements in the chemical composition were taken into consideration. Optimization model development was performed in seven steps using PROMETHEE / GAIA methodology by application of the AHP (*Analytical Hierarchy Process*) and the OEW (*Objective Entropy Weight*) approach in the allocation of the weight parameters for the optimization criteria. Optimization is done by selecting the following criteria: requires technology, economics requirements, ecology requirements and quality requirements of the final product. Four different scenarios of the technological process outcome are defined and the optimal mixture of available concentrates are defined using the PROMETHEE V methodology through a process of linear programming for all four scenarios.

Keywords: batch optimization, zinc, sulphide concentrates, PROMETHEE, linear programming

SLEIPNER PROJECT

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Abstract: This paper describes the "Sleipner" project, which describes the formation of CO_2 in industrial plants, his capture, compression and transport to storage where pumping in one or more wells stocks for appropriate geological formations suitable for long term storage. Over time, the CO_2 rises to the surface filling the pore space beneath the immediate withdrawal where over time, part of that are solvents and finally turns into minerals. Since storing CO_2 is not a human invention, but entirely natural phenomena, creating a closed circuit in the system of energy production, which the carbon that was originally removed from the earth in the form of gas, oil and coal, returns there in the form of CO_2 allows efficiently and safe storage during extremely long periods of time and stop the further increase in the concentration of CO_2 in the atmosphere.

Keywords: project, carbon dioxide, transportation, pipeline, storage

1. INTRODUCTION

Using increasing amounts of fossil fuels for electricity generation, industry and transport, continually increasing the amount of CO_2 released into the atmosphere. About half of this excess CO_2 generated to man's activities, re-vegetation absorbs or dissolves in the oceans, which still causes related adverse effects on sea plants and animals. The residue accumulating in the atmosphere, causing climate change.

Since CO_2 is in the group of greenhouse gases, which remain part of the sun's heat and thus causing the warming of the earth's surface it is urgent commitment to stopping the further increase in the concentration of CO_2 in the atmosphere from the current 387 ppm to the critical level of 450 ppm in the coming decades. To encourage companies to reduce their emissions of CO_2, the Norwegian government imposes a tax on CO_2 in the amount of approximately $50 per ton of CO_2 in the atmosphere. To avoid paying this tax, as a test of alternative technologies, there is a project at the Sleipner gas platform which is located in the North Sea, project called Sleipner CO_2 Storage Project (Figure 1). Built a special platform, Sleipner-T, which can support 8,000 tons treatment plant that separates CO_2 from natural gas, and pumped into storage under the platform, as well as under water. Sleipner-T factory produces about 1 million tons of CO_2 per year.

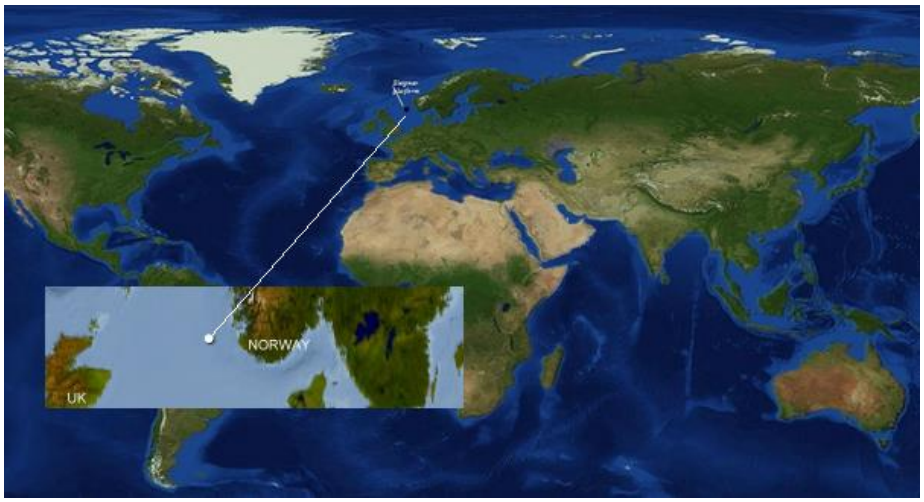

Figure 1. The geographical view of the Sleipner project

Impacts of any hypothetical discharge CO_2 depends on the specific location, a detailed knowledge of the geological structure allows all potential routes of migration, as well as the location with the lowest possibility of migration of CO_2, the gas behavior in order to evaluate and prevent any influence of CO_2 on humans and the ecosystem.

2. CAPTURE AND COMPRESSION OF CO_2

Impoundment or "capture" CO_2 is the first stage in the process of storing CO_2 in underground reservoirs. Then the CO_2 is compressed into a liquid that takes up significantly less space than gas. When CO_2 in power plant or industrial facility is separated from the flue gas, it is highly concentrated CO_2 is dehydrated and compressed to make transport and storage were as effectively. Dehydration is necessary in order to avoid corrosion of equipment and infrastructure, as well as hydrate formation due to high pressure. Compression is carried out simultaneously with the dehydration process that has several stages: repeated cycles of compression, cooling and water separation. Pressure, temperature and amount of water to adjust the mode of transport and the conditions of pressure underground storage. Key factors in the design of the compressor installation are: gas flow rate, inlet and outlet pressure, the heat capacity of the gas and efficiency of the compressor.

3. TRANSPORTING AND PUMPING CO_2

The composition and purity of CO_2 gives the following aspects of CO_2 storage project. The existence of a certain percentage of other substances, such as water, hydrogen sulid,

doubts pore and nitrogen oxides, nitrogen and oxygen acts on the chemical properties of CO_2 and, consequently, on the performance of individual processes and their effects. Therefore, the existence of these substances should be taken into account in the design phase of the compression, transporting and pumping, as well as the harmonization of working conditions. CO_2 can be transported by ship or through pipelines. The cost of transport by pipeline is less than the transport by ship, and the advantage is that it provides a steady flow of impoundment of the warehouse. All existing pipelines under high pressure in supercritical conditions for CO_2, where it behaves like a gas, but it has the density of the liquid. Three important factors determine the amount of CO_2 that can be transported by pipeline: its diameter, changes in pressure along the pipeline, as well as the thickness of the walls of the pipe.

After transportation to the underground storage of CO_2 under pressure is pumped into the bay. Pumping pressure must be sufficiently higher than the pressure in the reservoir rock, in order to suppress the fluid from the box-point of pumping. Number of wells is dependent on the amount of CO_2 to be stored, since the volume of CO_2 which is pumped in one hour, the thickness and permeability of reservoir rock, the maximum feed pressure and the type of the borehole. Since the main objective of long-term geological storage of CO_2, the formation must be hydraulically stable. High speed pumping can cause pressure rise in subparagraph pumping, especially in low permeability formations. Pressure pumping should not be higher than the pressure fracture the rock, because it could damage the bearing or bushing above the bay. To determine the maximum feed pressure which will cause cracks in the formation used geomechanical analysis and models.

Chemical processes can affect the rate of pumping. Depending on the type of reservoir rock, the composition of the fluid and the conditions in the depth (such as temperature, pressure, volume, concentration, etc.), can lead to dissolution and precipitation of minerals in the vicinity of the borehole. These processes can significantly influence the increase or decrease the speed of pumping. When CO_2 is pumped, a portion soluble in the salt water chamber, and the pH was slightly lowered under the influence of the decomposition of carbonate mineral tank wall. Carbonates are minerals that come in the first reaction, because the dissolution starts when start pumping. This process can locally increase the porosity of the rock. The high speed of pumping can be used to restrict the decrease in the permeability in the vicinity of the borehole or remove it from the area of geochemical equilibrium in which the crystallization takes place.

When pumped into the reservoir rock, CO_2 fills its pore space, which in most cases is already filled with water, layered, ie. brine. Since the dense CO_2 lighter than water, begins to rise. This movement is interrupted when CO_2 reaches the layer of rock that is impermeable, so the withdrawal. Usually made of clay or salt, the roof of acting as an insulator, preventing the further rise of CO_2 that accumulates just below the rocks.

In salt water, which fills pore space reservoirs, dissolves a small part upumpanog CO_2. The result is a lowering of the dissolution of the tray by the water in which was dissolved CO_2, which is heavier than water without the CO_2. The dissolution rate depends on the contact between the salt water and CO_2. The amount of CO_2 that can be dissolved is limited to a maximum concentration. However, due to the rise pumping CO_2 and lowering the water with dissolved CO2, constantly renewed contact between the salt water and CO_2, thereby increasing the amount that can be dissolved. Movement of CO2 related part of various

mechanisms of accumulation in traps in the Sleipner project is shown in figure 2. These processes are relatively slow, as it takes place within a narrow pore spaces. Rough estimates of the Sleipner project showed that about 15% of CO_2 dissolved after 10 years of pumping.

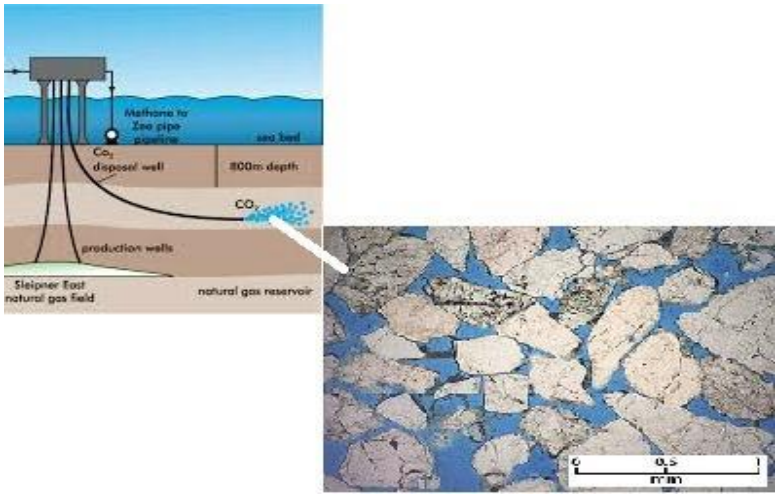

Figure 2. The effect of CO_2 in storage

Processes taking place in the warehouse are tracked: laboratory measurements, numerical simulations by comparing with the natural reservoirs and monitoring of existing demonstration projects of geological storage of CO_2. Only constant comparing and verifying these four sources of information can be acquired sound knowledge of all the processes that are happening in the warehouse. Safety and storage of CO_2 increases with time. The critical issue is to find a tray with a suitable roof of which can hold CO_2. All processes that are associated with the accumulation in traps dissolution and mineralization and residual accumulation in traps, preventing further migration of CO_2 to the surface.

4. MONITORING WAREHOUSE IN DEPTH AND ON THE SURFACE TERRAIN

Monitoring of CO_2 storage is done for operational, safety, social and economic reasons, and for reasons related to the protection of the environment. Monitoring of storage is essential for ensuring the long-term isolation of anthropogenic CO_2 from the atmosphere. It is necessary to monitor the functioning of the warehouse or on the sea and under the earth. When planning a strategy for monitoring the decisions that must be made dependent on the geological and engineering conditions specific for each warehouse, namely: the shape and depth of the deposit, the expected expansion of the CO_2 front, potential migration routes, geological composition roofing, during pumping, flow rate and surface features such as topography density populated opportunities, infrastructure, and ecosystems.

Selection of the appropriate method depends on the technical and geological characteristics of the storage and monitoring objectives. There are methods to directly monitor

CO_2 and those that indirectly observe its effect on the rock, fluid and environment. Direct measurements include analysis of fluid from deep wells or measurement of gas concentrations in the soil or atmosphere. Indirect methods include geophysical surveys and monitoring of changes in pressure in the wells or changes in pH in groundwater. When deciding on the most appropriate methods of measurement and locations must be carried out detailed research before start pumping, to serve as a reference for all future measurements. Also, each program monitoring must be flexible in order to develop a project storage. Strategies for monitoring, which can integrate all these issues, while at the same time reducing costs, will be a key component of risk analysis and security verification and efficiency warehouse.

It is possible to monitor the operation of the underground storage of CO_2 many methods that are present in the market or still in development. Research is currently underway, not only for the development of new equipment, but also to optimize the monitoring and reduction of costs.

5. CONCLUSION

Although the geological storage of CO_2 recognized worldwide as one of the credible options for mitigating climate change, there remains to establish the criteria of safety related to human health and the environment, before start development on an industrial scale. These criteria are especially important for the public and are crucial in the process of licensing that legislatures should establish details relating to safety requirements. Should mention that the criteria should be adapted to each individual site storage. The key assumption is that geological storage is to be permanent, and therefore not expected to be storage losses. However, the risk must be assessed and that the company be required to comply with measures to prevent any loss or abnormalities in the functioning of the warehouse.

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NATURAL RESOURCE MANAGEMENT AS A FUNCTION OF SUSTAINABLE DEVELOPMENT IN MODERN CONDITIONS

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Abstract: In contemporary conditions, it is increasingly emphasized the importance of sustainable development. In that sense, the protection and preservation of a healthy environment is an imperative of any modern society. It is a wide range of duties that relate to large number of subjects, from citizens through business entities to local governments and the highest social bodies and institutions.
It is generally known that business activities greatly endanger the living environment and the most affected are benefits of the earth - air, water, forests, flora and fauna. This leads even to the question of survival of all living beings on earth.
Conflict claims of economy and ecology can be balanced only with adequate management of natural resources. This practically means that using the natural resources must not endanger the living environment and resulting environmental damage must be repaired. Moreover, exploitation of renewable natural resources should be in line with the process of their regeneration. On the other side, the usage of nonrenewable resources must be conducted in an especially rational manner, which includes maximal orientation on substitutes and the recycling process.

Keywords: natural resources, sustainable development, environment, natural resources management.

1. INTRODUCTION

In the contemporary conditions, One of the basic principles of sustainable development is, of course, improvement of environmental quality. Unfortunately, there was no adequate attention paid to this matter. Serious debates on this issue started during the seventies of last century within the consideration of limits to economic growth.

Otherwise, the World is now faced with serious environmental problems of planetary importance, such as:

1. "Ozone holes"- damaging the ozone layer that protects all living things on Earth from harmful ultraviolet rays of the sun;
2. "Greenhouse effect"- continual warming of the planet that could lead to melting of eternal snow and ice, and thus to increase water levels of seas and oceans;
3. "Harvesting" Amazonian rainforest - considered to be the lungs of the planet, thereby directly threatening the world climate.

4. "Increased pollution"- as a result of rapid economic development [1].

For this reason, the exploitation and use of natural resources must not undermine the quality of the living environment. The mankind must pay more attention to natural values as air, water, soil, forests, geological resources, flora and fauna. In this sense, natural resource management is gaining in importance.

2. TERM, CLASSIFICATION AND SIGNIFICANCE OF NATURAL RESOURCES

There are a considerable number of definitions of natural resources in economic theory. Every their author has his/her view and points out their character, their significance and the role in economic development, however, among these definitions there are no substantial results. We will point out some of them.

According to Komar, the resources mean energy that is used in the production process in accordance with the development of productive forces [2]. According to Branko Djeric, natural resources constitute a special segment of manageable nature that is a part of nature that is used in the economic development and can be economically valorized [3]. Further, for Blagoje Zarkovic, natural resources are different types of natural wealth which are the basis of human life and its production activities [4]. Finally, a rather complete and comprehensive definition of natural resources was given by professor Gojko Rikalovic. According to him, 'the natural resources" are specific forms of natural conditions in that stage of economic development involved in the reproduction process and are directly exploited in the production or processing. What elements of nature will appear as natural resources depend on the achievements in the development of technology, the economic possibilities and appropriateness of use and the level of exploitation"[5].

From all the aforementioned it comes out that natural resources are only one part of the natural conditions, that is a gift of nature, which is used in the process of reproduction to create new useful values.

Otherwise, the resources in nature, depending on the criteria that are used in this field, are classified in different ways. One of the most common classifications is according to the degree of depletion. According to this division, all natural resources are classified as:

1. Depletable, and
2. Undepletable.

Depletable natural resources are reduced or depleted during use. Besides, it is especially important whether these resources are reproduced or regenerated by their use. Accordingly, depletetable resources are divided into:

1. Renewable energy, and
2. Non-renewable

Natural resources as soil, flora and fauna and some mineral resources that renew or regenerate at exploiting belong to this group. In contrast to renewable, non-renewable natural resources reduce or deplete by use. Such characteristics have energy mineral resources as well as metals and nonmetals.

On the other hand, a particular group is made by undepletable natural resources. They are in the space frames considered final, but from the point of use are unlimited or abundant. The first group of natural resources include: solar energy, air, wind, water, seas and oceans, tides, geo energy etc. It should be pointed out that between depletable and undepletable natural resources there is no strictly established difference, however such division can be considered conditional.

In economic theories, in addition to this, there are also many other divisions of natural resources. Here are some of them:

According to the possibility of exploitation:

1. Potential natural resources that will be used in the far future;
2. Natural resources that are to be considered in the near future, and
3. Natural resources, that can be used now.

According to the possibility of compensation [6]:

1. Recoverable, and
2. Irreplaceable natural resources

According to the possibility of replacement – substitution:

1. Replaceable, and
2. Irreplaceable natural resources

According to the degree of exploration:

1. Available, and
2. Unavailable natural resources.

It is interesting to mention that the S. Milenkovic classifies all natural resources into 19 groups and N. Rainer in as many as 74 units [7].

Economic resources represent an important factor of economic development. Although their importance somehow decline due to continued advances of science, engineering and technology, knowledge, skills and craftsmanship in their work, they will still be an essential factor in defining the economic structure and economic development in general, especially in underdeveloped countries. Also, they play an important role in maintaining a healthy environment. Their exploitation should be conducted in conformity with prescribed standards without endangering living environment and human health.

3. MANAGEMENT OF ECONOMIC RESOURCES

Dynamic economic development with environmental protection justifies the need to control economic resources. This is a wider public interest. Every country aims to adjust the economy to its comparative advantages of development, before all to available natural resources.

Otherwise, under the management of economic resources means a set of measures, methods and activities that provide the optimum level of exploitation of these resources to the achievement of desired economic and social objectives. Basically, these activities are based on the principles and assumptions of the concept of sustainable development. In addition, the sustainable development means the harmonized system of technical, technological, economic and social activities in the overall development in which natural and real values of the Republic of Serbia are used on the principles of economy and ratio in order to preserve and enhance environmental quality for present and future generations [8].

Management of natural resources includes three segments:

1. Strategic planning,
2. Realization of the strategic settings, and
3. Controlling the execution of strategic goals.

Management of natural resources begins with strategic planning. This is the first stage at which goals and objectives and the means and methods to achieve them are established. Relevant documents define the level of exploration of natural resources by type, spatial distribution, diversity, volume and quality, then, the balance sheet categories (spatial and temporal features, quantity, quality, vulnerability, reproducibility, strategic reserves) and the foreseen trends of change and a way of evaluating the conditions for sustainable economic use of resources and goods. Then, for each individual economic resource and the good, through plans, programs and principles the ways of utilization and protection are carefully elaborated.

The next stage is the realization of goals and objectives stipulated by the strategic documents and plans, programs, and foundations. Legal entities and individuals use the natural resources on the basis of the offered projects and approval of the competent state authorities. In addition, economic and other entities are obliged when use natural resources to follow the appropriate legislative and other prescribed standards in this field.

Use and protection of natural resources and goods are subject of control of appropriate authorities. According to applicable legislation, the control of these activities is performed by authorities and organizations of the Republic of Serbia, the Autonomous Province of Vojvodina and local authorities.

In the past, the pursuit of a rapid economic development, caused a high degree of depletion of natural resources, both renewable and non-renewable, which led to some disruption of balance in nature and threats to the environment. Here are a few examples:

In the second half of the 20th century due to poor processing methods about 550 million hectares, or one third of arable land all over the world was degraded. Such tendencies are still in progress;

Reduction of the forest area. It is estimated that the annual cut down is about 30 million hectares of forest. It has an unfavorable impact on the ecosystem, given that forests absorb large amounts of harmful carbon dioxide while producing necessary oxygen [9].

Besides, other resources as water, flora and fauna, air and living environment in general are endangered. In some areas the situation is alarming. Something similar is the situation of non-renewable resources.

In such circumstances, the question arises: how to harmonize relations between economy and ecology? The answer is to be found in the strict application of the concept of sustainable development.

3.1. MANAGEMENT OF RENEWABLE NATURAL

Renewable resources, as noted above, represent a special group of depletable resources. They are spent at use, but at the same time restore, or regenerate. The essence of management of these resources is reflected in harmonizing the relationship between the degree of depletion and the degree of regeneration.

Bearing in mind that the flora and fauna are the most important segment of renewable resources, the greatest attention is paid to management of these resources. Every year an annual plan of production (growth) is made for each species of plants and animals as well as for the scope of use (depletion), then, the way of the plan realization, and ultimately the control of execution of planned objectives.

Accordingly, the annual volume increase of timber in the year 2007 in the forests of Serbia is 9,079,772 m², while the volume of forest cut amounts 2,247,000 m² which is several times smaller than the increment. To this fact the resulting damage to forests as for example natural drying and a certain amount of uncontrolled timber cut that is not recorded should be added to this calculation.

Special attention is given to the wild flora and fauna. By appropriate regulation issued by the Government of the Republic of Serbia, various species of flora, fauna and mushrooms are considered as a protected species and under what level of control can be collected from natural habitats, use and trade. The main objective of oversight of the collection, use and trade of protected species is based on ensuring their sustainable use, preventing the collection of these species from natural habitats in amounts and ways that would threaten their survival in the future, the structure and stability of such living communities.

Based on the estimated status of species in their natural habitats, every year the annual quantities of protected species that may be collected for commercial purposes are established. In addition, for each protected species the conditions and manner of collection are regulated. So, for example, collecting endangered species of flora, depending on which parts or developmental stages are used, are under condition that such species are collected in the optimal stage of vegetative development for use. It is also regulated at what species where underground organs are used, a part of the underground organ is to be left in the soil together with vegetative bud.

According to a prescribed contingent of wild plant species, and the advertised announcement, the competent ministry shall grant licenses to interested legal entities and

entrepreneurs for the collection, use and trade of wild flora. For this purpose, an adequate compensation will be paid.

The species and quantities of wild plants that can be collected in the year 2011 are shown in the table below [10].

Table 1. Contingents of wild flora and mushrooms that can be collected in the 2041 (Selected species with larger quantities)

No. Latin name	Traditional English name (for existing) plants	Quantity in kg
A. PLANT SPECIES		
1. Achilla millefolium L.	1. Milfoil, Verbena	140,000
2. Allium L. ursinum	2. Cremosa, Bear garlic	600,000
3. Althaea officinalis L.	3. Marshmallow, Sweet Mallow	230,000
4. Betula pendula Roth	4. Birch	160,000
5. Centaurium umbelatum Gilib	5. Brush, stave, Grass of fever	25,000
6. Cornus mas L.	6. Cornel berry	200,000
7. Crataegus monogyna Jacq.	7. White hawthorn, hawthorn	260,000
8. Crataegus L. oxycantlia	8. Red hawthorn	100,000
9. Fragaria vesca L.	9. Wild Strawberry, Strawberry	330,000
10. Geranium robertianum L.	10. Mercury grass, Needle	80,000
11. Hedera helix L.	11. Ivy	300,000
12. Hypericum perforatum	12. St. John's Wort, Virgin's grass	250,000
13. Juniperus cemunis	13. Juniper, Cade	2,000,000
14. Juniperus communis L. Ssp. nana Syme	14. Low Juniper	100,000
15. Ononis spinosa L.	15. Rabbit thorn, Wolf thorn	100,000
16. Origanum vulgare L.	16. Oregano	100,000
17. Petasites hybridus L.	17. Cocklebur	150,000
18. Prinus spinosa L.	18. Blackthorn	180,000
19. Rosa canina L.	19. Wild Rose, Hip rose	5,000,000
20. Symphytum officinale L.	20. Black comfrey, comfrey	300,000
21. Teuorium chemaedrys L.	21. No traditional name	50,000
22. Thymus serpyllum	22. Thyme	300,000
23. Tilia tomentosa Moench	23. White lime, Silver linden	80,000
24. Vaccinium myrtillus L.	24. Blueberry	3,100,000
B. MUSHROOMS		
1. Boletus edulis Bull. Fr	1. Summer, autumn porcini	5,000,000
2. Cantharelluss cibarius L.Fr.	2. Chanterelle	1,800,000
3. Craterelluss cornucopiodes Pers.	3. Brown trumpet	500,000
4. Lactarius deliciosus LSFGray	4. No traditional name	150,000
5. Marasmius oreades Fr.	5. Oread	50,000

Source:Official Gazette of Republic of Serbia.

A similar procedure is carried out for wildlife fauna is concerned. For example, collecting of protected species of snails can be done from 1 June to 1 October, frogs from 1 June to 1 August and fish (beluga) from 1 June of 31 March of the next year. It is forbidden to collect, use and trade the following sizes of protected species – snails with shells width less than 3 cm, frogs weighing less than 50 grams and bigger ones of more than 120 grams, or length of

less than 9 and bigger than 15 cm, more than 50 individuals of horned viper at the site of collection and whose length is less than 50 cm and males at the site collection and whose length is less than 50 cm, and beluga male, whose length is less than 180 cm in length and females less than 210 cm. The species and quantities of animal species that can be collected in the year 2011 are given in the table below.

Table 2. Contingents of fauna that can be collected in the year 2014

No.	No. Latin Name	Traditional English name	Quantity in kg
1.	Hirudo medicinalis	Medical leech	500
2.	Pelophylax kl. esculenta	Edible frog	5,000
3.	Pelophylax ridibunus	Frog	5,000
5.	Helix aspersa	Garden snail	200,000
6.	Helix leuceru	Forest gray snail	200,000
7.	Helix pomatia	Vineyard snail	200,000

Source:Official Gazette of Republic of Serbia.

Depending on the assessment of the situation in the field, the Ministry may provisionally prohibit the collection of certain endangered species of flora and fauna in certain areas, or on the other hand, in the entire state. In this way it protects the survival of some species and prevents disturbance of the structure and stability of living communities.

However, it should be noted that many failures occur in this field. There is no adequate assessment of the situation in the field, so it happens that much larger contingents of objectively possible are approved for collecting and trading. This can greatly endanger the continued survival of some species, especially flora. Such is the case with the following species of wild flora: Alchemilla sp., Centraurium umbelatum Gilib, incana Lam., Lamium albumh., Marrubium vulgare L., Polygonum bistorta L., Potentilla erecta (L) Rauschel, Primula elatior (L) Hill, Primula veris L., Primula vulgaris Hudson etc.

Besides the aforementioned, it is important to add to the state of the hunting game. In this field every year a draft plan containing the state of hunting game and allowed shooting possibility. This plan applies to the Republic of Serbia and hunting areas - regions. In doing so, one must take into account the sustainable use, in order not to jeopardize the survival of certain species.

The following explanations present some examples of management of renewable natural resources. A similar approach is applied in other areas when these resources are concerned.

3.2. MANAGING NON-RENEWABLE NATURAL

Unlike the previous group of resources, management of non-renewable natural resources is much more complicated and complex. These resources permanently reduce by their utilization. This group includes mineral resources.

Mineral resources, because of their specificity, require adequate management, primarily of strategic character, in order to achieve desired goals by their exploitation, above all, the optimum level of efficiency and effectiveness.

The basic approach in the management of non-renewable natural resources (minimal resources) reflects a high degree of rationality in their use. This is achieved by intensive exploitation whose main goal is to achieve maximum utility with the minimal possible natural resources.

By strategic management of mineral resources at one side, their quasi-use, should be provided and on the other side, the planned economic growth. In other words, the management of these resources has to ensure achievement of sustainable development.

When it comes to managing of non-renewable resources, the question of substitution and recycling is unavoidable. This is one of the ways of their conservation and rational use. Development of science and technology opens the way for the application of various forms of substitution. This particularly applies to the replacement of non-renewable resources, and finding suitable substitutes for nonrenewable natural resources.

The other area, also of importance for the management of natural resources is recycling. The advantages of recycling are numerous: protection and conservation of natural resources, ensuring quality and low cost of raw materials for processing industry, maintaining a healthy environment etc.

Exploitation of mineral resources can greatly undermine the quality of the living environment. This usually leads to land degradation, destruction of flora, pollution of the environment - air, water, to the endangerment of human health.

The essence of management of mineral resources in these circumstances is reflected in the effort to reduce the damage to the natural environment, as well as their proper removal. Environmental costs borne by entities that led to their creation. They are counted in the cost and further transferred to selling prices of products.

In this respect the principle of prevention and precaution provides that "any activity must be planned and implemented so as to: cause the least possible change in the living environment, is the least risk to the environment and human health, reduce the load space and the consumption of raw materials and energy in building , production, distribution and utilisation, include the possibility of recycling, prevent or limit environmental impact at the very source of pollution.

The precautionary principle is realized by assessment of environmental impact and using the best available technology and achieved technology, know-how and equipment'. [10].

4. CONCLUSION

Natural resources are an essential factor of economic development and preserving a healthy environment all over the world. Although their importance is somehow declining in terms of economic development, because other factors of development get more and more important role (technology, know-how and especially knowledge), thus their role in the ecological sense is growing.

Economy and ecology ones from two conflict areas have become complementary ones. Permanent technical and technological progress allows business activities without any major damage to the environment at one side, while a healthy natural environment contributes to the

preservation of natural values and human health, on the other side. This provides both economic growth and conservation of the living environment.

The realization of such complex goals can be achieved only with adequate management of natural resources. It is a complex and responsible, but inevitable process in contemporary business activities. Only by sustainable use of natural resources (renewable and non-renewable) economics and ecological stability, all this can be achieved with the goal of economic development and increase of overall human welfare.

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COMPARISON OF WQI MODELS

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Abstract: Surface water quality is assessed using water quality index (WQI). Since there is no global standardization of methods, the software for evaluation of WQI (which consists of two sub-models WQI-1 and WQI-2), based on experimental and literature models, partially compliant with the standards of authorized institutions in Serbia, recommendations of the World health Organization (WHO) and EU Directives was generated in this work. WQI-1 program is illustrated with the example of processing parameter values of the water quality of the Danube at the location Bezdan in 2009. Then, for each of the 17 measuring locations on the Danube water quality was evaluated by methods SWQI, WQI-1 and WQI-2, with the range of quality according to EU recommendations, followed by a comparison of results. The mean value of the index of water quality according to SWQI method is increased by 3.810 index points compared to the WQI-1 method and 14,462 compared to the WQI-2 method. Water quality determined by methods of WQI-1 and WQI-2 is one rank lower than the rank of a certain SWQI method.

Keywords: WQI model, comparison, water quality, the Danube.

EVALUATION OF AIR QUALITY IN BELGRADE URBAN AREA

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Abstract: In this work, air quality data (CO, SO_2, O_3, PM_{10}, $PM_{2.5}$ and NO_2) corresponding to the time period between 2010 and 2011 and collected at two monitoring stations in Belgrade, Serbia, were used in order to compute air quality index (AQI). AQI is ranking air quality, measured at a given measurement point within a certain period of time, as good, bad, very polluted. And it is very easy interpretable by public. The results have shown that the level of air pollution at both monitoring stations can be described as good and moderate for SO_2, NO_2, CO and O_3 for the whole measurement period. AQI values for PM_{10} concentrations were described as moderate and good, for the 96% of days per year, and 'unhealthy for sensitive groups' for 4%. of the year. Regarding the concentration of $PM_{2.5}$ air quality was classified as good and moderate for almost 70% days a year, the other 30% were classified as unhealthy and very unhealthy.

Keywords: AQI, urban air pollution evaluation, linear regression

1. INTRODUCTION

The problem of air pollution in urban areas has existed for decades, but the attitude toward it has changed over time (Fenger, 2009). To a certain extent it was considered as a symbol of prosperity and development, so all attempts to solve the problem remained without results. However, in the mean time the world has changed dramatically: the world's population has doubled, the number of people living in cities has increased four times and energy consumption at a global level almost five times.

In most of the developed countries, the air quality in urban areas has been greatly improved in the last 50 years. However, in economically less-developed countries, economic development still has an advantage over ecology (McGranahan and Murray, 2003). In Latin America, Asia, and in some European countries, most of the population is moving to the cities, and also because of the very strict environmental standards developed countries are transferring their industry in the countries with more liberal standards regarding this issue.

The main sources of pollution in urban areas are anthropogenic in origin, and primarily these are industry and traffic. Given that some urban areas don't have a typical industrial area, in such areas pollution comes from other sources, primarily from traffic. In the less developed countries of Europe (which includes Republic of Serbia) the process of migration from rural to urban areas was evident, which as a result brought to increase of greenhouse gases emissions, primarily through increasing traffic frequency. The number of vehicles which use Euro 4 engines is still small in this part of Europe (Baldasano et al., 2003). On the other hand,

frequency of the traffic is becoming larger each year, so according to the official report of the Serbian Ministry of Interior, the total number of registered motor vehicles in Belgrade, in 2009, was 568 200 (MIRS, 2009).

In 1976. EPA introduced Pollutant Standard Index (PSI), which was used to determine the air quality in urban areas. PSI daily value was determined based on a highest concentration of one of the five major pollutants: PM_{10}, O_3, SO_2, CO and NO_2. PSI did not take into account the impact of other pollutants that are also harmful to human health (Qian et al., 2004). PSI was replaced in 1999 with Air Quality Index (AQI), and included $PM_{2.5}$, in addition to the existing pollutants. Although AQI has fully replaced the PSI in the U.S., most of the other countries were not able to accept AQI, because measurements of $PM_{2,\ 5}$ required very expensive equipment (Cheng et al., 2007).

AQI is ranking air quality, measured at a given measurement point within a certain period of time, as good, bad, very polluted. And it is very easy interpretable by public. The higher the AQI value, the greater the air pollution and the greater the danger to the environment. Traditionally, AQI is calculated by comparing measured values of pollutants' concentrations with standard values. Given that in the EU air quality regulation which is accepted by the Serbian national regulations doesn't exist uniquely defined AQI, the Serbian Agency for Environmental Protection defined Serbian Air Quality Index (SAQI). Serbian air quality index (SAQI) has 5 categories depending on the concentrations of some pollutants (SEPA, 2011). Values of the pollutants' concentrations by category of air quality index SAQI, for 2011, are given in Table 1.

Table 1. Serbian national ambient air quality standards

Time period	Pollutants	limit value	tolerance value	Excellent	Good	Acceptable	Polluted	Very polluted
	SO2	125		0-50	50.1-70	75.1-125	125.1-187.5	>187.5
	NO2	85	125	0-42.5	42.6-60	60.1-85	85.1-125	>125
24 h	PM10	50	75	0-25	25.1.1935	35.1-50	50.1-75	>75
	CO	5000	10000	0-2500	2501-3500	3501-5000	5001-10000	>10000
	O3-8h max	120		0-60	60.1-85	85.1-120	120.1-180	>180
	Black smoke	50		0-25	25.1-35	35.1-50	50.1-75	>75
	SO2	50		0-30	30.1-40	40.1-50	50.1-75	>75
	NO2	40	60	0-26	26.1-32	32.1-40	40.1-60	>60
one year	PM10	40	48	0-20	20.1-28	28.1-40	40.1-48	>48
	CO	3000		0-1500	1501-2100	2101-3000	3001-4500	>4500
	Black smoke	50		0-50	25.1-35	35.1-50	50.1-75	>75.1

Previous research concerning the determination of air quality in Belgrade (Žujić et al., 2009), has calculated the AQI based on the presence of five pollutants in the air (SO_2, CO, O_3,

NO_2, and black smoke) at the six measuring stations for the period 2003-2006 . The calculated values have shown that air quality in Belgrade for that period, can be characterized as critical and very bad for 20% of days per year, regarding the concentrations of black smoke. During the same period, in regard to other pollutants, such as SO_2 and NO_2, air quality was characterized as moderate and good, for more than 80% days per year.

For the purposes of this study, the data from the two measuring sites in Belgrade were used, in the period 2010-2011. In relation to the available data set, the AQI was calculated for six pollutants (PM_{10}, O_3, SO_2, CO, NO_2, $PM_{2.5}$), which were taken as the criteria for assessing air quality in Belgrade, using the procedure proposed by the EPA (2003). The aim of the study was to determine the status of air quality in the capital of Serbia, in the most understandable way to the public.

2. MATERIALS AND METHODS

Area of study

Belgrade, the capital of Serbia, (latitude 44° 27 44N, longitude 20 27 44E), has about 2 million inhabitants and it is located at 116.75 m above sea level, at the confluence of the Sava and Danube. Climate, typical for this area is moderate continental with four seasons, while the average annual temperature is 11.7°C.

Republic of Serbia is part of the European network for continuous monitoring of air quality. Pollutants' concentrations are measured at 41 locations around the country. In Belgrade are operating 6 measuring stations for measuring the air quality. Their control and calibration is supervised by the official Agency for Environmental Protection, which operates under the Ministry of Urbanism and Environmental Protection. Air quality data are available on the Agency's website in real time (www.sepa.gov.rs). In this paper data from two automatic measuring stations in Belgrade, were used. Table 2 shows the characteristics of the measuring stations. Two different types of measuring stations were selected on purpose, a typical traffic and one with less traffic frequency, in order to determine possible differences in the quality of air regarding the present pollutants' concentrations.

Table 2. Characteristics of measuring stations

Name	Longitude	Latitude	Altitude (m)	Operated since	Pollutants measured	Type of station
Pancevo bridge	20°49E	44°81N	105	2007	SO_2, NOx, NO, NO_2, CO, O_3, BTX, PM_{10}, $PM_{2.5}$, PM_1	Urban traffic
Zeleno brdo	20°53E	44°78N	243	2008	SO_2, NOx, NO, NO2, CO, O_3, BTX, PM_{10}, $PM_{2.5}$, PM_1	Urban background

Data analysis method

For calculation of AQI value the procedure proposed by the Environmental Protection Agency (2003) was used. First, the sub-index for each pollutant was calculated separately

according to the proposed procedure (EPA, 2003), and then as AQI daily value was taken sub-index of the pollutant which has the highest value (Sharma et al., 2003b). The equation for calculating the quality sub-index for each pollutant separately is given below:

$$Ip = \frac{Ihi - Ilo}{BPhi - BPlo} * (Cp - BPlo) + Ilo \quad (1)$$

Where: I_P= the index for pollutant P

C_P = the rounded concentration of pollutant P

BP_{HI} = the breakpoint that is greater than or equal to Cp

BP_{LO} = the breakpoint that is less than or equal to Cp

I_{HI} = the AQI value corresponding to BP_{HI}

I_{LO} = the AQI value corresponding to BP_{LO}

Table 3. Breakpoint concentrations defined by the US Environmental Protection Agency for the calculation of AQI

	SO_2 (24h average in µg/m^3)	NO_2 (1h average in µg/m^3)	PM_{10} (24h average in µg/m^3)	CO (8h average in mg/m^3)	O_3 (8h average in µg/m^3)	$PM_{2.5}$(24h average in µg/m^3)
0-50	0-90	*(NO2 has no short-term NAAQS)	0-50	0-5.1	0-128	0-15.4
51-100	91-383		51-143	5.2-10.9	129-168	15.5-40.4
101-150	384-596		144-237	11-14.4	169-208	40.5-65.4
151-200	597-809		238-330	14.5-17.9	209-248	65.5-150.4
201-300	810-1607	1244-2373	331-395	18-35.4	249-748	150.5-250.4
301-500	1608-2673	2374-3903	396-563	35.5-58.7		250.5-350.4

Table 3 shows the breakpoint concentrations for each pollutant that is used in process od AQI calculation. Breakpoint concentrations vary from standard to standard and different standards are given in the literature, depending on the country to which they relate (Nagendra et al., 2007). In Serbia, for example, according to SAQI, air quality can be assessed as excellent, good, acceptable, polluted and very polluted (Table 1). Given that different pollutants were used in this study (PM_{10}, O_3, SO_2, CO, NO_2, $PM_{2.5}$), compared to the SAQI (SO_2, CO, O_3, NO_2, PM_{10} and black smoke), AQI was determined based on the standards proposed by the EPA (2003). Table 4 shows the extent of AQI, health effects that each category has and labeling with colors, as proposed by the EPA (2003).

Table 4. AQI range

Index values	Descriptor	Color codes	Purpose
0-50	Good	Green	Convey positive message about air quality
51-100	Moderate	Yellow	Convey message that daily air quality is acceptable from public health perspective, but
101-150	Unhealthy for sensitive groups	Orange	Health message for members of sensitive groups
151-200	Unhealthy	Red	Health advisory of more serious effects for sensitive groups and notice of possible
201-300	Very unhealthy	Purple	Health alert of more serious effects for sensitive groups and the general population.
301-500	Hazardous	Maroon	Health warnings of emergency conditions

Source: Environmental Protection Agency

3. RESULTS AND DISCUSSION

According to the aforementioned EPA procedure, AQI values were calculated for two measuring stations in Belgrade. Tables 5 and 6 show calculated sub-indices for measuring points Zeleno brdo and the Pancevo bridge, for the period 2010-2011.

Table 5. AQI value for measuring point Zeleno brdo, period 2010-2011.

Pollution category	2010						2011					
	SO_2	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$
Good	81.7	100	100	98.8	73.8	31.1	98.9	100	100	88.8	98.9	33.7
Moderate	18.3	0	0	1.2	25	39.6	1.1	0	0	11.2	1.1	64.1
Unhealthy for sensitive groups	0	0	0	0	1.2	13.4	0	0	0	0	0	2.2
Unhealthy	0	0	0	0	0	15.3	0	0	0	0	0	0
Very unhealthy	0	0	0	0	0	0.6	0	0	0	0	0	0
Hazardous	0	0	0	0	0	0	0	0	0	0	0	0

The values denote percentages of days in each year

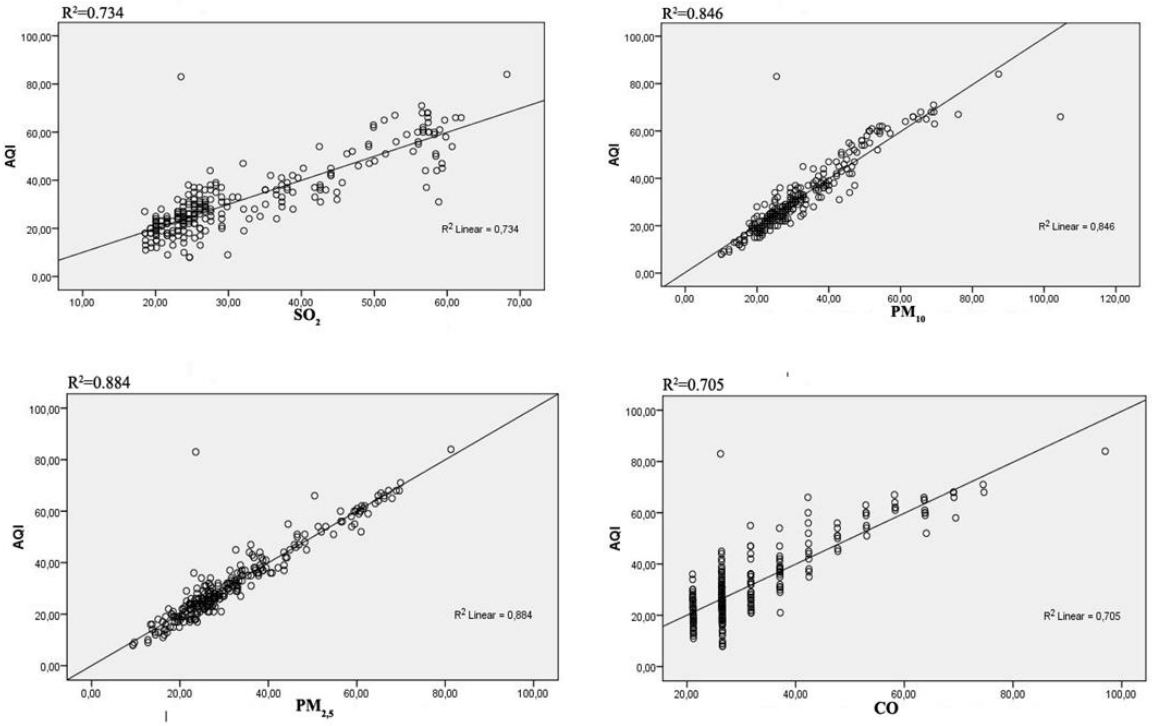
Table 6. AQI value for measuring point Pancevo bridge, period 2010-2011.

Pollution category	2010						2011					
	SO_2	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$
Good	100	88	100	99.2	69.6	26.5	100	100	100	100	55.2	7.6
Moderate	0	11	0	0.8	27.2	47	0	0	0	0	40.7	73.8
Unhealthy for sensitive groups	0	1	0	0	3.2	14.2	0	0	0	0	4.1	8.9
Unhealthy	0	0	0	0	0	11.9	0	0	0	0	0	8.3
Very unhealthy	0	0	0	0	0	0.4	0	0	0	0	0	1.4
Hazardous	0	0	0	0	0	0	0	0	0	0	0	0

The values denote percentages of days in each year

Results obtained by calculating sub-indices for each pollutant have shown that the air quality at sampling location Zeleno Brdo (Table 5), for the period 2010., can be classified as unhealthy and very unhealthy for almost 30% of the year regarding the concentration of $PM_{2.5.}$ Regarding the concentrations of other pollutants (SO_2, CO, O_3, NO_2) air quality was described as good or moderate for the whole year. Very encouraged is the fact that it is seen progress in improving air quality for the period of 2011 compared to 2010. In that way the percentage of days, which were rated as unhealthy and very unhealthy, regrading the concentrations of $PM_{2.5}$ decreased from 30% to only 2.2% per year.

Table 6 shows the air quality sub-indices calculated for all pollutants for measuring point Pancevo bridge, for the period 2010-2011. Air quality at this measuring point can be classified as unhealthy and very unhealthy for almost 30% of the year regarding the concentration of $PM_{2.5}$. Regarding the concentrations of other pollutants (SO_2, CO, O_3, NO_2) air quality was described as good or moderate for the whole year. It may be noted that the obtained results are the same as in the case of the measurement point Zeleno brdo. At the measuring point Pancevo bridge was also noted a slight improvement of air quality regarding the concentrations of $PM_{2.5}$, and the number of days when air quality was classified as unhealthy and very unhealthy decreased from 30% in 2010. to 20% of the days in 2011.



Slika 1. Linear regression of calculated air quality index (AQI) and each sub-index at measuring point Pancevo Bridge (2010–2011) in Belgrade urban area.

Linear regression was performed in order to investigate the relation between the air quality index (AQI) and the sub-indices, as shown in Figure 1. Value of NO2 sub-indices was very low throughout the study period so that it is not taken into account. The Figure 2 shows that PM10 (R2 = 0.846), PM2.5 (R2 = 0.884), SO2 (R2 = 0.734) and CO (R2 = 0.705) showed a

good relation with air quality index. The results also showed that there is no association between O3 sub-indices (R2 = 0.043) and AQI.

These results do not surprise, given that with increased urbanization, accompanied by the increased frequency of traffic, there has been observed an increase in PM2.5 concentrations in other urban areas (Wang et al., 2005). The major sources of this pollutant are dust, secondary aerosols, traffic, but it also has been proven that meteorological conditions have a major influence on its formation (Zhao et al., 2009). Due to the increased concentrations associated with serious health consequences in relation to the larger particles (PM10), measurement of PM2.5 is very important in order to control its concentration (Wilson and Suh, 1997).

4. CONCLUSIONS

This paper presents air quality assessment, based on data collected at two monitoring stations in the urban part of Belgrade, in the time period 2010-2011 AQI was calculated for pollutants, PM_{10}, O_3, SO_2, CO, NO_2, $PM_{2.5}$, which are labeled as the air quality criteria according to the procedure prescribed by the EPA. The results have shown that the level of air pollution at both monitoring stations can be described as good and moderate for SO_2, NO_2, CO and O_3 for the whole measurement period. AQI values for PM_{10} concentrations were described as moderate and good, for the 96% of days per year, and 'unhealthy for sensitive groups' for 4%. of the year. Regarding the concentration of $PM_{2.5}$ air quality was classified as good and moderate for almost 70% days a year, the other 30% were classified as unhealthy and very unhealthy. The good side of the obtained results is the fact that improvement of air quality regarding $PM_{2.5}$ concentrations can be observed in 2011, from 30% of days classified as unhealthy to 2.2% per year for measuring station Zeleno brdo. A somewhat smaller improvement was recorded at the measuring station Pancevo bridge (from 36.5% to 18.5% days per year).

Since it was found that fine particles $PM_{2.5}$ are biggest "culprit" for the poor air quality in Belgrade, it should be paid attention to the need for caution in charge of controlling and reducing its concentration.

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ANALYSIS OF FERTILITY AS AN ASPECT OF SUSTAINABLE DEVELOPMENT OF SOIL IN ČAČAK BASIN

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Abstract: The paper looks at the presence of basic chemical parameters used for determination of soil fertility contained in alluvial soils on the territory of Čačak. Arable soil samples were collected from 30 different locations in the close vicinity of the river Zapadna Morava, in both urban (industrial) areas of the town and rural areas of the town. Samples were taken from 0–30 cm depth and analysed for the chemical reaction (pH), percentage of humus content, total nitrogen content (N), and available phosphorus (P_2O_5) and potassium (K_2O) contents. The analysed sites were ranked using the PROMETHEE method with the results and graphic layout expressed through GAIA plane. The ranking involved five criteria which represented the values of each of the analysed parameters. According to the values of the Shapiro-Wilk's test (0.05 significance level), contents of all the elements examined, were within the limits of normal distribution. Statistically significant positive correlations were found between K_2O – humus, K_2O – N ($p < 0.05$), and humus – N, K_2O – P_2O_5 ($p < 0.01$). According to the results of T-test, there was no statistically significant difference between the sites located in rural area of the town and the ones located in urban (industrial) area. Generally, our study infers that the alluvial soil in the municipality of Čačak can be considered as agriculturally safe and fertile.

Keywords: Čačak, fertility, PROMETHEE/GAIA, soil.

1. INTRODUCTION

Like air and water, soil is an integral component of our environment, and together with water constitutes the most important natural resource. The wise use of this vital resource is essential for sustainable development and feeding the growing world population [1]. Allowing primary production in terrestrial ecosystems, soil provides about 99% of food for humanity and is a precondition for existence of life on earth. For this reason it is necessary to maintain its function and quality [2].

From the ecological standpoint, the most important characteristic of soil is its fertility. Fertile soil represents the basic means for agricultural production. Soil exploitation often leads to the disturbance of balance among soil components, which inevitably leads to its damage. Soil is strongly influenced by the manner of cultivation, application of fertilizers and chemical melioration agents. Fertility is the ability of soil to provide plants with necessary nourishment,

water, air, heat, and other factors of life during the entire growing period, so as to achieve maximum yields [2]. Many agro chemists interpret fertility as the content of soil nutrients available to plants. Thus, a high level of fertility implies high organic matter content, high content of different forms of nitrogen, phosphorus and potassium available to plants, as well as pH value close to neutral.

According to the data listed in the National Strategy of Sustainable Development [3], over the past fifteen years the share of agricultural soil in Republic of Serbia has decreased by 10.6%, while the share of arable soil decreased by 10%.

The National Strategy addresses the key national priorities of the Republic of Serbia, whose fulfillment will most contribute to achieving the vision of sustainable development by 2017. The fifth section presents the objectives, priorities and measures related to the protection of natural resources, among others, of the soil.

The strategic objectives of sustainable soil use include:

- Harmonization of legislation relating to the use and protection of soil with EU legislation;
- Preventing further loss of soil and the conservation and improvement of its quality, especially through industrial, mining, energy, transportation and other activities;
- Protection against degradation and soil use changes, and development of agricultural soil.

Similar conclusions are also listed in the National Programme of Environmental Protection [4]. It states the following:

- In order to preserve diversity within the integrated system of environmental protection, it is necessary to monitor the state and soil use patterns, to identify sensitive and loaded areas, define the extent and characteristics of soil pollution;
- The main goal of progress in sustainable soil use in the Republic of Serbia should include better integration of soil protection into sectoral, local and regional policies and plans, implementation and wider application of proven techniques and best practices for rehabilitation and remediation.

This document lists "the lack of systematic monitoring of soil quality" as one of the problems in the framework of sustainable soil use in the Republic of Serbia.

Hence, the subject of this paper was: (1) to determine the concentrations of basic parameters of soil fertility contained in alluvial soils which are used for agriculture [5-12] on the territory of Čačak; (2) to analyze their mutual relationships [8, 9]; (3) to rank the investigated sites in terms of the presence of the mentioned elements; (4) to determine if there is statistically significant difference between the sites located in rural area of the town and the ones located in urban (industrial) area. The ranking of sites which involved five criteria (chemical reaction (pH), percentage of humus content, total nitrogen content (N), and available phosphorus (P_2O_5) and potassium (K_2O) contents) was done using the PROMETHEE (Preference Organization Method for Enrichment Evaluation) multi-criteria

decision making method, while the GAIA (Geometrical Analysis for Interactive Assistance) plane was used for the graphical representation of results. A comparative analysis of results of related studies performed by other authors was also provided in the paper so as to obtain a more comprehensive insight into the issue.

2. MATERIALS AND METHODS

2.1 STUDY AREA

The city of Čačak is located in western part of central Serbia with the municipalities of Gornji Milanovac to the north, Požega to the west, Lučani to the southwest and south, and Kraljevo and Knić to the east. It is the administrative center of the Moravica District. The geographic coordinates of the city are 20° 07' – 20° 38' east longitude and 43° 44' – 44° 01' north latitude.

The pedological composition of the Čačak territory is diverse. The most common soil types are alluvial soil, vertisols, cambisols, and parapodzol. Alluvial soil is formed from deposits made by rivers, and it can be found in the Čačak basin all along the West Morava River. Morphologically, the Čačak basin is a tectonic depression formed in the Oligocene by the lowering movement of two longitudinal faults. The surface area of the Čačak basin towards the Kraljevo narrowing is over 270 km^2. The basin lies at an elevation of 200 to 300 m. Alluvial soils belong to fertile soils, particularly in mid – and low river courses. They are composed of river sediment, silt, sand and gravel deposited during floods. They are highly rich in organic matter and is easy to work [7].

This is the region with probably the most diverse agricultural production on the territory of entire Serbia. Based on the data of the Republic Institute for Statistics, the surface area of Čačak is 636 km^2, whereby agricultural areas cover 433 km^2 (68% or 44.060 ha). According to the 2002 census, the city of Čačak (the municipality of Čačak, at the time of census) had the population of 117.072, with 73.152 and 43.920 people living in the urban and rural areas respectively [14]. Based on the number of people employed in various agricultural activities, agriculture is the primary branch of economy [13].

Table 1 shows names of places and coordinates of the sampling sites examined. The exact position of each sampling site was recorded using Global Positioning System (GPS). These locations, extending from Pakovraće and Prijevor in the North West to Mrčajevci and Mršinci in the south east, form the agriculturally important region of central Serbia.

Table 1. Sampling locations

Site	Location	Coordinates		Altitude [m]
		[N]	[E]	
1.	Parmenac	43° 53' 50.2404"	20° 17' 40.3044"	246
2.	Pakovraće	43° 54' 2.361"	20° 15' 58.4238"	253
3.	Riđage	43° 53' 50.0526"	20° 16' 45.0942"	281
4.	Beljina	43° 53' 37.8018"	20° 19' 22.4106"	243
5.	Ljubić Kej	43° 54' 5.2266"	20° 20' 12.7068"	237
6.	Prijevor	43° 53' 55.773"	20° 17' 27.7434"	246
7.	Prijevor	43° 54' 9.8748"	20° 17' 11.364"	247
8.	Prijevor	43° 54' 25.4298"	20° 16' 25.4202"	250
9.	Prijevor	43° 54' 2.7396"	20° 16' 22.695"	246
10.	Suvi Breg	43° 54' 1.0542"	20° 19' 7.2372"	240
11.	Stančići	43° 52' 56.1288"	20° 26' 34.8756"	223
12.	Mojsinje	43° 52' 57.648"	20° 27' 40.6044"	228
13.	Donja Gorevnica	43° 52' 22.8864"	20° 29' 7.0656"	223
14.	Mrčajevci	43° 51' 1.44"	20° 31' 21.36"	212
15.	Mrčajevci	43° 49' 50.3394"	20° 30' 7.4874"	211
16.	Kukići	43° 49' 56.7726"	20° 28' 23.106"	226
17.	Mršinci	43° 48' 47.2752"	20° 29' 24.2478"	224
18.	Zablaće	43° 50' 18.5742"	20° 27' 23.1084"	226
19.	Vapa	43° 51' 2.3034"	20° 26' 33.6474"	228
20.	Trnavska Baluga	43° 51' 58.8024"	20° 25' 29.4528"	225
21.	Trnava	43° 51' 52.0698"	20° 23' 57.0798"	231
22.	Atenica	43° 52' 20.9388"	20° 23' 52.4688"	230
23.	Konjevići	43° 53' 35.0946"	20° 23' 47.9934"	231
24.	Konjevići	43° 53' 37.6074"	20° 24' 12.7434"	231
25.	Konjevići	43° 52' 48.4176"	20° 24' 34.761"	228
26.	Konjevići	43° 53' 13.5558"	20° 23' 24.9678"	230
27.	Ljubić Polje	43° 53' 24.972"	20° 22' 32.4114"	232
28.	Ljubić Polje	43° 53' 50.2434"	20° 22' 1.6314"	236
29.	Preljinska Baluga	43° 53' 16.2276"	20° 24' 53.0352"	229
30.	Preljinska Baluga	43° 52' 41.8074"	20° 25' 38.6394"	225

2.2 METHOD OF SAMPLING AND MEASUREMENT

Samples were collected in spring 2013. Samples of cultivating soil (1 kg) in the disordered state were taken from depths of 0 cm to 30 cm. The sample material was thoroughly mixed and homogenized to reach the size of the analytical sample.

Six chemical parameters were analyzed: acidity i.e. soil chemical reaction (pH), percentual contents of organic matter (humus), total nitrogen content (N), content of forms of phosphorus (P_2O_5) and potassium (K_2O) available to plants, and carbonates content ($CaCO_3$) which was checked only if pH was higher than 7. Contents of the above parameters were

determined by standard methods for soil analysis used in the laboratory of the Faculty of Agronomy in Čačak. Organic matter (humus) was determined using the Kötzmann method, while pH value in 1.0 M KCl was checked using the potentiometric method (using glass elektrode pH-meter). Easily available phosphorus and potassium were determined using the Al-method according to Egner-Riehm [15], the former being identified by spectrophotometry, and the latter by flame-photometry. Total nitrogen was determined using Kjeldahl method modified by Bremner. The results are expressed in mg/100g of air-dried soil. Samples were left to air dry for 2 to 3 weeks prior to analyses.

2.3 STATISTICAL ANALYSIS

Statistical analysis, such as descriptive statistics, Shapiro-Wilk's normality test, Pearson correlation coefficient and T-test, were performed using SPSS 20.0 software for Windows.

2.4 MULTI-CRITERIA ANALYSIS

For ranking the sites according to soil fertility, seen from the point of presence of basic parameters of fertility, we have chosen the PROMETHEE multi-criteria decision-making method – MCDM [16, 17]. PROMETHEE methods are widely applied in different areas [18]. PROMETHEE/GAIA method is particularly useful for the selection of sites, ranking of sites and prioritization of remedial actions [19].

The PROMETHEE method is based on determining the positive (Φ^+) and the negative flow (Φ^-) for each alternative, towards outranking relations and in correlation with the acquired weight coefficients for each criterion-attribute [16, 17, 18]. In our research, the investigated sites served as the alternatives, whereas five analyzed elements were used as the ranking criteria.

The weighing of the criteria is known to play a major role in MCDA. It is thus essential for decision makers to be able to see to what extent changes of the weights of the criteria will impact the rankings provided by a multicriteria method [16, 17].

Defining appropriate preference function is also necessary when implementing this method. The preference function defines how pairwise evaluation differences are translated into degrees of preference. It reflects the perception of the criterion scale by the decision-maker [17]. The preference functions are crucial because they define how much one object is to be preferred to others [20].

The significant advantage of PROMETHEE is that it facilitates a rational decision making process which is achieved by virtue of a decision vector that directs the decision makers towards 'preferred' solutions [17].

In this paper, the VPSolutions Visual PROMETHEE 1.3 software was used to apply PROMETHEE I for partial – and PROMETHEE II method for complete ranking of the alternatives.

3. RESULTS

3.1 DESCRIPTIVE STATISTICS AND CORRELATIONS BETWEEN ELEMENTS

Table 2 shows the descriptive statistics for the contents of analyzed elements. Means and standard deviation used to describe central tendency and variation of the data [21] are given in the table in addition to the minimum and maximum values.

Table 2. Descriptive statistics

Parameter	pH	Humus (%)	Nitrogen (N%)	Phosphorus (P_2O_5 mg/100g)	Potassium (K_2O mg/100g)
Minimum	4,89	1,94	0,10	0,17	11,89
Maximum	7,25	5,68	0,28	22,05	38,00
Mean	6,10	3,57	0,18	8,56	23,07
Std. Dev.	0,59	0,93	0,47	6,34	5,90
Skewness	-0,165	0,431	0,484	0,431	0,289
Kurtosis	-0,450	0,090	0,083	-0,998	0,073

Skewness and kurtosis are also presented which can, to some extent, enable computing of the uniformity of the distribution which, in this particular case, was calculated using the Shapiro-Wilk's test (0.05 significance level). It renders the conclusion that all the elements, except P_2O_5 can be said to follow normal distribution of the concentrations (table 3).

Table 3. Shapiro-Wilk's normality test

Parameter	pH	Humus	N	P_2O_5	K_2O
Sig.	0.632	0.510	0. 510	0.022	0.846

Based on the values of Pearson correlation coefficient (table 4) statistically significant positive correlations were found between K_2O – humus, K_2O – N ($p < 0.05$), and humus – N, K_2O – P_2O_5 ($p < 0.01$).

Table 4. The Pearson correlation matrix of elements

	pH	Humus	N	P_2O_5	K_2O
pH	1	0.112	0.112	0.168	0.030
Humus		1	1.000**	0.230	0.363*
N			1	0.230	0.363*
P_2O_5				1	0.660**
K_2O					1

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

Comparative overview of the average values of analyzed elements according to town zones is shown in table 5.

Table 5. Comparative overview of the average values of analyzed elements according to town zones

Zone	N	Mean	Std. Dev.
Rural	22	42,1417	12,10374
Urban	8	39,5595	10,59424

Table 6 shows the results of T-test, in which we examined differences in the two zones of comparison as two independent samples.

Table 6. Differences in the zones of comparison

T - test	df	p	Mean difference	95% Confidence interval of the difference	
				Lower	Upper
0,533	28	0,599	2,58216	-7,35032	12,51464
0,568	14,159	0,579	2,58216	-7,16315	12,32747

According to T-test values (0,533/0,568 and 0,599/0,579 for T and p respectively), there was no statistically significant difference between the sites located in rural area of the town and the ones located in urban (industrial) area.

3.2 PROMETHEE RANKINGS

Table 9 shows contents of basic parameters of soil fertility measured in the sites examined above. Given that the presence of these elements in soil is the indication of fertility, all the criteria were defined as desirable (max). The soil in this part of Serbia is generally acidic, therefore, for the purpose of this investigation, soil chemical reaction (pH) is also defined as desirable (max), given that its pH value (6.3–7.3) is considered favorable for growing almost all plant cultures. As pH value at the most of examined sites did not exceed value of 7, carbonate content ($CaCO_3$) was not found among the criteria.

It goes without saying that not all the parameters exert identical influence on soil fertility, therefore they are defined by relative importance of each criterion. Each relative importance was assessed by a panel of experts, hence pH value and humus content (weight 0.30 and 0.25 respectively) are considered more important than nitrogen, phosphorus and potassium (weights 0.15).

In addition, preference functions were determined based on the examination data. Linear functions were chosen for all the criteria owing to their quantitative nature.

Table 9. Evaluation table

Alternatives	Criteria				
	pH	**Humus**	**N**	**P_2O_5**	**K_2O**
max/min	max	max	max	max	max
weight	0.30	0.25	0.15	0.15	0.15
Preference function	Linear	Linear	Linear	Linear	Linear
Q: Indifference	0.05	2.00	0.04	0.05	0.05
P: Preference	6.00	4.30	0.09	0.30	0.30
Unit	–	(%)	(%)	mg/100g	mg/100g
1. Parmenac	6.20	2.21	0.11	3.48	16.8
2. Pakovraće	5.55	3.03	0.15	9.81	28.74
3. Riđage	5.43	3.80	0.19	13.22	27.02
4. Beljina	6.22	3.21	0.16	2.81	22.56
5. Ljubić Kej	6.17	2.93	0.15	1.88	22.86
6. Prijevor A	5.38	3.60	0.18	1.92	26.35
7. Prijevor B	5.67	4.22	0.21	3.60	17.43
8. Prijevor C	5.90	4.27	0.21	11.63	22.29
9. Prijevor D	5.45	4.10	0.21	19.63	32.23
10. Suvi Breg	6.40	3.80	0.19	2.86	16.65
11. Stančići	6.48	4.63	0.23	22.05	38.00
12. Mojsinje	6.60	5.67	0.28	14.81	28.63
13. Donja Gorevnica	5.70	4.72	0.24	11.24	30.66
14. Mrčajevci A	6.93	5.68	0.28	3.47	24.65
15. Mrčajevci B	6.63	3.28	0.16	6.61	17.87
16. Kukići	6.33	3.71	0.19	4.41	18.82
17. Mršinci	4.89	2.78	0.14	0.17	20.81
18. Zablaće	6.21	4.51	0.23	12.50	26.77
19. Vapa	6.50	3.90	0.20	17.63	26.68
20. Trnavska Baluga	7.11	2.62	0.13	4.44	27.63
21. Trnava	6.43	3.12	0.16	11.64	17.43
22. Atenica	5.93	1.94	0.10	4.61	11.89
23. Konjevići A	5.58	3.67	0.18	11.44	19.63
24. Konjevići B	4.96	3.12	0.16	0.88	21.95
25. Konjevići C	6.39	2.21	0.11	16.33	24.84
26. Konjevići D	5.96	2.82	0.14	1.86	17.83
27. Ljubić Polje A	7.25	3.18	0.16	12.14	23.67
28. Ljubić Polje B	5.48	3.33	0.17	11.12	19.87
29. Preljinska Baluga A	6.54	4.23	0.21	1.26	12.97
30. Preljinska Baluga B	6.55	2.36	0.12	17.33	28.48

Complete ranking of the alternatives (sites) is obtained by calculating the Net flow (Φ) which is the difference between the positive (Φ^+) and negative (Φ^-) flows (table 10). The

greater the positive flow, the more important the alternative, while the opposite stands for the negative flow. Therefore, for the alternative to be more important from the perspective of the negative flow, it needs to be as small as possible.

Table 10. Preference flows

Sites	Φ^+	Φ^-	Φ
1. Parmenac	0,0678	0,3419	-0,2741
2. Pakovraće	0,2116	0,1546	0,0570
3. Riđage	0,2518	0,1090	0,1428
4. Beljina	0,1225	0,2263	-0,1038
5. Ljubić Kej	0,1083	0,2438	-0,1355
6. Prijevor A	0,1305	0,2238	-0,0933
7. Prijevor B	0,1112	0,2530	-0,1418
8. Prijevor C	0,2136	0,1514	0,0622
9. Prijevor D	0,3226	0,0497	0,2728
10. Suvi Breg	0,0828	0,2623	-0,1794
11. Stančići	0,3942	0,0072	0,3870
12. Mojsinje	0,4687	0,0454	0,4233
13. Donja Gorevnica	0,3168	0,0971	0,2197
14. Mrčajevci A	0,2722	0,1648	0,1074
15. Mrčajevci B	0,1602	0,2054	-0,0452
16. Kukići	0,1376	0,2077	-0,0700
17. Mršinci	0,0587	0,3426	-0,2839
18. Zablaće	0,3016	0,0900	0,2116
19. Vapa	0,2892	0,0590	0,2302
20. Trnavska Baluga	0,2261	0,1808	0,0453
21. Trnava	0,1427	0,2022	-0,0595
22. Atenica	0,0707	0,3715	-0,3008
23. Konjevići A	0,1555	0,1939	-0,0385
24. Konjevići B	0,0725	0,3172	-0,2447
25. Konjevići C	0,2395	0,1814	0,0581
26. Konjevići D	0,0555	0,3039	-0,2484
27. Ljubić Polje A	0,2538	0,1352	0,1186
28. Ljubić Polje B	0,1447	0,2124	-0,0677
29. Preljinska Baluga A	0,0822	0,2929	-0,2107
30. Preljinska Baluga B	0,2835	0,1221	0,1613

In this particular case, the sites were ranked from the ones with the lowest element content in soil to the sites with their highest presence, whereby their relative seriousness was also taken in consideration. Locations were ranked top to bottom, as shown in Figure 1. This manner of representation of the PROMETHEE II complete ranking is a novelty of the Visual Promethee software.

+1.0

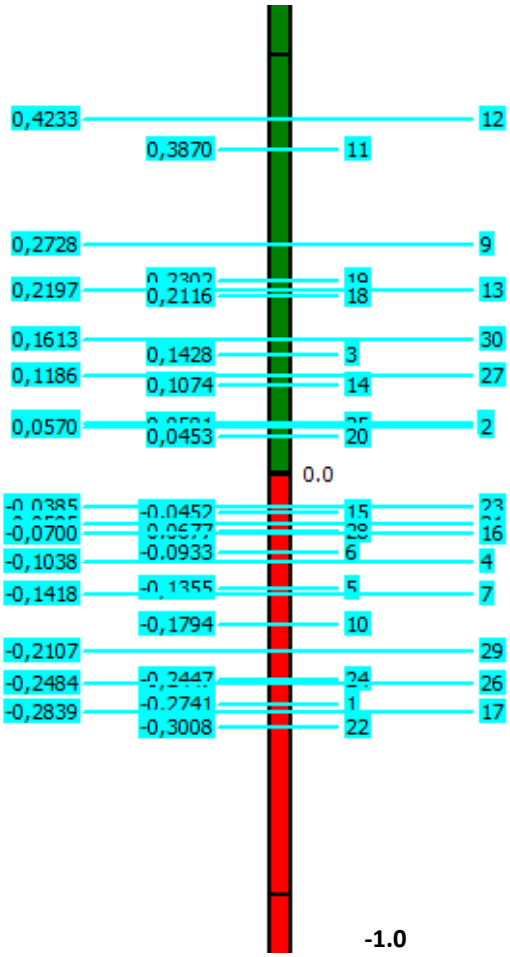

Figure 1. PROMETHEE II complete ranking of alternatives

Complete ranking of the alternatives showed that Mojsinje (Location 12), was the location with the most fertile soil (Φ = 0.4233), whereas the least fertile soil was recorded in Atenica (Location 22) (Φ = -0.3008).

GAIA planes offer a graphical representation of the results which can provide a clearer insight into the results. Figure 3 shows the graphical representation of locations and criteria using the GAIA planes, the value of Δ being 87%. This means that 13% of the total data was lost in the projection. Given that the application of such a manner of representation is justified when the value of Δ is higher than 60%, the validity of the application of the represented results in this investigation is justified [16].

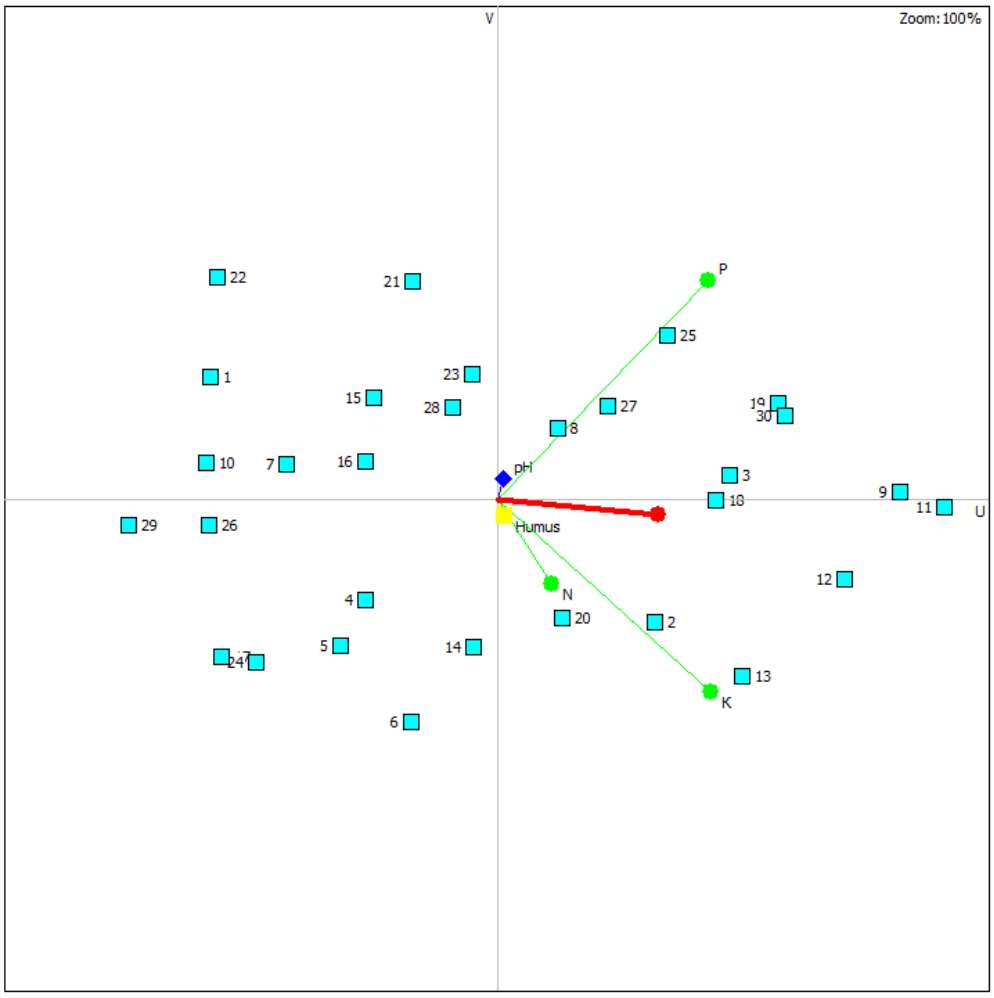

Figure 2. GAIA plane for the defined scenario

The closer the alternative (square) to the axis of a given criterion, the more favourable it is from the aspect of the criterion. Generally, the most favourable alternative is the one closest to the axis of decision-making (pi) (marked by the red line). This cannot be clearly observed in the two-dimensional representation of GAIA plane shown in Figure 3, however the 3D software enables us to pinpoint this location as Mojsinje (No 12).

4. DISCUSSION

Given that similar research had not been done on the territory of Čačak in earlier period, measurement results were compared with those carried out by individual researchers in the region and results obtained by the Environmental Protection Agency [5-12].

pH value ranged between 4.89 and 7.25, which reflects the overall state for this part of Serbia according to the Report from 2009 [10]. Humus content varied from 1.94 and 5.68%,

however most samples were well supplied with humus (over 3%), which is also in agreement with the values obtained in Central Serbia. Nitrogen contents ranged between 0.10 to 0.28 which means that all the samples are well supplied or have the high content of this biogenic element. Phosphorus supply in soil of Central Serbia is low (61% of samples ≤ 6 mg/100 g; 13% ≤ 6-10 mg/100 g), in contrast to Čačak region where P_2O_5 values in 14 out of 30 locations were higher than 10 mg/100 g with mean value of 8.56 mg/100g. As for potassium, most samples contain medium to high levels of the element (mean value 23.07 mg/100g), which is in agreement with potassium content in soil of majority areas in Serbia [10].

Mitrović and others [5] conducted similar investigation on seven locations in Central Serbia (Arilje, Požega, Užice, Kosjerić, Dragačevo, Kraljevo and Brus). The results were highly similar to those obtained in this study. It was only a single sample taken from a site in Arilje region that showed higher pH value (7.26), and with $CaCO_3$ content amounting to 6.46%.

Results obtained in this research are noticeably better than those obtained for 60 soil samples from Western Serbia in the research from Dugalić and others [8]. All the criteria are preferable in soil samples from Čačak except total content of nitrogen which is the same (0.18).

Report on the state of soil in 2012 [12], which also shows the results of the basic parameters of fertility in agricultural soil in Central Serbia and the territory of Zlatibor, Moravica and Raška District, are far inferior compared to the results of this study, and the results of the Report in 2009. According to these results, only 11% of the samples have a neutral and weakly alkaline reaction compared to 18% in the period 2006-2009, while the percentage of samples with acid and weakly acid reaction rose from 52 to 59%. Supply of available phosphorus is in most of the areas low (72% of samples with less than 5mg/100g) in relation to a report from 2009 when 61% of the samples had less than 6 mg/100g.

5. CONCLUSION

Apart from being the source of food and water, soil is also the source of biodiversity and the living environment of human beings. Therefore, it is necessary to regularly monitor the state of the soil in order to protect quality of life and survival of the living world itself. This statement largely relates to the cultivable soil whose fertility, as its most important characteristic, is crucially responsible for the yield which has an immediate effect on both quantity and quality of human diet.

This paper presents a comprehensive method of analysis of soil fertility using PROMETHEE method of multi-criteria analysis. The analyses on basic parameters of soil fertility which included samples from 30 locations, were assessed as soils with highest fertility to those with the lowest fertility. The study involved five criteria employed by the PROMETHEE method. The results imply that the most fertile soil is found at the location of Mojsinje (Location no 12), while the least fertile soil covers the location of Atenica (Location no 22). It can be concluded in general that the soil in Čačak basin has slightly acidic reaction, that it is medium supplied with humus, as well as with nitrogen and phosphorus but is well supplied with potassium. The results above show original soil fertility which can further be

improved by different agro technical practices. The results are mainly in agreement with those conducted in Central Serbia.

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THE ECONOMICS OF CLIMATE CHANGE AND MANAGING THE RISK CAUSED BY THE CLIMATIC CHANGES AT LOCAL LEVEL

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Abstract: It could be said today, more than ever before, that we are living in a world of changes in the society, starting from the economy and to the natural environment, these changes are so big that the past is not and could not be a reliable guide for the future. Climatic changes illustrate this at most because the climate has changed and it is certainly going to change rapidly, therefore it is necessary to evaluate the climate risks we are facing today, and also the climate risks in the future, in order to make decisions what we should do about them. Climate risks affect all the aspects of society starting from the direct impact on the lives of people, to the indirect impact on the economy trough the price of primary products, supply chains, all kinds of markets and the national economy. Adapting to these changes and raising the resistance to risks that may arise is the long-term economic, but also social investment.

Serbia is a member of the Intergovernmental Panel on Climate Change (IPCC), a working body founded in 1988 at the United Nations, which has so far published five reports about changes of the Earth's climate - but the people and the domestic economy are not informed about them. In conclusion, the report warns that the Earth's climate is changing and that change will be characterized with an increase of the average temperature and the growth of intensity and frequency of extreme weather events. Droughts and floods - they will happen (and already have happened, since we have witnessed floods this year) on average every three years at the beginning of this century, and by the end of the century it would become a standard form of climate each year.

Developing strategies for disaster risk management within the context of climate change, requires a variety of approaches and tasks in specific local circumstances. Impacts of climate extremes and weather events can pose a threat to human security at the local level. Vulnerability at the local level is attributed to the social, political and economic conditions and programs, including localized environmental degradation and climate change. Solving the disaster risk at the local level requires attention directed towards much broader sustainable development issues. While structural measures provide specific protection from disasters, they can also create a false sense of security. Current regulations and levels of creating structural measures may not be adequate under conditions of climate change.

The integration of local knowledge with additional scientific and technical knowledge, can improve disaster risk reduction and adaptation to climate change. Local population document their experiences on climate change, especially extreme weather conditions, in different ways, and this type of self-generated knowledge, encourages discussion of proactive adaptive strategies, and can detect existing capacity within the community. Ecosystem management and restoration activities, which are directed to resolving the deteriorating environment conditions are essential in the protection and maintenance the livelihood of

people in the light of climate extremes. Providing better access to and control of resources will improve the livelihoods of the people, and the ability to build long-term adaptation. Such approaches have been recommended in the past, but were not included in the construction of economic entities, till today.

Keywords: economy, climate change, managing the risk, local level

1. INTRODUCTION

We are living in a world of changes, starting from the society, the economy and to the natural environment, these changes are so big that the past could not be a reliable guide for the future. Climatic changes illustrate this at most because the climate has changed and it is certainly going to change rapidly, therefore it is necessary to evaluate the climate risks we are facing today, and also the climate risks in the future, in order to make decisions what we should do about them. Climate risks affect all the aspects of society starting from the direct impact on the lives of people, to the indirect impact on the economy trough the price of primary products, supply chains, all kinds of markets and the national economy. Adapting to these changes and raising the resistance to risks that may arise is the long-term economic, but also social investment.

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Developing strategies for disaster risk management within the context of climate change, requires a variety of approaches and tasks in specific local circumstances because the impacts of climate extremes and weather events can pose a threat to human security. Vulnerability at the local level is attributed to the social, political and economic conditions and programs, including localized environmental degradation and climate change. The integration of local knowledge with additional scientific and technical knowledge, can improve disaster risk reduction and adaptation to climate change. Local population document their experiences on climate change, especially extreme weather conditions, in different ways, and this type of self-generated knowledge, encourages the role of proactive adaptive strategies, and can detect existing capacity within the community.

2. ECONOMIC ASPECTS OF ECONOMY ADAPTATION TO CLIMATE CHANGE

Today, the term "climate change" is most commonly used when we talk about climate changes that are happening since the beginning of the twentieth century, and that occurred more as a result of human activities. By the beginning of the industrial revolution the climate change has happened as a result of the changes that occurred by natural circumstances, but today, the global warming is mostly a consequence of anthropogenic impact. At this time the average temperature on Earth is 0.8 degrees higher than it was before the Industrial Revolution, and the rise of temperature above 2°C would lead to dangerous climate change and devastating impact on plant and animal communities.

Whether the climate change is part of a natural cycle or the scary stories about them are only part of the scenario for another good profit at the expense of human gullibility? There is an undeniable connection between the economy (economic) development and the environmental state with the necessary natural balance, including climate change with the global conditions of life. Even the elementary definition of the notion of economy and ecology indicate inevitable conflicting relations, but also certain integral elements in models of economic and environmental development. The main task of the economy in relation to the environment is reduced to finding technologies and methods that ensure the most efficient processing of natural resources in goods and services for human needs, while the goal of environment is to keep the natural environment and resources protection and preservation unchanged. From an economic perspective the environment has the character of a composite good, because it supplies the economy with raw materials that are transformed into final products. This transformation allows the energy that the natural environment provides, but the environment also provides a range of final products to people - clean air, drinking water, but also the aesthetic and recreational value of the natural landscape.

Defined opposite of economy and environment is reduced to the problem of finding a mechanism for allocation of (natural) recourses which will along with the maximizing economic efficiency also ensure a maximum preservation of the ecological balance. The realization of the concept of sustainable development requires a whole range of new activities: a new technical and technological solutions, new legal and institutional arrangements, new forms of public communication and interaction at the national and local levels, adequate financial solutions, education and promotion.

The impact of global warming is evident from the equator to the poles: forests are retreating upward - a cooler location, the glaciers are melting on every continent, and increase the level of the sea. The impact of climate change will be complex and with great consequences for life on Earth. One of the areas that are fastest heated on the Earth is a region in which we live today, the Danube-Carpathian basin and the impact of climate change is evident in Serbia (changes in temperature and changes in the distribution of rainfall). In 2012, Serbia was hit with an unprecedented severe drought that halved agricultural crops and caused enormous damage to the economy - but it led to the awakening of the population and the local authorities against the dangers of global climate change.

Catastrophic floods which hit Serbia in May 2014, they found the country unprepared for this possibility and have caused, along with human sacrifices, and enormous material damage.

Imposes itself conclusion is that it is largely the result of the irresponsibility of government (national or local) authority in relation to the threat posed by climate change in a multi-year period. Great responsibility lies with the local media who ignore the documents of the UN and other international and national organizations and do not transmit articles about climate change from the foreign press. We can conclude that as a nation, but also as a state, we learn very slow and pay attention at this kind of events only when we have a problem that literally has hit the head.

We have the knowledge and the technology to try to avoid the disasters that are anticipated as a result of climate change. Many citizens, governments and industries are ready to face the challenge. United Nations Framework Convention on Climate Change (UNFCCC), an organization whose member is Serbia too (addressing practical programs for mitigating climate change and adapting to them), even in 2012 issued an instruction for adjustment of the economy and other sectors of society to these changes (National Plans adjustment), but neither the citizens nor the Serbian economy are familiar with it. [1]

Serbia is a member of "Intergovernmental Panel on Climate Change" (IPCC), established at the United Nations (IPCC - www.ipcc.ch) and founded with intention to assess the facts about global climate change and its effects on life on Earth. This intergovernmental body consists of 195 countries worldwide, and in the preparations work of its five voluminous reports, which talked about the state of the climate change on earth, as well as a number of recommendations to mitigate these changes and adapting to them, thousands of professionals have participated, as well as representatives of governments of the member countries. It is practically the most significant and most authoritative international body dealing with climate change on Earth. [2, 4, 5] Reports of the IPCC, risk assessment climate change, they conclude, in short, that the world faces two major risks: further increase in the temperature on earth (global warming) and dramatic changes in the steady state of the climate, i.e. it is faced with climate chaos and extreme weather, that will, in the first place, cause enormous damage to food production i.e. agriculture, but also other macro and micro-economic parameters.

The uncertainty related to climate change is wide and hard to predict, to such an extent that the standard tools for decision making in a state of uncertainty are totally inadequate. Projected climate change alerts Serbia. If the average temperature in Serbia continue to grow, the country could be hit by another major drought, food shortages and tropical diseases, according to a report published by Ministry of Environment and Spatial Planning regarding the climate changes which was adopted by the government [3]. The report also states that the long summer drought could be interspersed with short periods of heavy rainfall, which is enough to cause floods in certain parts of the country, as we have witnessed in recent years. We do not have three summer months with temperatures between 25 and 30 degrees Celsius, but instead the temperatures are over 40 degrees, accompanied by more days of increased precipitation.

As a result of climate change, cases of droughts and floods have become increasingly common, serious and expensive. The biggest victim of all the ever-present climate change is agriculture. In many areas, the increase in temperature and drought will limit agricultural production, which is one of the most important sectors of the Serbian economy. Water for drinking, industrial and agricultural use, is becoming scarce, because the temperature rise jeopardizes even further the already affected groundwater resources in Serbia. Forest fires are

more frequent and more severe, and is also expected a reduction of snow cover and the length of the winter period, which affects the water reserves in the soil. The impact on biodiversity, plant and animal species, became so significant that their movement can serve as an indicator of the warming of the planet. They are silent witnesses of the rapid changes taking place on Earth.

Serbia could also be affected by a great number of large fires, as a consequence of drought and high temperatures, and the most serious consequence could be a decline in the yield of grain and agriculture, which has so far been the most successful part of the country's exports. More frequent and intense droughts in recent years have caused severe damage to agriculture. During the drought yields in some areas were up to 40 percent lower than in periods without drought and a further climate change will only contribute to further reduce of yields of wheat, potato, sunflower and soybean.

The scientists predict that climate extremes will amplify the intensity and frequency (particularly high temperature and precipitation i.e., floods), and that the effects of climate chaos with cold or hot waves when their time is not, will occur on average every three years at the beginning of this century, and that would become the standard weather pattern every year by the end of the century. In short, the distinct characteristics of the seasons are losing (season sowing, ripening, harvesting), and weather changes will become less and less predictable or certain, so as we can see today in Serbia.

Here we should especially mention one of the recommendations from 2012 - Risk management of extreme events and disasters for better adaptation to climate change – [6] "Example of adaptation measures and criteria for assessment in agriculture": to provide forecasts and information about water supply; improve management of water resources; improve irrigation; better planning in the use (purpose) of land; develop a better type of seed and establish seed banks; introduce a system of agro-forestry (to mitigate the effects of high winds, snowdrifts and mitigate high temperatures in summer) and boost the local human and technical capacity;

At the same time, climate change would bring new diseases in humans and plants. People would be more likely to suffer from cardiovascular diseases and tropical infections, such as malaria. As of today, we have to make changes to adapt to economic and agricultural policies and to prepare citizens for the new situation. These adaptation measures should include the construction of new water supply systems, new systems for land irrigation, selection of new plants that will grow in this new climate, increased flood protection, and changes in the health system.

Climate change will be a lot more serious than it was previously predicted in what we have assured during this year. One of the critical importance is to reduce emissions of the greenhouse gas. "Greenhouse effect" is very important when we talk about climate change as it relates to the gases that keep the Earth warm and enjoy the most credit for the existence of life on it. Some of the gases (carbon dioxide) that make the greenhouse effect people produce in their daily activities. This additional amount of carbon dioxide is the main suspected for increased greenhouse effect and for Climate Change (catastrophe). Reducing greenhouse gas emissions can be achieved primarily by saving energy - energy that is saved does not have to be re-built.

Serbia has great potential for energy savings. As energy prices continue to rise, saving energy means saved money, and the planet also. We must turn to cleaner, renewable energy sources, such are geothermal energy, wind, sun and water [14, p. 1127]. The biomass, which is created in our forests and agricultural land, is also very suitable for the production of energy. The main objective is to raise the awareness about how everyone can impact on reducing greenhouse gas emissions that cause greenhouse effect and thereby help the mitigation of climate change by saving on the energy resources. The United Nations Convention on Climate Change recommended all countries to work on education and raising public awareness about climate change and energy conservation, which is the goal of the campaign "Global warming is a local problem," that WWF is leading in many countries of the world.

An essential role is played by the political and economic decision-makers, which are expected to rationally manage the natural resources in order to reduce the economic risks and provide for the protection of human life and property. The Department of Sustainable Development and Climate Change in the Ministry of Energy carries out activities related to: the development of strategies and plans for environmental protection in the field of energy for sustainable development, as well as implementation and monitoring of environmental protection measures in the energy sector, particularly in terms of decreasing influences of the energetics on climate change.

Cities today have to prepare for climate change, as well as to invest in the protection of natural disasters. For this purpose, they should build canals and dams for flood, they must be prepared for other extremes, such as droughts and heat waves, which will also become more frequent. Preventing the disaster is expensive, but who would say what is the excessive development and who can forbid the mayors of the local governments in Serbia to adopt measures that will result in emission reductions, primarily in terms of transport and energy products?! None of the projects for this purpose is not that much expensive as far as are the consequences if nothing is done about that.

Few people know that the construction sector consumes 40% of world energy consumption, and generates 30% of total emissions of greenhouse gases, even more than some other factory. The support must be in industrial ecology and innovation (such as developing the clinker which produces less carbon dioxide, new clinkers contain less limestone and can be warmed at lower temperatures, which allows the reduction of carbon dioxide by 25% to 30% as well as improvement of processes that efficiently exploit energy, optimize the composition of concrete and improve recycling.

The entire cement industry generates about 5% of CO_2 emissions globally. There are two reasons for this relatively high level of emissions, the first and most important is that the cement is a product that has multiple uses and is widely used. The second reason relates to the methods that are used for the production of basic components of cement, clinker, which requires physical-chemical transformation at high temperatures. Cement production generates CO_2, but it is the case with the production of all building materials - steel, aluminum, brick, and even wood, as it is with all other products.

Lafarge, one of the largest manufacturers in our country, develop and implement a comprehensive strategy to prevent climate change. The Group has successfully achieved the goals set for 2012 for one year in advance, and gave themselves three new objectives for 2015

and 2020, within the framework of the partnership which is developing for ten years already. Lafarge in Serbia also has an important role in achieving these goals, because Lafarge is committed to reducing CO_2 emissions globally by 20%. This decrease is almost four times greater than the one required by the Kyoto Protocol for industrialized countries. At the same time, in order to reduce the amount of fossil fuels that are used in the furnaces, the company has launched an ambitious program to replace fossil fuels with alternative, mainly industrial and municipal waste.

Climate change may also affect the tourism in many ways: Variable and unstable weather conditions will make difficult the functioning and planning in tourism; Natural weather disasters can harm tourism infrastructure, natural and cultural treasures and local communities: Many tourist infrastructure is located in sensitive areas; Climate change may affect the level of comfort of tourists, as well as the number of activities; The increase of the sea level and sea temperatures jeopardize coastal and island destinations, as well as port cities; Climate change can affect natural habitats and biodiversity, which are a major attraction for ecotourists and nature lovers; Changes in precipitation and the hydrologic cycle may affect the availability of freshwater resources in the destination, which is the basic need of tourists; Reducing snowfall has a direct impact on the mountain and ski tourism. Many tourist activities (skiing, swimming, wildlife, nature-based tourism) require specific weather conditions. A small increase in winter temperatures, for example, would eliminate the ski center on the lower slopes of the Alps. Response of tourists to climate change can be a negative impact on the attractiveness of the destination (for example, dead coral, scarcity of species, loss of habitat).

Although the pollution in tourism affects many aspects of tourism activities, the main problem is related to the exploitation and use of means of transport, especially in passenger and air traffic. In the broader context of sustainability in tourism development, the impacts of tourism on climate change can be linked to water consumption and energy consumption per capita, as well as the impact that tourism can have on the flora and fauna. Tourism contributes to the creation of carbon - dioxide, primarily through transport, heating and cooling facilities for accommodation, wherein the fossil fuels are mainly used. In order to reduce the negative impacts of tourism, it is necessary to adopt environmentally managing techniques and technologies. For a tourist destination, it is important to respond to climate change by introducing various strategies such as greater energy efficiency and the use of fuels with less carbon.

Plans for adaptation to climate change should be made starting from the regional and national, municipal and local, to those according to the type of hazards (droughts, floods) as well as the type of endangered sectors (agriculture, industry, energy, transportation networks, etc.). The British economist Nicholas Stern published a report in 2006, known as "The Stern review: The Economics of Climate Change", that deals with the influence of the global warming (climate change) on the global economy, where he claims that the climate change on earth is the biggest failure of the market economy in history and calls for significant investments in order to mitigate and prevent further climate change. He finds that the investments in this project, no matter how large they are, would be significantly paid out. [7]

3. MANAGING OF THE RISK CAUSED BY CLIMATE EXTREMS AT LOCAL LEVEL

In the context of this paper, the term "local" refers to the extent of the city (municipality, city, province, and region), control structures, institutions, grouping, conditions and a set of the experience and knowledge that exists on the scale below the national level. It also includes a variety of institutions (public and private) that maintain and protect social relationships and those relationships that have some administrative control over the spatial resources. The term "local" is important, because the locals always tempt a disaster at first hand, they retain the local and traditional knowledge valuable for disaster reduction and adaptation plans, and in the end they do not implement the adaptation plans by themselves.

Local data systems and knowledge are often neglected in disaster risk management. There is significant potential for adaptation to the system of geographic information, including the knowledge at the local level for support of disaster management activities. Indirect losses are quickly transferred to the account as important factors in accelerating the negative economic consequences. Adjustment costs, through a difficult estimation, could be reduced if the adaptation to climate change is integrated into the existing catastrophic risk management and development strategies.

Integrated disaster risk management in policy and practice, provides key lessons relating to climate change adaptation at the local level. Problem solving refers also to the approach in the multi-hazards planning and actions in the disasters and in the short time makes it easier to adapt to climate extremes over a longer period of time. The main challenge for local adaptation to climate extremes is to implement a balanced portfolio, as a "one size fits to all strategies." Successful measures simultaneously consider the main issues related to the improvement of the local collective actions, and the creation of access at national and international levels, to complement, support and legitimize such local actions.

First of all, disasters occur at local level and affect the local population. These impacts can have national and international implications and considering this, as a result, the responsibility for managing such risks requires connecting on local, national and global level. One of the possible options for disaster risk management in these cases are the strategies from the bottom and upwards, designed by and for the local places, while the other management options represent a product of global negotiations at all levels, which is then implemented through the national institutions at local level. We must not lose sight that some communities are able to cope with the risk of disaster, while others have limited resilience to disasters and lack of capacity (human and financial) to cope with the risk of disasters, and to adapt to climate variability and extremes.

Local communities routinely perceive the danger of climate impacts, with many cases of extreme weather and climate events. The importance of the analysis from a local perspective is that extreme weather and climate conditions will vary from place to place, having in mind that not all places have the same experience, particularly when such conditions have come true. Research shows that experience with disaster affects the behavior proactively in preparing and responding to the next event. The research show that the experience with a disaster have an impact at the future behavior in terms of proactive approach in preparing and responding to the next event. Local places are different according to their experience, who is

and what is in danger, and also, to the potential geographic extent of potential impacts and responses towards stakeholders and the people who make decisions. Local places have much experience with short-term responses of survival and adaptation to catastrophic risks, as well as the long-term adjustments, such as the establishment of local flood defense, the selection of crops that are resistant to drought conditions but also the seasonal or longer migration of one or more family members.

Disaster risk management must involve struggle from day to day, in order to improve livelihoods, social services, and environmental services. Local reactions and long-term adaptation to climate extremes will require a disaster risk management which recognizes the role of climate variability. This may involve the modification and extension of the principle of local disaster risk management, as well as experience through innovative organizational, institutional and government policies at all levels of jurisdiction (local, national, international). Given the large differences, it is clear that only one solution for managing disaster risk is not possible (there are differences between urban and rural communities in the terms of disasters and vulnerability to climate change and disaster risk and options for adaptation). In order to make the hazard vulnerability in relation with the climate changes effectively reduced, there is a need of coordination between different levels and sectors, besides the inclusion of a wide range of stakeholders at the local level.

It is important to know that while the climate change may alter the volume and/or frequency of some climate extremes, some other processes as ecological, social, political or economic processes (many of which are global in scope) affect the ability of communities to cope with disaster risks and climate-sensitive dangers. Efficient communication is necessary in the entire cycle of disaster management: reduction, readiness, response, recovery, particularly at the local level, where the communication constraints and opportunities are especially faced. It have increased the research field of obstacles by communicative impact of climate change in order to motivate constructive behavior and policy choice. Communicating likelihood of extreme impacts of climate change also represents an important and difficult challenge. Climate Research Communications deals with the issue of the way how information can be designed, and the mechanisms and timings of their distribution.

Structural measures can be used to minimize the effects of climate-related events, such as floods, droughts, coastal erosion and heat waves. Structural interventions that reduce the effects of extreme events are often employed in engineering jobs, to provide flood protection, such as dams, levees, sea walls, modifications to river channels, flood gates and tanks. However, structural measures also include those for strengthening the building (during construction and repairs), for improved water harvesting in areas affected by drought (e.g., roof catchments, water tanks, wells), as well as the impairment effects of heat waves (e.g. insulation and cooling systems). Although many of these structural interventions can successfully reduce the impact of disasters, they may also fail due to lack of maintenance, age or because of extreme events that exceed the level of engineering design. In the case that the frequency and magnitude of extreme events increases as a result of climate change, a new design level may be necessary. Technical considerations should also include issues of local social, cultural and environmental.

The benefits of early action are several times greater than the costs, and ignoring of climate change will eventually harm economic growth. If the action is taken before it will be

more cost effective. Developing countries, such as Serbia, largely depend on agriculture, which is most vulnerable to climate from all economic sectors. Because of this economic structure, low income and higher sensitivity to all impacts, including climate, climate change adaptation is especially difficult.

The costs of mitigation of around 1% of GDP are small relative to the costs and risks of climate change that would be avoided. [8, p. 33] There is no more time to waste, preventive measures should be taken as soon as possible to avoid further damage and future costs. Financing of natural disasters risk and insurance programs are good practices that can be defined as a financial protection against natural disasters, and there are increasingly more of such programs. The management of knowledge in all areas and capacity building are needed to build the internal capacity of staff through the sharing of knowledge and experience (implementation of integrated measures to adapt to climate change and the management of environmental risks and natural disasters).

The aim of the project (program) lays on generating local action plan for adaptation to climate change, environmental risk management and response to natural disasters, and the development of capacity of local communities of affected communities to adapt to climate change, management of environmental risks and response to natural disasters, as well as beginning of the realization the plan.

The importance of climate change is growing from year to year. Climate change impacts on the environment are growing, while the negative effects of natural disasters are increasing. In this region, the changes are most present and the average seasonal temperatures and changing rainfall patterns and intensity are in increase, which is reflected in more extreme droughts and floods. Damage, mostly from the flooding and drought are estimated in the hundreds of million dinars each year. In most cases, the most affected are the poorer part of the population. Natural disasters slow down the economic development, thus weakening the social capital.

Policies of adaptation to climate change are one of the most important environmental policies. One of the priorities of the Danube strategy within the pillars of environmental protection is the management of environmental risks. Environmental risks are a direct threat to human health and quality of living space. Natural disasters are relatively rare, but are remembered by their social, health, financial and environmental consequences. Danube River is a particularly sensitive area, with high exposure and high fragility and aquatic ecosystems.

Most municipalities do not have an Action Plan of adaptation to climate change, environmental risk management and response to natural disasters, nor the institutional and sector capacities are developed enough for this challenge in the future. Assessment of vulnerability of municipalities in the future should not be left to an ad hoc approach, nor should the consequence of climate change in the coming years be taken lightly. The specificity of these projects can be seen in the fact that the Action Plans contain a significant number of non-investment measures (and lack of capital works will not be an obstacle to its realization), as well as the components of the Action Plan that will represent not only the instruments of protection, but also the instruments of local human, infrastructure and economic development.

First of all, it is necessary to define methodology and formation of expert working groups. The main activity should therefore be associated with the assessment of vulnerability on the

territory of the municipality from environmental risks, natural disasters and climate change. Activities related to the development of the Local Action Plan and the development of capacities for local communities in order to adapt to climate change, environmental risk management and response to natural disasters: Involvement of the local community; Presentation of Action Plan to the public; Adoption of the Action Plan; Activities related to the implementation of the Action Plan; Activities related to the introduction of the system management of changes in local government; Activities related to the inclusion of components and priorities of the UN Framework Convention on Climate Change in local sector policies.

Different economic sectors show different sensitivity to natural disasters and unfavorable weather events. As one of the most sensitive sectors stands out the agriculture, and beside it other sectors that show significant sensitivity are the energetic, waterpower engineering and air transport. Participation of sectors that are dependent on weather conditions in the gross national income Serbia is significant, and that in 2005 amounted to 47.18% [World Bank, 2005].

4. ECONOMIC AND ENVIRONMENTAL ASPECTS OF ENVIRONMENTAL PROTECTION, ECONOMIC ACTIVITITIES AND CLIMATE CHANGES

The permanent increase in the intensity of the use of natural resources with the primary objective of meeting the increased needs of a growing population has caused a number of irreversible adverse changes in the environment and nature, which increasingly represent a source of certain environmental and climate problems. It is necessary to examine the connection between economic goals and environmental protection objectives of natural environments that is to say to define the development coordinated with the requirements and limitations of nature. The protection and environmentally sustainable use of biological diversity (biodiversity) is completely ignored and unjustly neglected in many countries, but also here. Interaction of the economy with nature has entered a phase which requires the permanent monitoring and active measures to ensure the smooth functioning of the economic process and reduction of the impact on the climate changes.

A new environmental ethic has appeared, ecocentrism, which places the eco system in the centre and makes the human as one with all other forms of nature, and the only thing that distinguishes it is the responsibility for the preservation of "life" in general as well as the human species and inanimate nature. Responsibility is derived from the fact that only a human being is endowed with a highly developed awareness and the ability to be the bearer of the moral values. The human on this planet can be saved if he takes into account its life and life in general, respect its life as well as life around him, because he often puts his daily needs for prosperity and increasingly perilous conformity of any kind above human life and health.

Therefore, a new view of a man's relation to nature and society has appeared. Environmental ethics or learning about good and proper action, learning about the business dealings which do not destroy nature, the economy is only a part of the human activities which include the manufacture, distribution and commercial movement of goods for the satisfaction of human needs, including luxury consumption. We are talking about a new

product of the environmental ethics which puts nature into the ethical focus, eco-system, not a man or a human (consumer) society. Validity of the ethics is now expanding to the rest of the living world, but also to inanimate world (natural resources and raw materials), that is to say on the world in general, where human responsibility and knowledge that a man is given a responsibility as a conscious being to be a guardian of all forms of nature must have its place. From the perspective of environmental economics, natural capital should be seen as the basis for the production of which is, at least, as important as the capital created by humans. [10, p.137]

In environmental terms, the economists must also strive for the principle of taking precautions - they should strive for minimal interference with the functioning of natural systems, especially when we cannot predict the long-term environmental and climatic effects. To determine how the environmental rationality is applied in our organizations a study is conducted where 104 companies were interviewed, some of which are in the private sector and some state-owned. The survey was conducted in companies in the Timocka krajina region, Jagodina, Pirot, Niš and Leskovac. To the question: Do you have employees who deal with environmental issues? 65.5% of the companies surveyed responded positively, and 34.5% negative. The results are not satisfactory, because the percentage of those who do not have employees engaged in environmental issues should be much smaller.

To the question: Are, in your opinion, the environmental function and the function of production management in the enterprise connected? A large number of respondents, 85% replied that they are related, which is true, and it can be concluded that business people understand the importance of the role of environmental rationality. To the question: What is the environmental rationality? Over 54% of respondents said they knew what the environmental rationality is. Due to the importance of environmental rationality today, this percentage should be much higher. A large number of respondents (37.5%) said they did not know and 8.3% responded that the environmental rationality is a secondary production function that is not very important.

To the question: In which direction you plan to develop your environmental rationality? A large number of companies (about 73%) gives great importance to environmental rationality and consumers, which is an encouraging fact. People and organizations understand the role of the environmental science and its importance in the company, and plan to continue to regularly train professionals and staff. Only 11% of respondents are satisfied with the current situation, and they do not want to change anything, and about 16% is not thinking about the further development in their company. It is evident that business organizations need to strengthen their efforts in environmental marketing research and based on them, define a strategy for further development.

China is now investing huge money in green technology and is slowly becoming a leader when it comes to using solar energy and wind energy. In Germany, when it comes to clean energy, over three hundred thousand jobs have been opened due to the trend of green economy and the use of sustainable energy resources, and our country, although rich in thermal mineral springs, do not make sufficient use of this comparative advantage. Thermo mineral spring in Serbia provide economic benefits through comparative advantages of renewable energy and environmental benefits due to the reduction of global warming and the impact of climate change. Geothermal water could have significant application in highly

intensive production of healthy (organic) food, for heating greenhouses and livestock farming, and other needs (air conditioning - heating and cooling buildings, etc.).

Benefits obtained by using geothermal resources are multiple and numerous, and can be divided into three main groups: socio-economic, environmental, technical and technological. Geothermal energy is local, autonomous source and does not dependent on anything. Its exploitation and utilization is independent from the international political, economic, war and other crises. The exploitation and utilization of geothermal energy does not depend on the import. Its use does not create the conditions for political and financial blackmail or conditioning of historic enemies in the world, as is the case with the import of oil. The use of this energy is not affected even by the weather conditions, nor floods, nor earthquakes, nor drought, nor storm, and its accumulation cannot be destroyed.

The structure of energy consumption in Serbia, low-temperature thermal energy makes up about 30-35%, and is covered by coal, wood, electricity, oil and gas. Coal is environmentally harmful, wood and electricity is a shame to waste for heating, and oil and gas we do not have. Serbia may cover 25-30% of the total heat consumption from geothermal sources. Thermo-mineral water with the use of heat pumps can have broad application in the industry. Hidden costs in the exploitation of fossil energy sources are a big unknown, it is impossible to predict them or to express them because they, mainly, originate from the adverse impacts on the environment (rehabilitation of opencast mines, reclamation of tailings impoundment - ash, mud strewn accumulation, relocation of settlements, roads, deforestation, destruction of fertile land) and as a result of all said above the climate change also, etc. The latest economic requirements, as a condition of high competence, give the use of this energy become a matter of prestige in terms of quality of life on the domestic and on the world market and it becomes a key postulate of national economic systems [11, p. 137].

Environmental strategy of society is not a matter of politics in the narrow sense, nor it could be subject to the current orientation of government. It is adopted and implemented in cooperation with economic interests, technical capabilities, and environmental, domestic and international standards, taking into account the experiences of environmentally advanced economies and in accordance to the findings of the experts' projections. With the help of social marketing it is necessary to take an active economic and environmental policy, with eligible measures and instruments, adapted to the economic system, the initial economic state, but also to the culture and traditions of the nation. People are increasingly demanding an information about the social responsibility of companies and institutions of the system and their responsibility towards the environment, and environmental awareness cannot be achieved by birth, but systematically created through the entire system of education, science, culture and (environmental) education. Nations which are not aware of that have a special responsibility for the future of the planet.

5. CONCLUSION

The basic definition of the term's economy and environment indicates the necessary adversarial relation, but also certain integral elements in models of economic and environmental development. Since the protection of human environmental is planetary

problem, the problem of all people, perhaps not equally expressed in all areas, but, if it is not solved on the global and local levels, it will certainly expand and create larger problems. If the protection of nature and environment has become a civilization problem, and economic profit motive of business manufacturers and other business entities, then one cannot ignore any of these questions. Practice has proved that this is a job for the state and its local institutions.

The term "local" influences the context of disaster risk management, the experience of disaster, states, and actions and adaptation to climate change. The classical understanding of economic wealth is changing, expert thought patterns are occuring in the valuation of natural resources and environmental factors. Environmental rationality has to become an integral part of economic theory and business practice. Alternative development opportunities for a large part of humankind are the development of alternative technologies, raw materials, energy, and mineral fuels. Despite some contradictions, and environmental and economic goals, each responsible nation must have a strategy for environmental protection and sound and sustainable development, and that strategy must be based on objective, expert determination of state, economic principles and opportunities, both at the national and local levels.

The use of geothermal resources in Serbia must be an important basis for economic development. Social, technological and economic advantages or benefits of their use are still significant compared to other energy sources, and may gain more if the value of concern for the increase of CO_2 in the atmosphere leads to economic measures that will discourage the use of fossil fuels. Geothermal energy does not increase the natural greenhouse effect and does not cause climate change, does not destroy the ozone layer and does not cause acid rain. It is necessary to increase the knowledge on sustainable economic development and environmental economics, as they are in the service of environmental rationality (increase of the interest, awareness raising, long-term research and monitoring of its implementation). This approach requires the application of the principles of environmental economics and action plans in the local economy, but also the proposition of the audit of calculating national income accounting system, so as to incorporate the amortization of natural capital and the application of the principle of taking precautions, especially when you cannot predict the long-term effects of climate change.

From the research it is evident that the task that is set in front of the theory and practice of environmental management and economics is not easy at all, but fortunately, the talent, creativity, imagination, intuition and science knows no boundaries in both the achievements and among people locally and globally.

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DETERMINING THE MOST POLLUTED SECTION OF BELGRADE-NIŠ HIGHWAY USING GIS APPLICATION

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Abstract: The aim of this paper is to develop a system, which can be used to determine the most polluted section of Belgrade – Niš highway. This system consists of mathematical operations used by computer program methodology for calculation of emissions from road transport - COPERT IV and a versatile dispersion model for predicting air pollution levels near highways and arterial streets – CALINE 3, in order to simulate the air pollutant dispersion in the area along the Belgrade – Niš highway. The results of COPERT IV methodology and CALINE 3 model were integrated in Geographic Information System (GIS), which was used for selecting the most polluted section of Belgrade – Niš highway and its surroundings, where air pollution levels were above limits. The results showed the simulation of pollutants dispersion in the case of the worst weather conditions and that the concentrations of particulate matter (PM) and sulphur oxides (SO_2), carbon monoxide (CO) and nitrogen oxides (NO_x) are the highest in the area of section Požarevac – V. Plana. The results of GIS showed that emission of motor vehicles has the influence on air quality; it mostly depends on fuel consumption, vehicle technology, and meteorological parameters. Unlike other models, GIS displays data on the map, marking a critical area, which enables easer application of environmental protection measures. Finally, it can be concluded that the application of GIS can improve the process of pollutant emissions reduction.

Keywords: air pollutants, vehicles, COPERT IV, CALINE 3, Geographic Information System (GIS)

1. INTRODUCTION

Although, transport is very important in today society, its increasing intensity has some unwanted effects. The use of motor vehicle is increasing despite its emission controls [1]. Road traffic is the potential source of metal pollution originated from combustion products from fuel and oil, corrosion products of vehicle components and road construction materials, etc. Reduction in lead concentration in petrol has led to a decrease in exhaust lead emissions within the last two decades [2]. Air pollution is the negative influence of transport and the main pollutants from combustion of fossil fuels are: NO_x, CO, SO_x, VOC_s and PM [3]. Different types of fuels have different concentrations of pollutants to the environment. NO_x is a primary pollutant, emitted by motor vehicles as well as all the combustion sources [4]. Every liter of fuel consumption during combustion makes 100 g of CO, 20 g of VOC, 30 g of

NO_x, 2.5 g of CO_2, and other substances like compounds of lead, sulfur and heavy particles, which cause air pollution [5].

Traffic density influences the heavy metal cotents in roadside soils, and the receant studies have shown an exponantial decrease with distance from the road, reaching background levels of 10-100 m [6]. That indicates that there is a need for better understanding of the environmental impact of roads. The application of GIS gives new opportunities in modeling the impact of roads [7]. The GIS model made for the area around Belgrade-Niš highway is represented in this paper. This model was created by integrating three models: transport, emission and dispersion model. The calculation of emission was performed based on the data about vehicle type and technology, transport density on 20 sections of Belgrade-Niš highway and type of fuel. Then, the emission results were used as inputs for dispersion model [8]. The results of dispersion model were used in GIS database, and finally, the query analysis of GIS enabled the selection of the most polluted areas, which were marked on a map and also in the table. The final results can be used for taking adequate measures in the purpose of minimizing the air pollution in those areas.

2. METHOD USED FOR DATA ANALYSIS

The inputs used for creating the emission model were: traffic flow on 20 sections of Belgrade-Niš highway, number of vehicles by technology, emission factors, mathematical operations of COPERT IV methodology, fuel consumption and meteorological parameters from the Republic Hydro meteorological Service. All the data about vehicles are also presented in the project of the Institute of Faculty of Traffic and Transport Engineering, University of Belgrade [5].

In the purpose of using data about vehicles in COPERT 4 model, it was necessary to adapt the existing categorization of vehicles to the vehicle classification in COPERT IV model, so we have divided the vehicles on passenger cars, light and heavy duty vehicles, buses, mopeds and motorcycles. We also had to classified the vehicles by type of fuel consumption on the vehicles that use leaded gasoline, unleaded petrol, diesel, LPG, hybrid and CNG. After that, vehicles were grouped according to engine capacity. The data about vehicles flow in 20 sections of the Belgrade–Niš highway were taken from the electronic publication published by the public enterprise Roads of Serbia. COPERT IV model provided the results of fuel consumption and total emission of pollutants.

In the purpose of determining the most frequent sections on the investigated highway, the participation of vehicles by category was expressed as a percentage and the sections of Belgrade-Niš highway were ranked, based on the total traffic flow (table 1).

Table 1. Participation of vehicles by category in total traffic flow by sections and their ranking

Naziv deonice	**Kategorija vozila (u %)**				**Rang**
	I	**II**	**III**	**IV**	
Beograd – Tranšped	83,10	0,40	10,61	5,89	1
Tranšped – Vrčin	83,08	0,41	10,59	5,92	2
Vrčin – M. Požarevac	82,08	0,44	10,98	6,50	3
M. Požarevac – Umčari	79,93	0,50	11,36	8,21	4
Umčari – Vodanj	79,80	0,50	11,37	8,33	6
Vodanj – Kolari	79,23	0,51	11,61	8,65	7
Kolari – Smederevo	79,07	0,51	11,64	8,78	8
Smederevo – Požarevac	77,99	0,51	11,95	9,55	5
Požarevac – V. Plana	77,03	0,50	12,03	10,44	12
V. Plana – Markovac	76,21	0,53	12,25	11,01	11
Markovac – Lapovo	76,60	0,52	12,15	10,73	9
Lapovo – Batočina	76,42	0,53	12,25	10,80	10
Batočina – Jagodina	75,55	0,54	12,55	11,36	13
Jagodina – Ćuprija	75,37	0,53	12,20	11,90	14
Ćuprija – Paraćin	75,38	0,54	12,30	11,78	15
Paraćin – Pojate	75,40	0,51	12,34	11,75	16
Pojate – Ražanj	73,51	0,49	12,48	13,52	18
Ražanj – Al. Rudnici	73,24	0,47	12,61	13,68	20
Al. Rudnici – Aleksinac	73,93	0,49	11,87	13,71	19
Aleksinac – Niš	74,97	0,45	12,24	12,34	17

In Serbia, the most vehicles use gasoline and diesel fuel. Passenger cars and motorcycles mostly run on gasoline, while buses, trucks and other light and heavy truck vehicles, mostly run on diesel [9]. Figure 1 shows that the highest consumption of gasoline and LPG was on Belgrade-Tranšped section, while diesel consumption was the highest on Požarevac-V.Plana section.

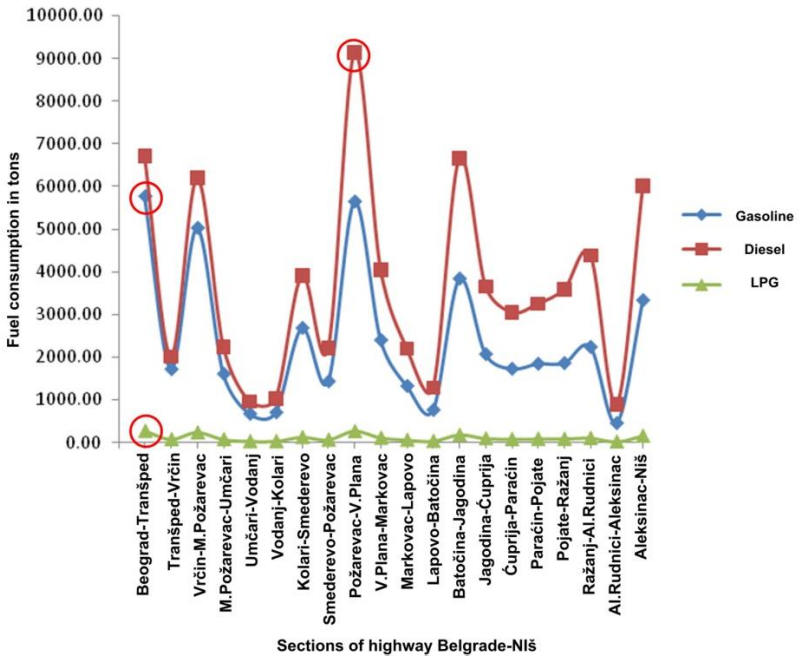

Figure 1. Fuel consumption in 2009 (gross annual value), by sections of Belgrade-Niš highway

The inputs for a dispersion model are the results of emission and meteorological parameters. This model is based on CALINE3 model, which is used for predicting levels of air pollution near highways [10]. The algorithms of CALINE3 model were used in GIS query analysis. Table 2 shows limitations of air pollutants in Serbia. We have used limitations for 24h time sampling in uninhabited areas, for the purpose of this study.

Table 2. Limits of air pollutants in Serbia [20]

Air pollutant (mg/m^3)	Time of sampling in uninhabited areas			Time of sampling in populated areas		
	24h	1h	annually	24h	1h	annually
CO	3	5	3	5	10	3
NO_x	0.07	0.085	0.05	0.085	0.15	0.06
PM	0.04	/	0.03	0.05	0.15	0.05
SO_2	0.1	0.15	0.03	0.15	0.35	0.05

3. RESULTS

COPERT IV methodology was used for calculating emissions of CO, NO_x, PM and SO_2, based on technical characteristics of vehicle manufacturers and data about activities. Figure 2

shows that the biggest emission for all four investigated air pollutants was on Požarevac-V. Plana section, so the area surrounding this section was the most polluted.

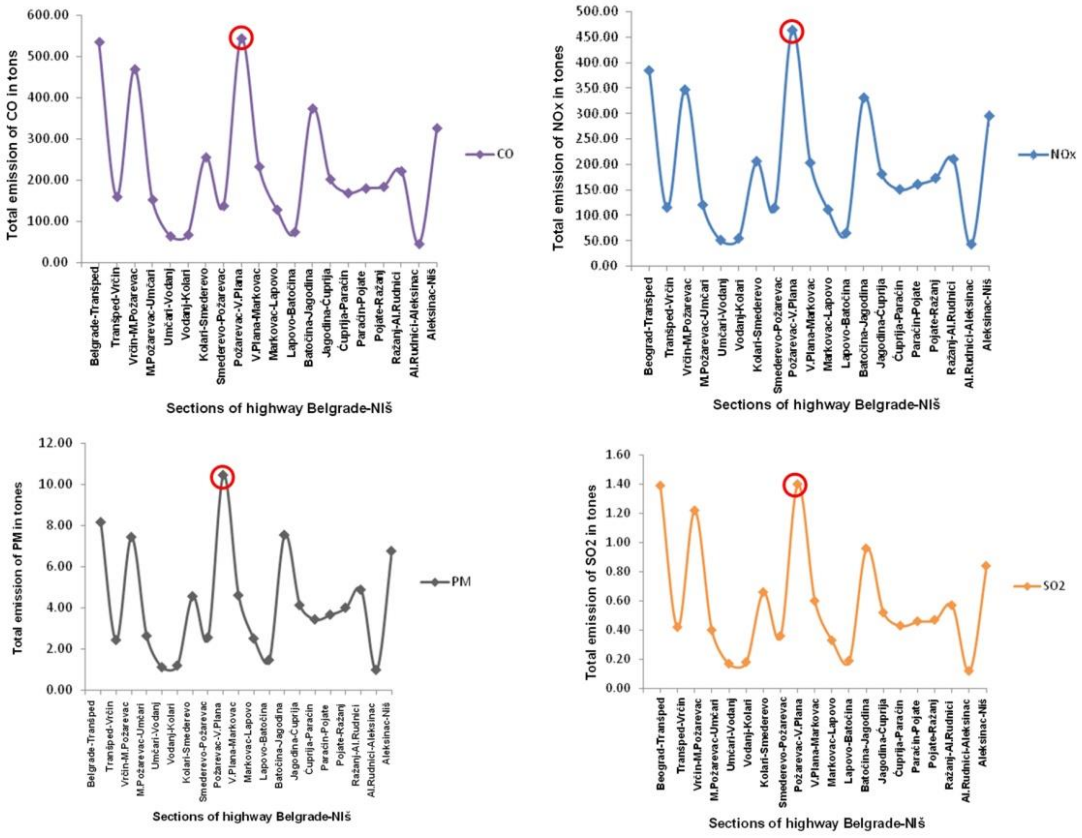

Figure 2. Emission of CO, NOx, PM and SO_2 in 2009 (gross annual value), by sections of Belgrade-Niš highway

The purpose of our investigation was to determine the most polluted section considering the worst meteorological conditions, so the assumption was that the wind speed was equal or higher then 1 m/s, stability class, according to Pasqual was set to 4, and all wind directions were taken into consideration. The calculation was made considering daily sampling in uninhabited areas, because Belgrade – Niš highway does not pass through populated areas. The results of dispersion model considering CO, NO_x, PM and SO_2, are represented in figures 3-6. They have shown that the concentrations of all investigated pollutants were the highest in the area of Požarevac – V. Plana section.

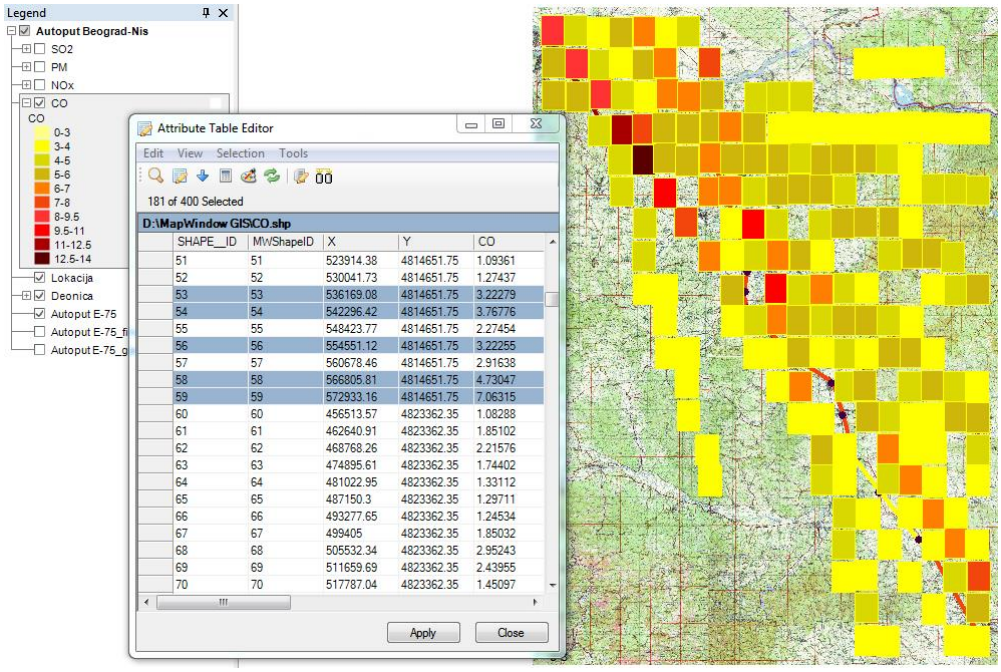

Figure 3. Mapping critical grids where the emission of CO is above limits in the case of the worst meteorological parameters

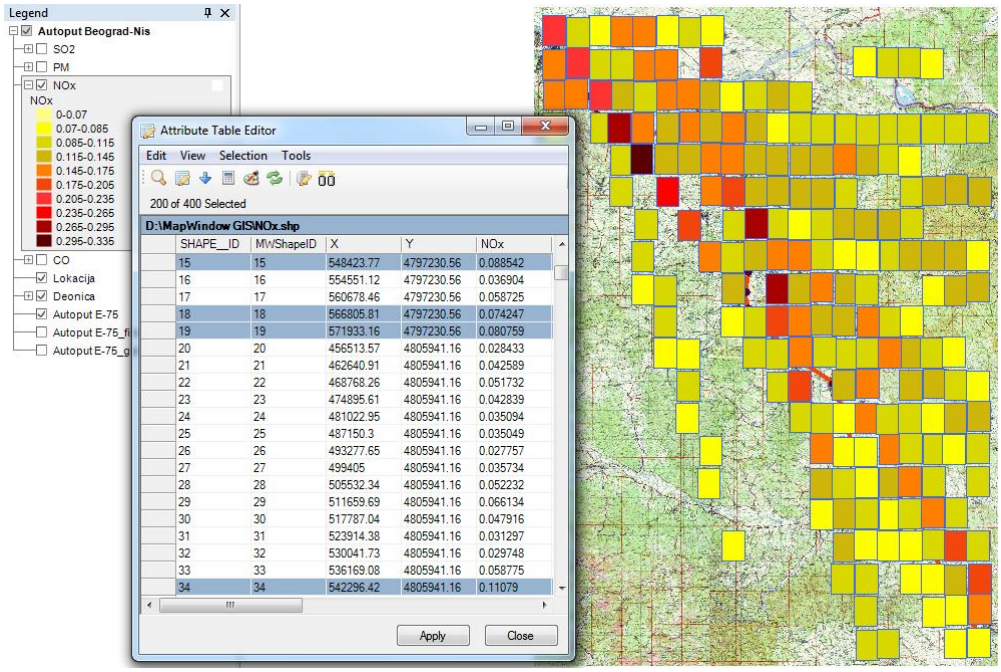

Figure 4. Mapping critical grids where the emission of NO_x is above limits in the case of the worst meteorological parameters

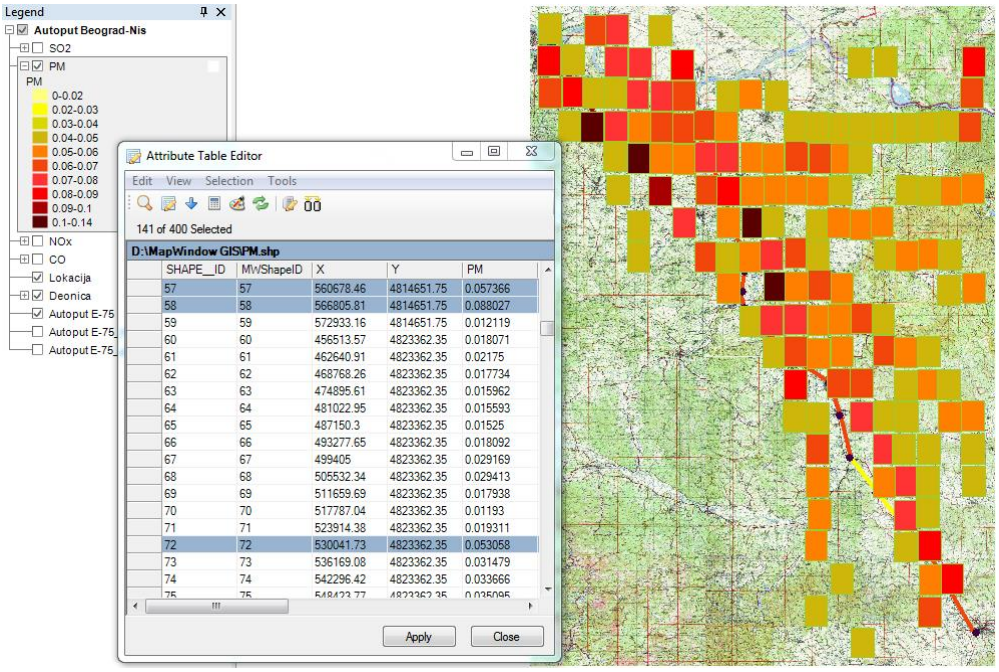

Figure 5. Mapping critical grids where the emission of PM is above limits in the case of the worst meteorological parameters

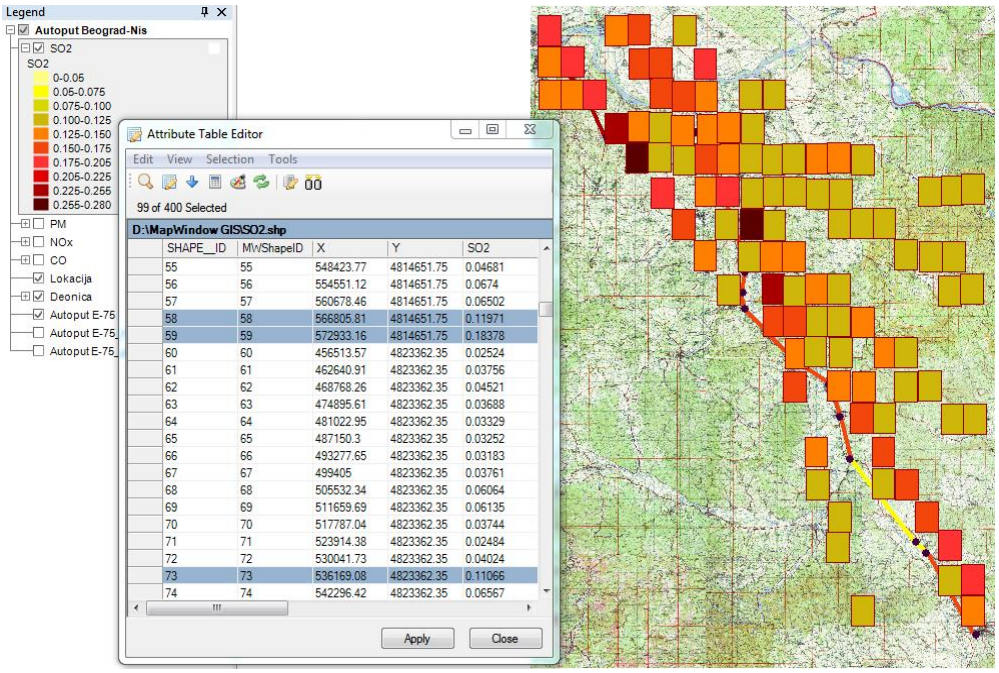

Figure 6. Mapping critical grids where the emission of SO_2 is above limits in the case of the worst meteorological parameters

4. CONCLUSIONS

The GIS-based model for determining the most polluted section on Belgrade – Niš highway was set up. The results of GIS showed that emission of motor vehicles has the influence on air quality and that it depends on fuel consumption, vehicle technology and meteorological parameters. The achieved results have shown that the integrated system can provide decision-makers valid emission information.

The aim of GIS model is that the data entered into geo database can always be adjusted and changed. The basis function of GIS is to present the results obtained on the basis of query analysis. Unlike other models, GIS displays data graphically on the map, marking a critical area, and in the table marking the lines with the information concerning critical area. Because of that ability, the application of GIS can improve the process of controlling pollutant emissions from road transport.

The research for determining the most polluted section on Belgrade – Niš highway has shown that the most polluted section is Požarevac – V.Plana, considering the worst meteorological conditions, where the assumptions were: the wind speed was equal or higher of 1 m/s, wind stability class was 4, and all wind directions (from 0^o to 360^o) were taken into consideration. The application of GIS models in determining the most polluted area caused by pollutant emissions from road transport is very important, because GIS provides results presented graphically on a map, so we can react faster.

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CORPORATE ENVIRONMENTAL RESPONSIBILITY

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Abstract:
Abstract. With increasing awareness on environmental issues and the magnitude of costs associated, it has become imperative for companies to integrate environmental efforts into their business strategy. There is a growing awareness among organizations on conservation and optimum utilization of natural resources to gain competitive advantage. Environmental responsibility is now accepted as a norm for sustainable organizations. Corporate environmentalism manifests either as part of corporate social responsibility (CSR) or safety, health and environment (SHE) project of an organization. Corporate environmental responsibility (CER) can be considered as part of the broader area of CSR. The elements of CER discussed here can be considered to be elements of CSR with an environmental focus that recognize the interrelationships among social, economic and environmental performance. This study seeks to increase understanding of the ENGO community's expectations of an environmentally responsible company by exploring the range and diversity of ENGO views.This study will help clarify the notion of corporate environmental leadership. Defining corporate environmental responsibility is an ongoing and dynamic process. A corporation will not easily achieve the goal of full environmental responsibility; rather, it will be continually challenged to adapt to new knowledge, technology and stakeholder expectations.

Keywords: Corporate environmental responsibility, Regulation, Stakeholders, Environmental management

1. INTRODUCTION

Globally, the concept of corporate social responsibility is moving from a fringe consideration to a core business issue and a permanent part of business management. In response, the World Business Council for Sustainable Development (WBCSD) has moved the CSR issue from a WBCSD project to a "Cross-Cutting Theme" and has stated in support for CSR: "For any company, giving a high priority to CSR is no longer seen to represent an unproductive cost or resource burden, but, increasingly, as a means of enhancing reputation and credibility among stakeholders — something on which success or even survival may depend. Understanding and taking account of society's expectations is quite simply enlightened self-interest for business in today's interdependent world."[1]

Corporations are beginning to respond to expectations of corporate responsibility by asking what is good for the environment, society and business, as well as how performance can be measured and evaluated. For some companies improving corporate environmental performance is simply "the right thing to do," while for others it is viewed as a strategic business advantage to increase competitiveness. These companies want to know what is expected of them so they can incorporate CER into their business strategies and become more competitive.[2] In the past two decades, CER has changed and continues to rapidly evolve to keep pace with new markets in the global economy.[3] Several forces are driving the evolution of CER, including consumer activism, shareholder and investor pressure, and competitive advantage.

1.1. CONSUMER ACTIVISM

"The environmental and human rights scandals of the past three decades have created consumers and employees who prefer companies that are doing the right thing."[4] According to an Environics International global survey of public expectations of corporations, consumers say the role of business is to make profits and create jobs; however, the role of business is also to help build a better society. In the survey, 40% of respondents had thought about punishing a specific company perceived as not being socially responsible; half the respondents had avoided the products of a specific company or spoken out to others against the company. Meanwhile, consumers were just as likely to "reward" a company perceived as socially responsible.[5]

1.2. SHAREHOLDER AND INVESTOR PRESSURE

Increasingly, investors are calling for disclosure of environmental risk, recognizing that environmental risk often translates into financial risk. Investors do not want financial institutions lending money to "environmentally doubtful projects, for example, which might bring huge clean-up costs and reputational damage."[6] This call by investors and insurers for greater disclosure contributes to increasing environmental performance concerns within companies.

For example, in 2005, the Carbon Disclosure Project, representing a consortium of institutional investors with $20 trillion in assets, requested that the FT500 (Financial Times) largest publicly traded companies disclose information on their greenhouse gas emissions.[7] Likewise, in 2002, Swiss Re Insurance, one of the world's largest reinsurers, announced it would withdraw liability coverage for executives that failed to adopt policies to address climate change.[8]

1.3 COMPETITIVE ADVANTAGE

Corporations are recognizing the potential competitive advantage to be gained by responding to stakeholder expectations for environmental performance of the company as a whole, or of its products individually. "Issues that many managers think are soft for business,

such as environment, diversity, human rights and community, are now hard for business … they are hard to ignore, hard to manage and very hard for businesses that get them wrong … managed well, these issues can be a source of competitive advantage."[9] In response to the business risks of not adopting or embracing CER, many companies are exploring how they can be more environmentally responsible. Companies realize that failing to invest time and resources in understanding stakeholder expectations and addressing their concerns upfront can increase business risk, leading to project delays and tarnished reputations.[10]

In response to these driving forces, a number of criteria have been developed to define CER, most notably by the socially responsible investing community. While the details of these criteria are generally proprietary, they find expression through public financial indexes such as the Dow Jones Sustainability Group Index and the Jantzi Social Index. Many of these criteria have been developed with the involvement of non-governmental organizations (NGOs), but to the authors' knowledge none were first driven primarily from an NGO perspective. Part of the work in this study was to explore how ENGO community defines CER and to identify key criteria for its evaluation. Increasingly, corporations are responding to multiple environmental performance demands and expectations from their stakeholders. Expectations from ENGOs can sometimes differ, depending on which environmental organization is consulted and which practice, policy, environmental license or business agreement is under scrutiny. This can be frustrating to corporations and to government agencies seeking to address public expectations on corporate environmental performance. Likewise, ENGOs are frustrated as they seek to encourage and promote CER with inadequate capacity and resources e.g., staff and finances.

The rapidly evolving global dialogue on CER is engaging a new community of players interested in sustainability e.g., pension fund managers and financial analysts and creating opportunities for some traditional players, including NGOs of all types, to become involved. Internationally there are numerous examples of coalitions with mandates specifically focused on corporate responsibility, such as The Coalition for Environmentally Responsible Economies (CERES),[11] Accountability,[12] and CSR Europe.[13] To move aspects of CER forward, businesses and NGOs are partnering in a number of ways including joint marketing projects, joint lobbying efforts and the exchange of ideas.[14]

Relative to other countries, there has not been much dialogue in Canada within the ENGO community on CER, and much less on CSR. In contrast, a consortium of ENGOs in Australia has articulated a common understanding of CER and explored ways of working cooperatively "to achieve better environmental outcomes in Australia through improving corporate environmental performance."[15] There is also a perception that European ENGOs are further ahead than ENGOs in Canada on organizing to collectively push corporations to perform better on environmental issues. Canada does have organizations focusing on corporate social responsibility, including Canadian Business for Social Responsibility (CBSR),[16], but these organizations are not ENGOs. Defining corporate environmental responsibility is an ongoing and dynamic process. A corporation will not easily achieve the goal of full environmental responsibility; rather, it will be continually challenged to adapt to new knowledge, technology and stakeholder expectations. As a result, the criteria presented in this study will likely evolve over time.

2. COMPONENTS OF CER

Corporate environmental responsibility takes many forms, depending upon a company's priorities and perceived needs, which are influenced by numerous factors such as company size, products and operations. To effectively explore ENGO expectations of CER performance, several components were identified. The components, though loosely based on the work of an ENGO consortium in Australia[25] exploring environmental sustainability, were identified during the interview process and further explored and refined at the national ENGO workshop. Although CER has been segmented into particular components in this report, it is a holistic concept, and there is a considerable amount of overlap among the components. For example, continuous improvement is implicit throughout all components, but it is also a specific planned process for reviewing and improving the quality of products and services. Similarly, transparency is an important part of stakeholder engagement and reporting, as well as a component in its own right. At a minimum, it is expected that an environmentally responsible company will demonstrate some level of action in each of these components.

2.1. ENVIRONMENTAL COMMITMENT AND AWARENESS

To demonstrate genuine environmental commitment companies must walk the talk; that is, build sustainability into their visions, annual goals, targets and plans, and have structures and processes to incorporate environmental considerations into all levels of business and decision making. Integrated environmental commitment means that all actions, large or small, are evaluated for their environmental impact. Applying a whole-systems approach with credible, science-based and ecologically sound criteria should be part of an evaluation mechanism. Corporations must embrace the triple bottom line, which means giving equal consideration to environmental, economic and social goals and commitments, and allocating sufficient resources to research that supports these commitments. must develop a long-term vision of sustainability and understand its societal role in contributing to sustainability. Corporations must show a willingness to examine and challenge current unsustainable practices. The company should openly acknowledge and fully disclose the past and present environmental impacts of the company. This may involve repaying ecological debt to communities for past environmental damages. Local communities and stakeholders must be proactively engaged in dialogue about company operations, plans, and research and development agendas. Companies can promote environmental values through repeated educational programs and employee reward systems that empower staff to be creative and innovative on environmental initiatives. The staff of a company that takes a leadership role in environmental responsibility would understand environmental issues pertinent to the industry, be aware of regulatory requirements and company performance in these areas, and be able to disseminate best practices, internally and externally, to other companies and industries. There are many examples of exceptional leadership in corporate environmental responsibility. A few ENGO representatives cited examples including the visionary efforts of Interface Inc. CEO Ray Anderson or the strong environmental commitment exemplified by Mountain Equipment Co-op and IKEA. Although there is no set path a company can take to become

environmentally responsible, ENGOs have a clear idea (and a long list) of the positive actions that companies can take to demonstrate environmental awareness and genuine commitment.

2.2 STAKEHOLDER ENGAGEMENT

There was general consensus among ENGO representatives that the current models of stakeholder engagement are inadequate. ENGOs expressed feelings of disempowerment as a result of lack of resources and capacity, and a sense of frustration with the unequal degree of influence that they hold relative to other stakeholders (e.g., shareholders, government) in the predominant approaches to stakeholder engagement. This interest-based (e.g., economic, social, environmental) inequality, which occurs even with those companies espousing triple bottom line and sustainability objectives, underpins a commonly held view that many models of engagement are predominantly driven by public relations objectives i.e.,"duty to consult" rather than the establishment of effective relationships.

For a company to be truly committed to stakeholder engagement, it must be willing to include input from stakeholders at all levels – global, regional and local – in such a manner that is thorough and thought-provoking, and whereby each voice is heard and considered in the decision making process.

Similar to the challenge of defining "stakeholder," identifying the key elements of engagement posed a significant challenge as ENGO representatives possessed a wide variety of experiences of stakeholder engagement, both positive and negative, that differed in nature (project vs. issue-specific), intent (consultation vs. engagement) and motivation (e.g., voluntary vs. government requirement). Perspectives varied from the need to be able to effectively engage in a regulatory decision-making process to the possession of the authority to "veto" a proposed project or activity.

However, there was a strong consensus that in either scenario access to information, analysis and resources to allow for effective understanding of the project or activity was essential. A shift from contemporary "consultation" approaches to engagement with "full, effective and empowered participation" includes the following:(stakeholder) could initiate a dialogue, rather than short-term, project/objective-related dialogues.

- Funding and resources to allow affected parties to expand their knowledge to make informed decisions. This could come from a third-party funding source e.g., it could come from government, which would tax corporations and create this fund, somewhat like Superfund in the US.
- Two temporally distinct stages of engagement and/or dialogue should exist — one that addresses whether the project is appropriate and one that discusses how a project should proceed.
- Regulation should dictate the timing and extent of stakeholder engagement discussions.
- "Informed" consent requires access to adequate information (and a role in determining what, and how much, information is necessary) and access to independent third party review, and scientific and/or technical advice or expertise.

- Transparent documentation of stakeholder concerns must exist to a) create a record and b)ensure that monitoring programs can be implemented (and reported) on these specific topics or issues.

Transparent and informed community and stakeholder involvement in research and development should be supported.

2.3 MEASUREMENT, AUDITING AND REPORTING

The three main pillars of quantitative and qualitative environmental performance analysis are measuring, auditing and reporting, which together provide corporations and stakeholders with the information required to accurately analyze current performance and to identify future actions. The Canadian environmental community generally recognizes and understands the value of measurement, reporting and auditing and believes there are shortcomings to current corporate practices. There is interest in advancing the Canadian ENGOs' understanding of how measurement, auditing and reporting processes are undertaken and how the results are used to compare performance within and across sectors and to provide information outside of the corporation. Some ENGO representatives would like to participate in steps to fully integrate environmental indicators in current CSR reporting and auditing measures. Ultimately, ENGOs are pushing for improved environmental reporting practices combined with actual environmental performance improvements.

2.3.1 Measurement

Many ENGO representatives insisted that credible, science-based principles of measurement (such as the system conditions promoted by The Natural Step) be adopted by the business community. Holistic measurement tools (in the style of ecological footprint[28] and materials intensity indices) are required to fully account for all environmental impacts from a company's daily operations and to facilitate assessment of cumulative impacts. A company should gather measurable results i.e., actual outputs and impacts to the environment, rather than estimations, for the purposes of tracking, evaluating and learning from its efforts. In areas of high industrial or urban activity, it is important for companies to coordinate and cooperate their reporting to reflect the cumulative impacts of all the companies operating in a given geographic area e.g., within the boundary of a town or within a city's industrial park. A commonly accepted and mandated set of indicators, developed through a multi-stakeholder process, is needed to measure corporate performance on environmental, social and financial terms. The Global Reporting Initiative (GRI) is one such program supported by ENGOs as a framework to examine when selecting indicators,[17] although it was noted that the GRI does not provide enough sector-specific content to provide a complete picture of corporate performance.[18]There is a great deal of interest from the ENGO community in the development of a carbonintensity reporting index,[19] with a total cost accounting scheme that would be incorporated as a disincentive for greater carbon intensity. This includes the implementation of carbon budgets on a per project and per company basis.

2.3.2 Reporting

Reporting is an important means of communicating information about corporate environmental performance. ENGOs asserted that useful reports use meaningful metrics; report actual, measurable results and impacts on core environmental issues (rather than reporting on process); track and report trends over time; and report mistakes as well as successes. There was broad criticism among ENGO representatives of the current practice of producing one"promotional brochure" style annual report containing information limited to the positive environmental stories that the company wishes to communicate widely. ENGOs expect that corporate environmental reporting practices will respond to the needs of stakeholders in a timely manner. Internal and external audiences were identified as having differing informational needs. For instance, reports designed for internal audiences i.e., employees, boards should tie directly into internal feedback loops and continuous improvement cycles with the goal of improving performance.

These internal reports should also include a response mechanism to promote internal corporate dialogue and communication among all levels in the company. External reporting must be posted publicly and include full disclosure of environmental performance in a timely manner. Some ENGOs representatives suggested that environmental reporting be undertaken on fiscal reporting timelines e.g., quarterly reporting. ENGOs encourage companies to seek best practices and key examples to improve their corporate reporting. In Canada, Stratos has published a detailed review of corporate sustainability reporting.[20]

2.3.3 Auditing

In general, ENGOs are supportive of a rigorous auditing and verification process that feeds into corporate and public awareness and understanding of environmental performance. To ensure measurement and reporting credibility and promote greater transparency, ENGOs strongly emphasized the importance of having the corporate auditing process verified by independent third parties. While internal auditing is encouraged to promote organizational learning and accountability, and particularly to feed into the continuous improvement cycle, external audits are required. Third party auditors must be accredited under a recognized program and have relevant experience to be proficient within the sector in which they are performing audits.[21] Credible auditors must operate independently from the organizations they are auditing. An independent auditing agency for environmental compliance is needed, whereby external audits of corporate measurement and reporting could be funded from a regulated percent of a company's sales revenue. Many ENGO representatives want to be more involved in the auditing process, whether as auditors themselves, or as advisers to the auditing process, to increase their confidence in the process.

3. TRANSPARENCY

Transparency is essential in the decision-making process and in stakeholder interactions. Transparency is necessary to help build capacity among stakeholders to allow informed

participation in decision-making processes. For instance, a company should provide interested stakeholders with information on how environmental, economic and social impacts and issues are incorporated into decisions. As well, companies must give feedback on how stakeholder input is incorporated into decisions.

Companies must be willing to share non-confidential information, including raw data, in an easily accessible manner, to be transparent through the full, accurate and timely disclosure of information about its operations. Some ENGOs stated that definitions of confidentiality and full disclosure need further exploration to better understand the expectations of corporations, governments and ENGOs. Companies are also encouraged to openly acknowledge and fully disclose the past and present

environmental impacts of the company and take full accountability for past actions. Companies that transparently share and acknowledge their history, combined with sincere and direct communication of their CER values, commitments and conduct, will undoubtedly increase ENGO confidence in their performance. ENGOs suggested that a progressive company could demonstrate leadership in CER and its commitment to transparency by taking a lead role in setting up a public registry to facilitate the

open sharing of information. While progressive companies are expected to take a lead role in information disclosure, the regulation of monitoring and information disclosure may be required.

ENGOs also agreed that the environmental community must demonstrate and practice transparency, including the disclosure of data, funding sources, etc.

4. COMMITMENT TO CONTINUOUS IMPROVEMENT

Continuous improvement (CI) is a planned process for reviewing and improving the quality of products and services. Commitments are made to constantly improve environmental performance in a company's processes, operations and activities. Leadership in CER is shown by a company that strives to continuously improve, tracks its improvement and demonstrates how it has improved performance and reduced its environmental impact. ENGOs identified several important recommendations for companies with respect to continuous improvement, including:

- Address all components of CER through a framework of commitment to continuous improvement Support any continuous improvement program and corporate performance claims with verifiable measurement of real results;
- Adopt a management system approach to implement and formalize the continuous improvement commitment;
- Institutionalize a continuous improvement culture throughout the entire company; and
- Seek stakeholder input to the continuous improvement cycle.

These core recommendations encapsulate the fundamentals of continuous improvement that would have to be present for a corporation to be considered a CER leader. They are discussed further below

For example, components of CER, such as transparency or reporting, should be addressed within a framework of commitment to continuous improvement, whereby companies set targets and goals for continuous improvement and report on their progress. Improvements must be reported based on performance targets and results measured qualitatively (and quantitatively wherever possible) on specific practical measures e.g., dematerialization or reducing emissions. The company must compare these results against a baseline, the starting point for any improvements, and set targets for continuous improvement against this baseline. ENGOs generally supported the use of a management system approach to institutionalize continuous improvement, yet stressed that it is the actual improvements in environmental performance that occur on a continuous basis, not the mere existence of a management system, that demonstrate CER. Continuous improvements can be monitored through formal management systems, such as the ISO 14001 environmental management system (EMS) standard, which requires companies to make a commitment to continuous improvement in a corporate environmental policy. ISO 14001 and other EMS standards include environmental performance auditing and the implementation of feedback mechanisms to identify opportunities for improving performance and tracking of progress. A continuous improvement ethic should be ingrained in a company's corporate culture to stimulate organizational change. Commitment should be driven from the top of an organization through senior management and even at the Board of Directors level. With executive commitment to continuous improvement in place, companies are encouraged to appoint leaders at all levels that can champion continuous improvement and facilitate the integration of improvement strategies throughout the organization. In addition, resources must be dedicated to educating and training employees. Company employees are an invaluable asset in the continuous improvement process, and companies are encouraged to harness this energy and enthusiasm in driving continuous improvement across the company. Employees must also be involved in the feedback loop of the continuous improvement cycle. CER requires companies to move beyond a limited focus on maximizing shareholder value to a broader focus on maximizing total i.e., stakeholder value.[22] For this to occur, routinely externalized implications of business decisions[36] must be factored in when identifying areas for continuous improvement. ENGOs expect corporations to actively seek stakeholder input to identify and help to internalize environmental impacts associated with corporate practice, and to incorporate these into programs driving continuous environmental improvement.

The continuous improvement process should also address stakeholder concerns and priorities. These would be integrated through formal mechanisms, such as an external stakeholder committee, to facilitate discussion around CER performance within the context of continuous improvement.

Continuous improvement can also be advanced by seeking external guidance and feedback, including those of ENGOs, on CER initiatives. Continuous improvement requires consideration of the broad scope of sustainability issues so companies are encouraged to develop and improve contact with sustainability experts. These experts bring a broader

perspective from outside the organization and can help guide the company on its continuous improvement journey.

5. OPPORTUNITIES AND CHALLENGES FOR CER BY COMPANY TYPE

Most ENGOs agree that there is no fundamental difference in expectations of environmental performance or leadership among companies of varying ownership structures and size, as the need for corporate environmental responsibility does not change. What does change are the opportunities and challenges presented both for the company in adopting and advancing CER, and for the ENGO community in engaging companies in CER (see Table 1). For the purposes of this study, opportunities and challenges for advancing CER have been loosely grouped based on company ownership structure e.g., publicly traded, privately held, and size i.e., large, medium and small corporations. However, depending on the context, opportunities and challenges can cut across these boundaries e.g., publicly traded companies can have visionaries and privately held companies can be managed by profit-driven, short-sighted executives. Table 1 lists the specific barriers and opportunities for CER identified by ENGOs, based on corporate profiles. ENGOs thinking about their role in advancing CER, will consider the opportunities and challenges associated with engaging companies of various types. In doing this, ENGOs can identify strategies to leverage the opportunities and reduce challenges.

Table 1. Opportunities and Challenges for CER Based on Company Structure and Size

Company Type	Engagement of Companies in CER
Publicly traded	Opportunities for CER • Market pressure can be applied more effectively as shareholder accountability is stronger i.e., greater potential exposure to the business value case, when and where one exists. • Direct impact on company policy by increasingly informed and concerned shareholders on CER-related issues e.g., addressing CER issues through shareholder meetings. • Greater intensity of scrutiny brought about by accountability to shareholders. Challenges for CER • Often less flexibility to be ambitious and demonstrate leadership in CER because of conservative interpretations of the notion of fiduciary duty.
Privately held	Opportunities for CER • Visionary and dynamic leadership e.g., leaders with environmental values potentially have less barriers to making change as they only have to get the owners on board. • Flexibility of private companies e.g. less responsible to shareholders. • Autonomy to do things differently allows private companies to move forward more nimbly. Challenges for CER • Stakeholders have difficulty influencing values of leadership i.e., CER laggards. • Less public disclosure and accountability. • Fewer avenues for external audience to affect change.
Customerowned	Opportunities for CER • Members with an emotional attachment to the company care more about its actions. • More responsive to member requests, different kind of bottom line. Challenges for CER • Level of environmental responsibility dependent on the values of its members
Crown corporations	Opportunities for CER • Higher public accountability e.g. more avenues from which to hold them accountable. • Structure does not bind crown corporations to holding shareholder profit and return on investment above environmental performance e.g. more opportunity to implement a true triple-bottom-line business plan. Challenges for CER • Transparency i.e., can be difficult to obtain information from crown corporations. • Visionaries can be limited by bureaucracy and government in power.
Size	
Large corporations	Opportunities for CER • More resources to dedicate to sustainability initiatives. • Have the capacity to make dramatic changes. • Greater concern for their corporate reputation e.g., larger companies often more in public spotlight. • Wider geographic influence with global operations — opportunity to apply high environmental standards globally. Challenges for CER • Higher visibility means more pressure from multiple stakeholders e.g., potentially conflicting demands. • Complexity and large size of organizations
Medium and small corporations (<500 employees and < $50M in annual revenues)	Opportunities for CER • Can be more responsive to local needs and accountable to the community they operate in. • Increased opportunity for faster change. • Less complex structure for implementation of process. Challenges for CER • Lack specialist staff and resources. • Can be less concerned with company reputation. • Less exposure to public scrutiny.

(*Source: Statistics Canada.)*

6. CONCLUSION

An environmentally responsible company is one that has two epiphanies: 1) the dominant social institution epiphany where it realizes that corporations have become more powerful than nations, and therefore it has a responsibility to society; 2) the environmental epiphany where it realizes that its purpose is sustainability. As an engine of society, an environmentally responsible company aligns its business with ecological principles. Its business is to help society achieve sustainability.

This study explores environmental non-governmental organization (ENGO) perspectives on Corporate Environmental Responsibility (CER) as well as ENGO expectations of companies striving to improve their environmental performance. Issues considered range from high-level concepts e.g., continuous improvement to operational practices e.g., reporting.

There are various factors to CER, but an ambiguity prevails through the whole process of corporate environmentalism and beyond compliance actions. This paper puts forward a conceptual idea depicting that if the external factors continuously pressurize the corporations, managers internalize the externalities of CER, and then a synergistic effect between the two kinds of factors will lead the organizations to CER. This initiation entails tangible and intangible benefits for the organization. The accrued benefits in turn motivate managers to accept and implement principles of CER. External factors of CER and their effect on organizations have been well established. Disclosure reports enhance transparency and accountability in corporations, create public awareness and hence exert heavier pressures on laggard enterprises or offer more incentives for the good performers. In a study, Minz (1995) showed that the US Environmental Protection Agency's effectiveness in enforcement varied considerably depending on presidential regimes and larger political processes. Clark (2005) states that corporations are not only influenced by regulations but other stakeholders as investors, surrounding residents, industrial associations, and employees instigate for proactive environmental measures. Wu (2009) empirically found that competitive pressure to produce differentiated products, reduce costs, attract and retain quality employees, and create product and process innovations is a significant factor deterring environmental violations and a likely factor contributing to environmental over-compliance. There is strong and consistent evidence that the environmental values and beliefs of upper management

affect a facility's choice of compliance level. Firms that behave strategically in environmental management are more likely to be over complying with an environmental standard (Wu, 2009).

This paper describes the major antecedents to CER, which are crucial in understanding the motivation behind environmental violations and over-compliance. These antecedents are central to the design of environmental policies (Wu, 2009). Government policies can facilitate organizations through tax reduction and enable them to adopt CER strategies. Managers can also focus on the barriers and means to overcome those in order to follow proactive environmentalism. This framework helps managers to take notice of cognitive barriers of CER and overcome those to gain the benefits of CER. Usually benefits of CER, remain veiled under the cognitive and institutional barriers. Systemic and long-term perspective will aid managers in overcoming barriers to CER. Only firms with sufficient financial resources and

management capabilities can pursue a proactive environmental strategy. They also suggest that corporate environmental performance is likely driven by management's strategic choice in the context of firms' resource constraints and may evolve over time. This is particularly relevant in developing country context, where organizations vouch for financial profits. In developing countries, the concept of environmental responsibility is slowly gaining acceptance and stakeholders are becoming aware of their environmental rights. Thus, the system is evolving from "no environmental concern" to change in regulations, evolving of environmental policies and disclosure reports with more transparency and accountability. CER is still in transition, progressing slowly toward proactive environmentalism and sustainability. This paper conceptually describes the inter-dynamic relationship between various factors, barriers and benefits in implementation of CER. This needs to be further tested and established for better understanding of motivations and hindrance in CER and its various implications.

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15. In 2001, the ENGO Total Environment Centre (TEC) in Australia published the *Environmental Sustainability Assessment: A TEC approach for companies seeking good performance outcomes* in which they engaged a number of environmental groups. The goal was to develop a systematic, ENGO-defined, evaluation process to inform stakeholders and encourage sustainability in the corporate sector, More at <http://www.ecologicalfootprint.com/>
16. The GRI provides an outline of specific content and benchmarks for 36 environmental indicators. Visit <www.globalreporting.org> for more information.
17. For a discussion of the strengths and weaknesses of GRI relative to other frameworks for measuring business sustainability, see Veleva, V., and
18. Ellenbecker, M. (2000). "A Proposal for Measuring Business Sustainability: Addressing Shortcomings in Existing Frameworks." *Greener Management International: The Journal of Corporate Environmental Strategy and Practice, 31* (Autumn), pp. 101-119.
19. Carbon intensity refers to the amount of carbon (greenhouse gases) emitted per unit of production.

20. See "Building Confidence: Corporate Sustainability Reporting in Canada" Stratos with Alan Willis and Associates. 2003.
21. The Forest Stewardship Council model was cited as a good example of a rigorous and reliable third party auditing process.
22. See Global Reporting Initiative's 2002 *Sustainability Reporting Guidelines* (GRI *Guidelines*) available at www.globalreporting.org or Stratos's Benchmark Survey Methodology in " Building Confidence: Corporate Sustainability Reporting in Canada" Stratos with Alan Willis and Associates. 2003. Available at www.stratos-sts.com
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PROCESS OF WASTE TYRES PYROLYSIS

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Abstract: Waste tyres pyrolysis is process of thermal decomposition that accures in the plant reactor under non oxidative conditions. As feedstock for pyrolysis reactor tyres can be used whole or shredded. Products of waste tyres pyrolysis process are: pyrolysis oil, pyrolysis gas, char and metal wires. Waste tyres pyrolysis is a special form of energetic waste utilization, because it's outputs are mainly used as energy-generating products. All pyrolysis products are valuable secondary raw materials. Pyrolysys oil and gas are used for plant reactor heating, metal wires are used for steel production and char is widely used for tyres manufacturing, pigments etc. Tyres pyrolysis process does not generate waste. Air emissions occur from burning pyrolysis oil and gas for plant reactor hetaing. Waste tyres pyrolysis process satisfy most of the ecological and economical criteria.

Keywords: pyrolysis, tyres, waste.

1. INTRODUCTION

Waste tyre is any tyre that has been removed from its original use and includes tyres from motorized transportation (passenger cars, bus, plain etc.). Waste tyres are categorized as special wastes because consist polymer that are not biodegradable. That why pyrolysis of waste tyres and utilization of its outputs has important ecological and economical significance. Waste tyres management in Bosnia and Herzegovina is not developed. Tyres are illegally dumped or stockpiled.

Waste tyres management in EU countries according to the ETRMA in 2010 [1]:

- Export to south end east European countries 10%
- Retreading 8%
- Material recycling 40%
- Energy recovery 38%
- Landfills 4%

There is no reliable data on the quantities of waste tyres in Bosnia and Herzegovina. Estimations are that annual generation of this waste is around 20 000 tonnes. One of the methods used for waste tyres management is process of pyrolysis. Several tyres pyrolysis plants in Bosnia and Herzegovina are in the construction phase or test phase. One of those

plants is "TSP-EUROGUMA" in Sarajevo. In this paper are described parameters of this plant.

2. COMPOSITION AND PARAMETERS OF TYRES

A conventional tyre is product with a complex structure and composition and contains mixtures of rubber, steel wire, textile fibres and other mineral materials. Radial tyres have the widest application (figure 1.). Radial tyres differ from traditional diagonal bias-play tyres in their construction. The plies of reinforcing tyre cord extend from bead to bead at a 90 degree angle to the centreline of the tyre. Directly on top of the radial plies and under the tread is a full length belt made up of several plies of cord or steel. They minimize tread wear and improve flexibility of the sidewall for better handling. Basic characteristic of tyres used on trucks and busses is higher ratio of natural rubber while passenger car tyres contain higher ratio of synthetic styrene-butadiene rubber (table 1) [2].

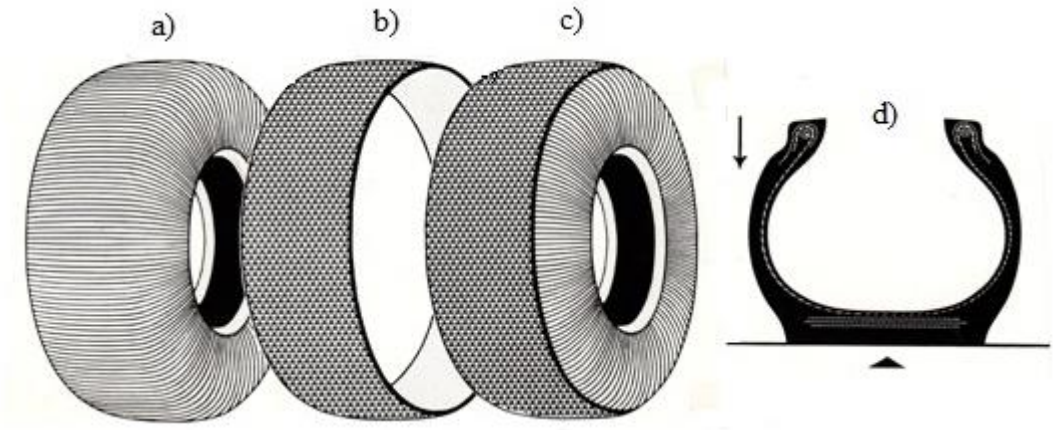

Figure 1. Basic structural parts of radial tyre: a) tyre cord, b) belt, c) tread, d) cross section

Table 1. Average composition of tyres for passenger cars and trucks

Component	Passenger car	Trucks and busses
Natural rubber	21	31
Synthetic rubber	24	14
Char, SiO_2	28	21
Steel wire	12	24
Textile	4	1
Other	11	9

Chemical composition of tyre differs from one manufacturer to other. Mixtures of components built in tyre are business secret of every manufacturer. Passenger car tyres and trucks tyres differ by chemical composition because of different loads applied and scope of application. That is why it is not possible to give accurate chemical composition of tyres. In table 2 materials present in passenger car tyre are shown. Table 3 shows average chemical

composition of materials built in tyre and table 4 shows average number of tyres and tyre mass for some vehicles [2,4,5].

Table 2. Average materials present in passenger car tyre

Ingredient	Content (%)
Carbon polymers (natural or synthetic rubber)	47
Carbon black	21,5
Steel	16,5
Textile	5,5
Zincoxide	1,0
Sulphur	1,0
Other	7,5

Table 3. Average chemical composition of materials built in passenger car tyre

Ingredient	Content
Carbon	ca. 70 mass %
Iron	16 mass %
Hydrogen	7 mass %
Oxygen	4 mass %
Zinc oxide	1 mass %
Sulphur	1 mass %
Nitrogen	0,5 mass %
Salts	0,3 mass %
Halogens	0,1 mass %
Copper compounds	200 mg/kg
Cadmium	10 mg/kg
Chrome	90 mg/kg
Nickel	80 mg/kg
Lead	50 mg/kg

Table 4. Average number of tyres and mass per tyre for some vehicles

Type of motor vehicles	Medium weight (kg)	Average number of tyres
Motorcycle	2	2
Passenger car	6,5	4
Van	9	4
Omnibus	32	5,3
Trucks and tanks	38	5,6
Single-axle trailer	12	2
Multi-axis trailer	35	4,5
Tractors	30	4,5

3. MAIN PRINCIPLES AND PRODUCT CHARACTERISTICS OF WASTE TYRE PYROLYSIS AT "TSP-EUROGUMA" PLANT

3.1 BASIC PROCESS PRINCIPLE AND PRODUCTS

Pyrolysis (pyr-fire, lyein - decomposition) or gasification is thermal degradation of organic compounds under non oxidative conditions which leads to cleavage of macromolecules and pure forms of carbon are obtained. Organic components, when heated become unstable and decompose into simple products. Heating of organic compounds up to 550 °C result in slow pyrolysis, while at temperatures between 800 i 1100 °C fast pyrolysis occurs. During pyrolysis in temperature range from 300-350 °C organic compounds are converted to C_{25} and C_{40} aliphatic (long molecule chains with 25-40 atoms of carbon), with further increse in temperature C_2 and C_6 are converted into olefins which are at higher concentrations and temperatures converted into aromatics.

Basic chemical reactions during process of organic compounds pyrolysis are:

$$C+CO_2 \rightarrow 2CO$$
$$C+H_2O \rightarrow CO+H_2$$
$$C+2H_2 \rightarrow CH_4$$

Pyrolysis process at "TSP-EUROGUMA" is classified as slow pyrolysis, up to maximum temperatures of 450 °C. Figure 2 shows main components of "TSP-EUROGUMA" pyrolysis plant and figure 3 shows technological scheme of pyrolysis process in that plant [6].

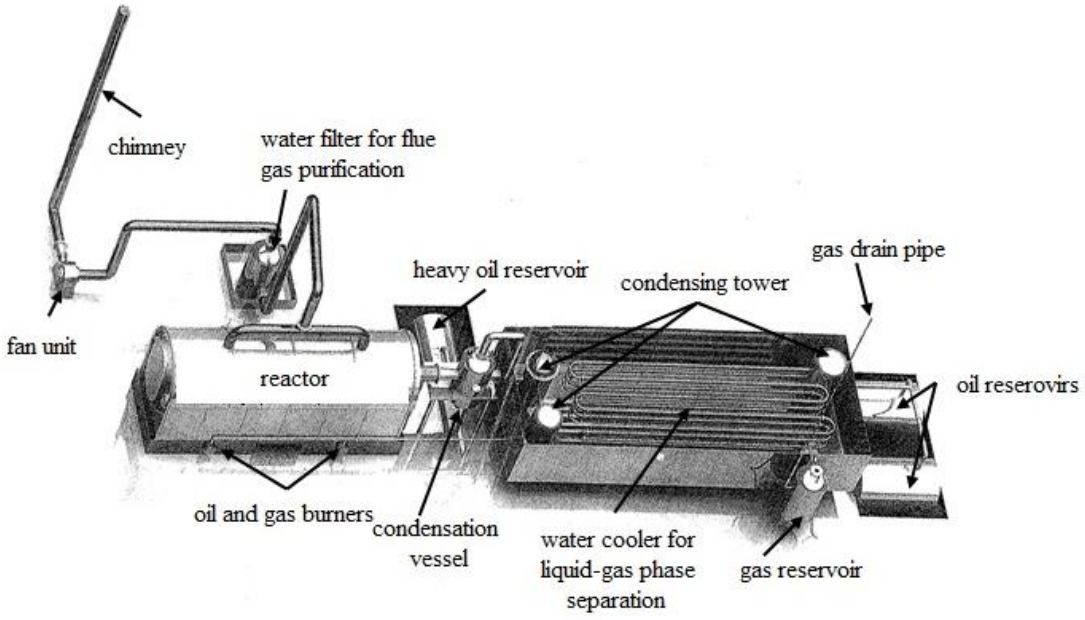

Figure 2. Main components of "TSP-EUROGUMA" pyrolysis plant

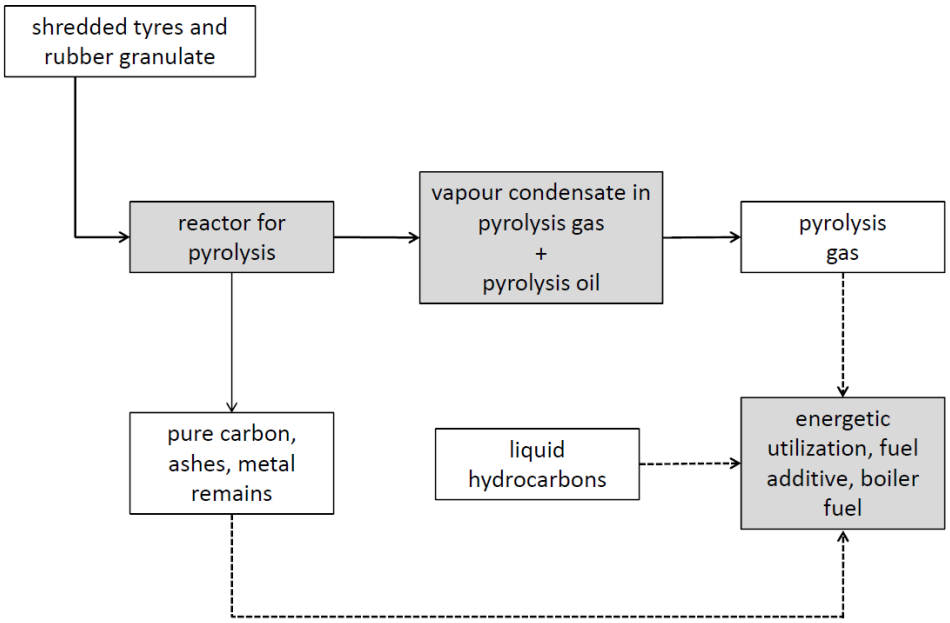

Figure 3. Technological scheme of pyrolysis process in "TSP-EUROGUMA" plant

Pyrolysis reactor (V= 8m^3) is heated by burning process products - pyrolysis oil and gas.products. Products of waste tyres pyrolysis process and average mass fractions are shown in table 5 [7].

Table 5. Products and average mass fractions of waste tyres pyrolysis process

Products of pyrolysis process	*Mass %*
Char	38
Oil	30
Gas	15 (ca. 40% CH_4)
Metal wire	17

Waste tyres pyrolysis process in "TSP-EUROGUMA" plant lasts 10-12 hours. After reactor is cooled char and metal chord are removed from reactor and then reactor is feed with shredded tyres. Waste tyres pyrolysis cycle (heating, discharging and feeding) lasts approximately 24 hours. According to this parameters and reactor volume (V= m^3) annual capacity of the plant "TSP-EUROGUMA" is ca. 2 000 tonnes.

3.2 BASIC CHARACTERISTICS OF WASTE TYRES PYROLYSIS PRODUCTS

Basic characteristics and area of application of waste tyres pyrolysis products are shown in table 6,7, and 8. Pyrolysis oil is similar to diesel oil while pyrolysis gas is similar to natural gas.

Table 6. Basic characteristics of pyrolysis char [7]

Parameter	Unit	Value
Basic characteristics		
Density	kg/m^3	346-430
Lower calorific value	kJ/kg	29 000-34 100
Moisture	%	0,6
Sulphur	%	1,81-2,31
Ash	%	< 12
pH value of water extract	-	10,25
Loss at 105°C	%	0,44
Volume of benzene sorption	cm^3/g	0,16
Specific outer surface	m^2/g	85,1
Specific adsorption of outer surface	m^2/g	51,77
Desiccant activity of methylene blue	mg/lg	55,7
Appearance	Parts, size 2-20 mm. brittle ends, color black with shades of grey, porous structure	
Application area: - filters manufacture (active carbon), - shoe industry, - pigment colours manufacture, - manufacture of toner cartridges for printers and copy machines, - solid fuel (briquettes), - sorbents		

Table 7. Basic characteristics of pyrolysis oil [7]

Parameter	Unit	Value	
		Diesel fuel (100%)	Synthetic diesel fuel from tyres,(100%)
Basic characteristics			
Density	kg/m^3	830	825
Lower calorific value	kJ/kg	42 500	44 800
Specific fuel consumption	kg/kWh	0,24	0,227
Evaporation process: - start of evaporation - end of evaporation	°C	-	 30-70 200-250
Kinetic viscosity	cSt	-	6,97 20
Solubility in water	%	-	20
Application area - addition to diesel fuel, - oil for boilers, crude oil replacement, - possible further processing for obtaining new oil products			
Appearance - dark oily liquid with characteristic oil odor, - black colour with shade of brown			

In waste tyres pyrolysis plant "TSP-EUROGUMA" at reactor discharge, in condensation pot, heavy pyrolysis oil is separated. This oil has characteristics similar to crude oil (table 8). By further processing of this oil, naphthalene can be obtained up to 25 %.

Table 8. Composition and characteristics of hardly volatile components [8]

Components	Unit	Value
Benzene, toulol, xylene aromatics	mas. %	5
Naphthalene and methyl naphthalene	mas. %	20 - 30
Gaseous chromates	mas. %	70
Extraction residue	mas. %	6 - 10
Density	kg/m^3	1.000 – 2.000
Ashe	mas. %	10
Organic chlorine	mg/kg	5
Inorganic chlorine	mg/l	1.000 – 2.000

After volatile components pass through water cooler, volatile pyrolysis oil is being separated from pyrolysis gas. Main component of easily volatile fractions of pyrolysis oil is benzene (between 30-50%). Pyrolysis oil is used as fuel while pyrolysis gas is used to improve octane number of fuel. Main characteristics of pyrolysis gas from waste tyres pyrolysis process which is used for reactor heating is shown in table 9 [5]. Pyrolysis gas consists of methane, ethane, propane and has a quality of natural gas.

Table 9. composition and characteristics of pyrolysis gas [7]

Parameter	Unit	Value
Basic characteristics		
Density	kg/m^3	0,8
Lower calorific value	kJ/kg	8.250
Gas components content		
N_2	%	32 – 40
H_2		18 – 25
CO		15 – 18
CO_2		10 – 18
CH_4		4 -7
$C_2 – C_4$		2,5 – 5,0
Moisture		20
Application area: - about 50% of total gas quantity is used for reactor heating. The rest of gas is realised to the atmosphere (burned in a flare or send through actice carbon filter) or stored.		
Appearance: - odourless gas with mild white colour, with smell of soot, flammable at temperatures above 90°C		

Chemical composition of waste tyres pyrolysis process is shown in table 10.

Table 10. Chemical composition of waste tyres pyrolysis process [4]

Parameter	Unit	Char	Pyrolysis oil	Pyrolysis gas
Carbon	%	91,5	86,6	85,76
Hydrogen		2,0	10,3	14,24
Nitrogen		0,4	0,6	in traces
Oxygen		0,2	0,8	in traces
Sulphur		2,1	1,2	in traces
Clorine		0,11	-	-
Chlorides	mg/m^3	-	-	0,3
HF		-	-	< 0,06
SO_2		-	-	< 1,35
Moisture	%	24	0,6	20

4. WASTE PRODUCTION AND AIR EMISSIONS FROM WASTE TYRES PYROLYSIS PROCESS

Waste is not produced during process of waste tyres pyrolysis. Smaller quantites of municipal waste are generated during preparation of tyres this treatment (storage, shredding and reactor feeding).

Air emissions occur in combustion process of pyrolysis oil, for reactor heating. Purification of combustion gases in "TSP-EUROGUMA" plant takes place in water filter. Emissions from pyrolysis gas and diesel fuel combustion are shown in table 11 [8].

Table 11. Emissions from pyrolysis gas and diesel fuel combustion

Parameter	Unit	Value	
		Diesel fuel, 100%	Sinthetic diesel fuel (from tyres), 100%
CO_2	kg/kWh	0,2949	0,2960
H_2O		0,0960	0,0980
N_2		1.1140	1,1100
O_2		0,0564	0,0600
Char	g/kWh	0,4110	0,3060
CO	g/kWh	0,1900	0,1500

5. CONCLUSION

One of the available systems for waste tyres utilisation in environmentally friendly way is pyrolysis. Products of waste tyres pyrolysis are secondary raw materials as well as energy generating products. Generation of waste and air emissions to the atmosphere are minimal. Suitable locations for installation waste tyres pyrolysis plants in Bosnia and Herzegovina are recycling yards at regional sanitary landfills and tyres retreading facilities with higher capacity. According to waste tyres production in Bisnia and Herzegovina we can expect

installation up to 10 waste tyres pyrolysis plants with reactor volumes of 5-8 m^3. Pyrolysis oil and gas can be used directly for reactor heating and energy generation at plant location. Metal cord and solid carbon (graphite) have a secure market. Thus, recycling of waste tyres in Bosnia and Herzegovina in waste tyres pyrolysis plants meet all economic and ecological criteria.

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ECOLOGICAL ADVANTAGES OF USING TECHNOGENIC WASTE MATERIALS IN CEMENT INDUSTRY

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Abstract: The paper problematizes the use of technogenic waste materials (secondary raw materials), primarily fly ash, in cement industry. In this paper, primarily, economic benefits (reduction of heat and electricity, reducing the amount of exploited natural raw materials) and environmental benefits (reduced emissions, reducing the amount of disposed waste) as well as European trends of use of fly ash in the cement industry are listed. As confirmation of the possibility of using fly ash from thermal power plant "Ćatići" in the cement industry, in the paper are also mentioned the results of physico-chemical characteristics of cement with 50% ash.

Keywords*:* cement, fly ash, sustainable development, secondary raw materials

1. INTRODUCTION

In Bosnia and Herzegovina there are currently two cement factories: in Kakanj and Lukavac. The annual cement production of these two plants is about 1 000 000 tonnes, which covers about 60% of the total cement consumption in Bosnia and Herzegovina.

The above-mentioned fact that it is produced only 60% of the total cement consumption in Bosnia and Herzegovina, says enough that the discussion of the cement industry development makes sense. When the development of the cement industry is mentioned it is clear that implies the sustainable development which include: the largest possible reduction in the exploitation of natural raw materials (limestone, marl, clay, quartz, sand, etc.), as well as minimal emissions to the atmosphere with the best possible financial effect.

2. RAW MATERIALS IN THE CEMENT INDUSTRY

One of the possible solutions for mentioned problems is the use of secondary raw materials in the cement industry. Raw materials that are currently available or will be available soon, and that by its physical and chemical characteristics fulfill the requirements are:

1. fly ash (electrofilter ash) from thermal power plants,
2. granulated slag and
3. silica fume from ferrosilicon production.

From the above secondary materials currently in Bosnia and Herzegovina as a cement additive is used only by-product of thermal power plants (electrofilter ash), but lately more and more interesting it becomes granulated slag due to the initiation of the integrated production in the Ironworks in Zenica.

The European trend is that the participation of clinker in cement from year to year decreases and increases the content of the above-mentioned secondary raw materials. In 2002 average share of clinker in cement accounted for slightly over 70%.

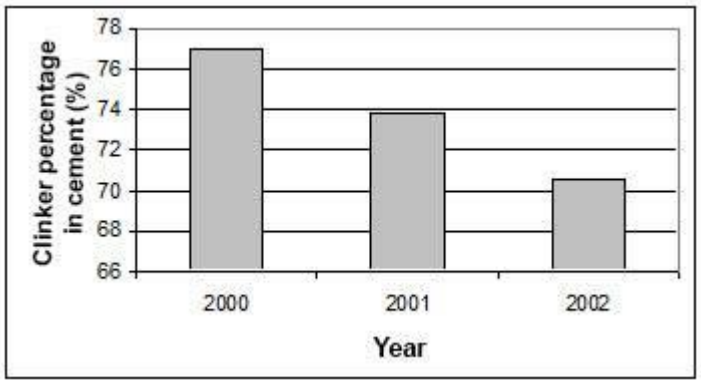


Figure 1. Percentage share of clinker in cement [4]

2.1. THERMAL POWER PLANTS FLY ASH AS A RAW MATERIAL

Fly ashes belong to the artificial pozzolanic materials. Pozzolans are defined as substances that by themselves do not have binding properties, but if they are milled in the presence of lime and water they result in stable constructions with hydraulic properties According to their chemical composition, pozzolans, artificially or natural, represent aluminosilicate materials with extremely acidic character.

Fly ash particles are mostly glassy spheroids, which size can vary from 1 microns to about 150 microns, and the typical size of the particles can be taken below 20 microns.

Fly ashes have specific characteristics which are significantly different from other industrial mineral supplements. Besides, variations of fly ash characteristics are much greater than blast furnace slag or SiO_2 dust characteristics variatons, because they depend on the type and quality of used coal and technological conditions of burning (temperature) and on cooling mode of fly ash particles [1].

The chemical composition of fly ash varies in a very broad range. According to H. Peters the chemical composition of fly ash varies within the limits given in Table 1.

Table 1. Chemical composition of fly ashes by Peters [2]

Ingridient	Fly ash from coal	Flying ash from brown coal and lignite
A.L.	**3 – 10**	**5 – 15**
SiO_2	**30 – 55**	**5 – 15**
Al_2O_3	**15 – 35**	**2 – 10**
Fe_2O_3	**5 – 10**	**2 – 20**
CaO	**2 – 10**	**20 – 50**
MgO	**1 – 3**	**3 – 5**
SO_3	**0 – 3**	**3 – 25**

2.2. THE ECONOMIC AND ENVIRONMENTAL EFFECTS OF THE FLY ASH USAGE

The use of fly ash has a number of of positive influences both economic and environmental:

- Reduction of heat and electricity consumption,
- Reduction of the raw materials exploitation necessary for the production of clinker,
- Reduction of CO_2 emissions by reducing the share of clinker in cement,
- emissions reduction of NOx and SOx,
- Reduction of fly ash waste landfill,
- Production of multiple types of eco-cement.

The Cement Plant Kakanj, as a substitute clinker annually uses about 120 000 tons of fly ash. For 2002, the average amount of CO_2 emitted into the atmosphere during the production of one ton of cement is 580 kg (Figure 2). From which it follows that the replacement of 120 000 tons of fly ash in cement manufacturing reduced CO_2 emissions by 69 600 tons.

Average emissions of NOx and SOx in 2002 were 1,3 and 0,1 kg/tonne of clinker (Figure 3). Which means that by using the above-mentioned amounts of fly ash emissions of these gases are decreased by 156 tons of NOx and 12 tons of SOx.

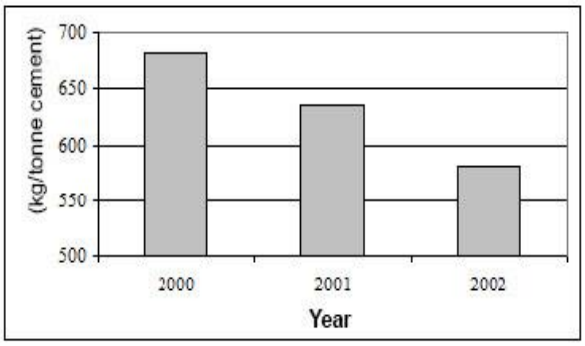


Figure 2. Specific CO_2 emission per ton of cement [4]

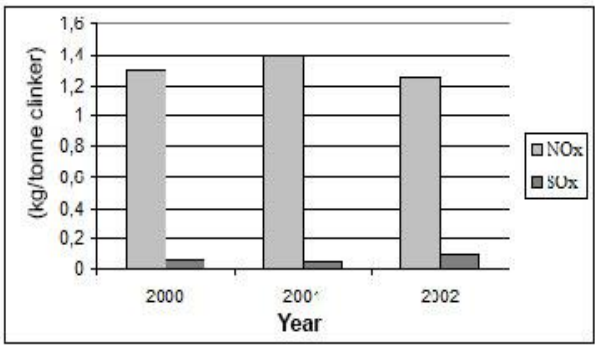


Figure 3. The average emissions of NOx and SOx per ton of clinker [4]

Due to the very high production of electricity in power plants, there is a big problem depositing huge amounts of fly ash, that at the same time becomes one of the main causes of air pollution in the near and far enviroment, in which fly ash is made, or in which is deposited. It should be noted that its disposal, which is mainly done hydraulically, almost irreversibly destroys the huge areas, mainly agricultural land in which re-cultivation must be invested substantial resources.

If we take into account that the bulk density of fly ash is 650 kg/m^3, for depositing the said amount (120 000 tons) of industrial scrap, only in one year, it is necessary to ensure the landfill of total capacity of 185 000 m^3. Assuming that the height of the landfill is 10 m, the total land area for disposal of annually amount of fly ash in TC Kakanj would equate 18 500 m^2.

The use of natural materials such as limestone, clay and sand is necessary for the production of cement. Sustainability in this field involves the responsible management of natural resources, reducing the use of natural resources, by recycling and increasing use of alternative materials. Saving natural resources will not only reduce production costs, but will also keep the reserve materials for future generations.

On average, for the production of one ton of cement in 2002 was necessary to exploit approximately 1380 kg of natural raw materials (Figure 4). Substituting 120 000 tons of fly ash has reduced the exploitation of natural raw materials for 165 600 tons.

An important economic aspect of the use of fly ash is to reduce the consumption of heat and electricity necessary to produce clinker.

The average energy consumption in 2002 amounted to 3400 MJ/tonne of clinker, while the average electricity consumption was 109,9 kWh/tonne of cement (Figure 5). So, it would take for the production of 120 000 tons of cement 444 000 GJ of heat and 13 188 MWh of electricity.

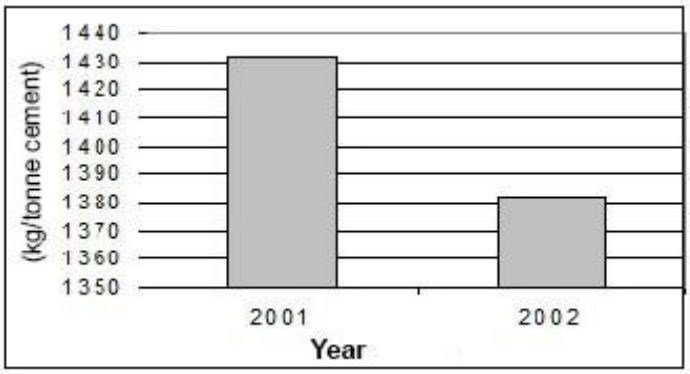
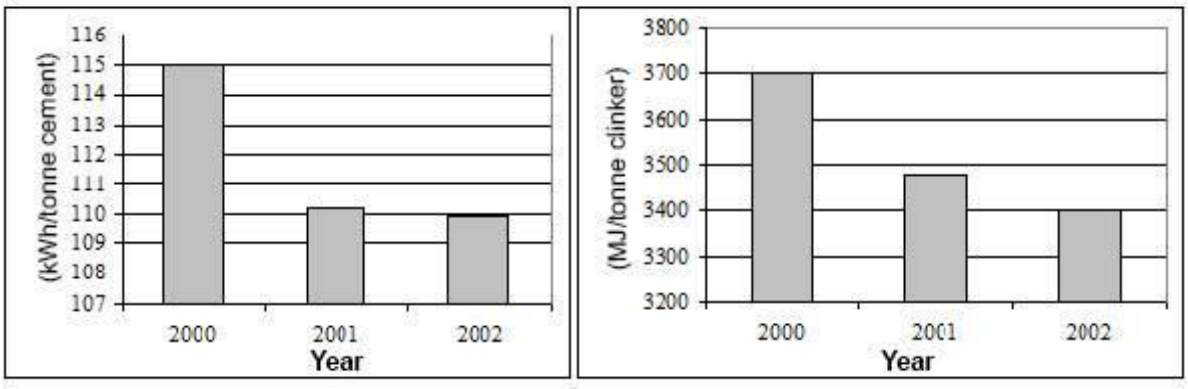


Figure 4. Average consumption of natural raw materials per ton of cement [4]



a) *b)*

Figure 5. Average consumption of: a) thermal energy b) electricity [4]

The most effective solution to the aforementioned problems lies in converting fly ash and other industrial scrap into raw materials that can be successfully used to produce the full spectrum of building materials, among which the most important is cement.

As we see Cement Factory "Kakanj" has already achieved significant results in the application of the fly ash from thermal power plants as secondary raw material in the cement industry (about 120 000 tonnes per year), but it should aim that increases use of this raw material as much as possible.

2.3. CHARACTERIZATION OF THE FLY ASH FROM THERMAL POWER PLANT „ĆATIĆI“

The fact that one matter after the manner of its origin belongs to a group of fly ash does not mean that the ash automatically belongs to the group of pozzolanic materials. This is explained by chemical or mineral composition of fly ashes. This composition is defined by the content of impurities present in the applied solid fuel or by regime of its combustion in the boilers of thermal power plants. The limiting factors pozzolanic activity of fly ash are:

- chemical composition,
- content of unconsumed carbon,
- fineness of fly ash.

In terms of of chemical composition in the limiting factors are included the content of SiO_2, MgO, SO_3, alkalis and the content of unconsumed carbon, which is expressed through the loss of annealing. It is believed that the carbon content in fly ash should not exceed 7%, but should amount to 3-5%.

The chemical composition of fly ash from Thermal power plant "Ćatići" is given in Table 2.

Table 2. Chemical composition of fly ash [5]

Component	Content (%)
SiO_2	47,18
Al_2O_3	20,79
Fe_2O_3	8,94
CaO	16,80
MgO	2,45
K_2O	1,47
Na_2O	0,27
SO_3	1,65
A.L.	0,08
Σ	99,63

From the table it can be seen that the content of carbon in the fly ash (0,08%) is far below the maximum value, which can be explained by the high temperature combustion of coal in the mentioned Thermal power plant.

Regarding the participation of the amorphous (glassy) phase in the structure of fly ash it is preferred that this share is high as much as possible. The reason for this is that the reactivity of fly ash increases with the share of the amorphous phase. On the reactivity of fly ash has a beneficial effect increase in the share of smaller size particles.

The results of particle size distribution, Class -43 μm, for aforementioned power plant fly ash, determined from a cumulative density curve, are shown in Table 3.

Table 3. Particle size distribution of fly ash [5]

The particle size, μm	Share of particles,%
<30,6	99,9
< 25	92,0
< 20	82,9
< 10	45,0
< 8	32,4
< 5	11,6
< 3	1,45

It can be concluded that 82,9% fly ash particles are smaller than 20 μm, which is very convenient for the reactivity of the ash.

Further it will be given the results of physico-chemical characteristics of cement with 50% ash.

Regardless of the content of fly ash in cement, the beginning of binding for all cements is longer than 60 minutes, which is the requirement prescribed by standard EN 197-1. Beginning of setting time is prolonged with the content increase of fly ash in cement, and this means that the reactivity of the cement decreases with increasing content of fly ash. In the case of cement without the addition of fly ash beginning of setting time is 125 minutes, and in the cement with the addition of 50% ash beginning of setting time is 235 minutes. By examining the continuity of volume as a function of the content of fly ash in cement it has been concluded that the cement containing 50% ash has a very small expansion which is far below the allowable values prescribed in the standard EN 197-1. The heat of hydration of cement with 50% ash after 7 days is 218,4 J/g. With increasing content of fly ash in cement increases the resistance of cement to sulfate corrosion. Cements with the 50 % ash content can be used in conditions where it is required stability of the cement composite towards the aggression of sulfate ions. With increasing content of fly ash in cement, there is a reduction of bulk density of cement. The specific density of cement without the addition of fly ash is 3,10 g/cm^3, and for cement containing 50 % ash is 2,92 g/cm^3. This phenomenon occurs because fly ash has a specific density of 2,7 g/cm^3, which it is less than the specific density of the clinker [1].

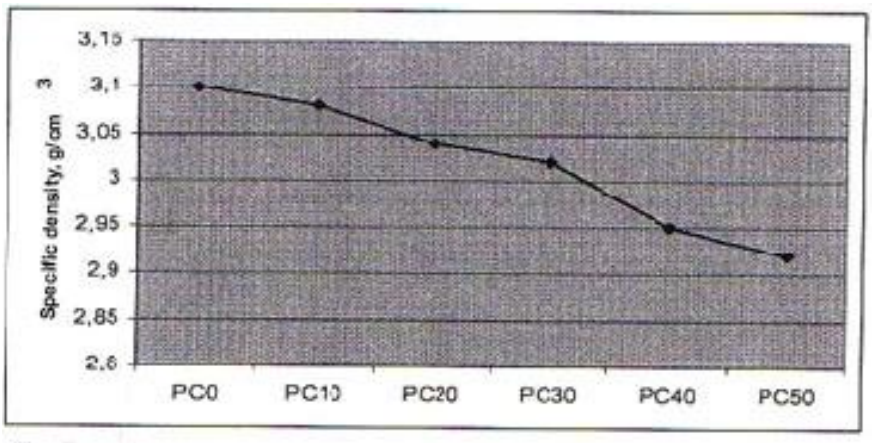


Figure 6. The dependence of the specific density from the ash content [1]

4. CONCLUSION

The use of secondary raw materials in the cement industry can deliver significant positive economic and environmental effects such as saving on energy consumption, savings in consumption of materials, reduced emissions into the atmosphere (CO_2, SO_2 and NOx), reducing the space required for the disposal of of fly ash etc. The use of secondary raw materials in Bosnia and Herzegovina has reached an appropriate level, but not the European

threshold of use of these raw materials, it is therefore necessary to continue to work to increase the use of these by-products in the cement industry and in other branches of the construction industry.

That the fly ash from our power plants can be applied in the cement industry show the results presented in this paper. All examined characteristics of fly ash such as chemical and phase composition, size and distribution of fly ash particles suggest that this fly ash is very convenient for use in the cement industry.

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MANAGEMENT TECHNOLOGY, SYNTHETIC SUBSTANCES AND ECOLOGY STABILITY

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Abstract: Economic development; all it more to base on use synthetic, to change and new to program and to draw up the plans for materials, which are effect science, to apply in the industry and other economic fields and technology. This synthetic substances (to obtained and in laboratoris) to have and an advantages; but and effects pollution nature environment. On foundation of management development; necessary it production and materials process, to bring into accord with long-term maintenance ecology equilibrium. Market of mechanizm in this roundish it ineffective. Natural resources are immeasurable and precious capital. Exist and broader moralistic, ethical standards. Scientists are remind on: recognize the dangers. Have it the way out of an uncertain state?

Keywords: Science, technique and technology, materials, substitution, compensation, ecology, exits.

1. PRETHODNE UVODNE DETERMINANTE

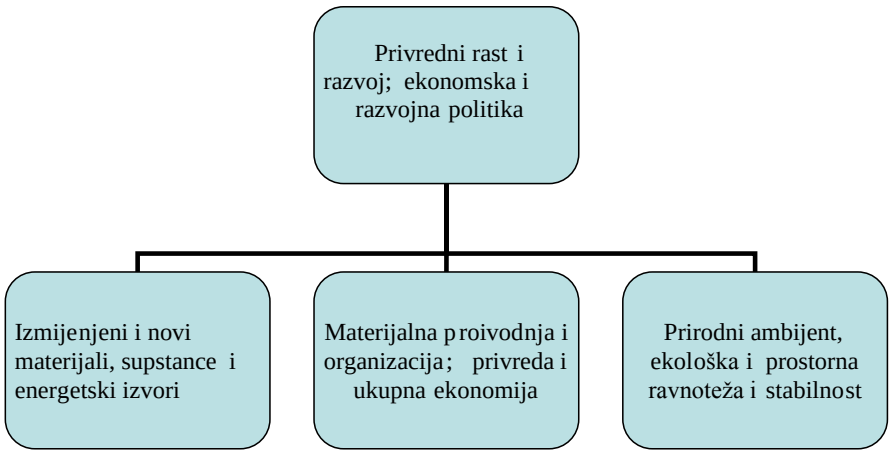
Predmet, domet, svrha i cilj ovog rada; jeste ukazivanje na kompleksni, povezani i složeni odnos: međuzavisnosti, međuuslovljenosti i međuuzročnosti; preobraženih, sintetičkih i novih supstanci i materijala, proizvodnje, privrede i ekologije; u savremenim uslovima ekonomskog rasta i razvoja. U gabaritima analize prirodnih činilaca; polazi se od: a) geografskog, teritorijalnog prostora; b) resursa neposredno datih u prirodi; v) njihovog produktivnog, ekonomičnog, rentabilnog, efikasnog i efektivnog korišćenja; tj. rezervi, ili zaliha. U kreiranju, formiranju i oblikovanju zaliha; odlučujuće djelovanje postiže: 1. dostignuti nivo i stepen razvijenosti nauke, tehnike i i tehnologije; 2. kvantitet i kvalitet činilaca; 3. nivo cijena na užem, širem inter-regionalnom i najširem svjetskom tržištu. Tako se ostvaruje: a) procesni tok kontinuirane transformacije i preobražaja resursa u rezervne zalihe; b) pomjeranje, premještanje, granice i tačke rentabiliteta (ili praga rentabilnosti); v) supstitucije i kompenzacije. Prema ovome; u oblikovanju tehno-ekonomske kategorije zaliha; najbitniji elementi su: 1) prirodna izdašnost i raspoloživost činilaca; 2) ekonomski kvalitet prirodnih resursa; 3) tehničko-tehnološki uslovi korišćenja i eksploatacije. Oskudnost, skučenost, nedovoljnost (insuficijencija) kvalitetnih prirodnih resursa; hroničnog je (dugovremenog i trajnog) vida i široko je disperzirana, (rsprostranjena) i diverzifikovana (izmijenjena) pojava. U savremenim uslovima razvoja i vremenu epohe tehnoloških

revolucija; dolazi do naglih, brzih, skokovitih i „grčevitih" promjena, šokova. Predmeti rada postaju sve više proizvod čovjekove djelatnosti, sa unaprijed određenim kvalitetnim obilježjima. Kompleksni proces privrednog razvoja; sve se više bazira na upotrebi preobraženih i novih materijala i sintetičkih i hemijskih supstanci. Materijali se oblikuju; eksperimentalno i u laboratorijama i sl. Ukazuje se da, iako su dobijeni vještačkim metodima, ovi materijali su jeftiniji i otporniji u odnosu na pojedine prirodne izvore; sa omogućavanjem izmijenjenih i novih industrijskih i ukupnih poizvodnih primjena i potreba (aplikacija). Poseban značaj dobijaju materijali i energetski izvori koji u minimalnom stepenu zagađuju prirodnu sredinu i okruženje. Ovo je od prioritetne važnosti u domenima rastućih, akutnih ekoloških zagađenja i ogromnih rizika.

Koristi se prikladni metodološki aparat: deduktivne, induktivne, strukturne, komparativne, logičke i ostale analize; sa odvajanjem pojave od od suštine, bitnog od nebitnog, tj. na određenim nužnim nivoima apstrakcije, ali i sagledavanjem mogućnosti konkretnog, praktičnog valorizovanja.

2. POVEZANOST MATERIJALNE; EKONOMSKE I EKOLOŠKE KOMPONENTE

U sadašnjoj fazi i etapama tehničko-tehnološkog i ekonomskog razvitka; objektivno ne postoji nijedan prirodni resurs, posebno energetski, koji se može eksplaoatisati i koristiti mimo državne kontrole. Proces eksploatacije neposrednih prirodnih izvora i bogatstava, odvija se u realno sve manje povoljnim uslovima i okolnostima. Materijali i sintetičke, hemijske i druge supstance; u najvećoj mjeri efekat su savremene nauke (fundamentalnih, primijenjenih i razvojnih istraživanja [13; 80-83]; inkorporirane u tehniku, tehnologiju, industriju i ukupnu materijalnu proizvodnju. Na drugoj strani; kristalizuje se gorući problem i dilema očuvanja narušene prirodne, ekološke ravnoteže. Ovu složenu povezanost, možemo pregledno predstaviti i dijagramskim putem:



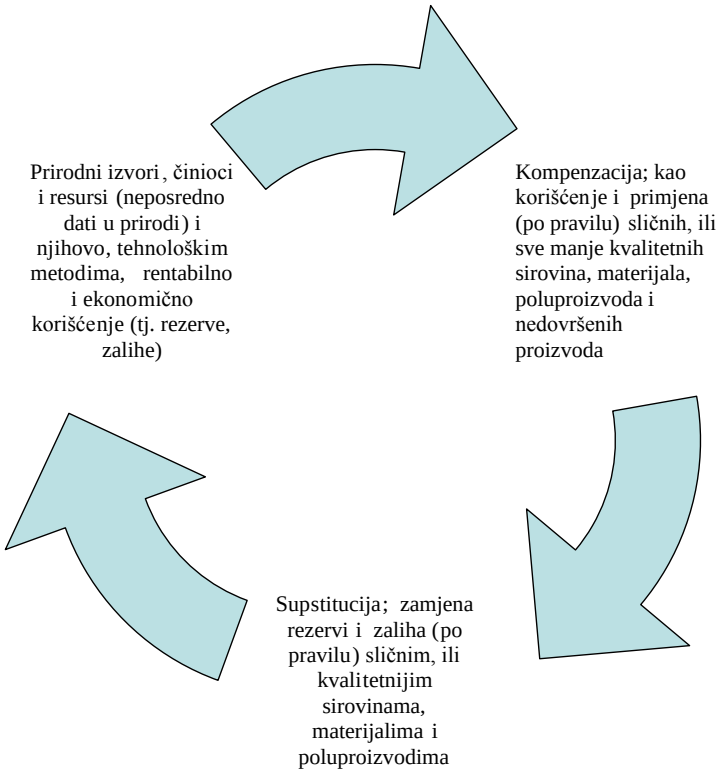
Dijagram 1.: Materijali i sintetičke hemijske supstance; izvori energije; ekonomija i ekologija

Tokom protoka vremena; pojedini, prvenstveno neobnovljivi (neregenerativni) prirodni resursi (ugalj, nafta, prirodni gas i dr.), kontinuirano se intenzivnim korišćenjem; iscrpljuju i

umanjuju. Ovom faktičkom činjenicom; 1. povećava se vrijednost; 2. i cijena njihove eksploatacije; 3. kao i izoštravaju principi, kriterijumi i mjerila: produktivnosti, ekonomičnosti, rentabilnosti, efikasnosti i efektivnosti. Zamah dobija proizvodnja vještačkih izvora i materijala.

Intenzivni i enormni stepen eksploatacije pojedinih prirodnih izvora uzrokovao je pojavu razvojne „sirovinske barijere"i kriza. Naročito dolaze do izražaja krize: 1) hrane; 2) sirovinska; 3) energetska kriza i dr. Prirodne uslove shvatamo i tumačimo u širem smislu; tj. osim prirodnih bogatstava, podrazumijevamo opšte i kompleksne proizvodne činoce (tj. zemlju, klimu, reljef, vodoprivredni potencijal i dr). Resursi i izvori prirode, raznovrsne su i raznolike izdašnosti.

U toku razvojnog procesa; pojačavaju se, sa druge strane, limitirajući činioci i opasnosti od mogućnosti zagađivanja prirodnog ambijenta i narušavanja ekološke ravnoteže [11;195]. Drugim riječima; pitanjem eksploatacije prirodnih uslova, povezane su i dileme i razmimoilaženja u pogledu mogućnosti korišćenja pojedinih prirodnih resursa, čije proizvodno-ekonomsko valorizovanje i aktiviranje pretpostavlja narušavanje i zagađivanje prirodne okoline i ambijenta. Sa ovim u vezi, naglašene su najasnoće i konfliktnosti; ukoliko se eksploatacijom različitih prirodnih resursa, transformiše i mijenja prirodni ambijent, izgled i obilježja prostora, parcijalno, ili u cjelini. Dugoročnom razvojnom i tekućom ekonomskom politikom i praktičnom realizacijom mjera i aktivnosti; streme se uskladiti: 1.materijalno-energetski; 2. ekonomski; 3. ekološki interesi i ciljevi.



Dijagram 2.: Prirodni resursi i rezerve; zamjena i nadoknada, supstitucija i kompenzacija

U domenu energetskih resursa i goriva; konstatuje se da prirodni gas u minimalnom stepenu zagađuje prirodni ambijent. Pojedine (pesimističke) dijagnoze, projekcije, prognoze i procjene; predviđaju različito trajanje pojedinih energetskih rezervi: 1. uglja; još blizu dva vijeka (192 godine); 2. nafte; blizu pola vijeka (41 godinu); 3. prirodnog gasa; 2/3 vijeka (67 godina) [7; 134]. Međutim; optimističke varijante i određujuće alternative; procjenjuju trajanje rezervi prirodnog gasa još čitavi vijek [9; 401-402]. Prirodni gas; na osnovi činjenice da mu je osnovni sastojak, hemijski elemenat, metan (CH_4), postiže najniži koeficijenat emisije ugljendioksida, po jednici oslobođene energije. Iz ovog uzroka; prirodni gas je ekološko gorivo budućnosti [9; 406]. Prirodni gas nema čvrstih ostataka. Indikativan je primjer preusmjeravanja proizvodnje, npr. automobilske industrije; u pravcu korišćenja ovog prirodnog goriva. Preciznije; prirodni gas, koristi se: a) osim u energetske; b) i u neenergetske svrhe, kao bazna sirovina u prerađivačkoj hemijskoj industriji (proizvodnji azotnih djubriva, sirćetne kisjeline, metanola i ostalih hemijskih jedinjenja); v) kombinovano. Konkretnije; prirodni gas posjeduje prednosti u upoređenju sa drugim (fosilnim i konvencionalnim) gorivima. Na drugoj strani; nafta i naftni derivati, kao i ugalj i dr.; zagađuju prirodnu okolinu. Industrijska proizvodnja; korišćenjem tzv. „prljavih tehnologija", u znatnoj mjeri zagađuje prirodni ambijent i sredinu. Optimalno i svrsishodno upravljanje tehnologijom i organizacijom; omogućava postizanje bitnih tehno-ekonomskih principa efikasnosti i efektivnosti.

U teoriji; pod efektivnošću, podrazumijeva se i inventivnost i inovativnost. Međutim; pod ovim pojmom, moguće je sa drugog aspekta i šire posmatrati radnu sposobnost; kao i intenzitet korišćenja sredstava, u postizanju jačih tehno-ekonomskih efekata. Efektivnost se može posmatrati kao uži pojam od efikasnosti. Koeficijenat efektivnosti moguće je sagledavati sa stanovišta efekata: 1. dužeg; 2. ali i kraćeg i 3. kombinovanog vremenskog roka. U teoriji ekonomskog i privrednog razvoja; nije racionalno tokove, shvatati, objašnjavati i tumačiti samo i isključivo jednim činiocem. Naime; tehno-ekonomski procesi, složeni, su kompleksni i isprepletani; mnogobrojnim vezama međuzavisnosti, međuuslovljenosti i međuuzročnosti. Ovo podrazumijeva da u objektivnoj stvarnosti; nijesu realne „čiste"; već kombinovane i mješovite tehno-ekonomske strategije rasta i razvoja. Tehnologija predstavlja: odrednice, povezana svojstva, sredstava rada (oruđa za rad, opreme). Isto tako; tehnologija podrazumijeva: povezani, procesni spoj, kombinaciju, kompoziciju, proizvodnih činilaca; eksploatacije i korišćenja opreme, materijala (predmeta rada), znanja za realizaciju proizvodno-reprodukcionih zadataka. Na ovaj način; tehnologija se javlja kao bazična podloga za transformacije i promjene u organizaciji rada i proizvodnje. Upravljanje tehnikom i tenologijom; bazira se i na informacionoj intenzivnosti sredstava, prozvoda i procesa [8; 471-479]. Tehnologija; kao koncept uglavnom postepenog, evolutivnog organizacionog učenja i primjene (ali i sa naglim, revolucionarnim fazama i etapama), nalazi se u osnovi razvijanja strategije. Organizacija; podrazumijeva širok spektar i lepezu aktivnosti i mjera, počev od: 1. tehničke podjele rada; 2. funkcionisanja raznovrsnih tehničkih i tehnoloških sistema; 3. do inventivno-inovativne realizacije i sprovođenja u neposrednoj privrednoj praksi. Konkretnije, organizacija kao razvojni faktor; razlikuje se od ostalih „klasičnih" i konvencionalnih faktora (tj. zemlje, rada i kapitala) [4; 368-369]. Racionalnom organizacijom; nužno je optimizirati i minimizirati primjenu „prljavih" tehnologija i tehnoloških postupaka; u produkciji novih sintetičkih materijala i supstanci.

Produktivnost rada možemo, kao jednim od prikladnih metoda računati sljedećom relacijom:

$$P = Q/R$$

Gdje je:

P = produktivnost rada (i sredstava);
Q = fizički obim proizvodnje (vrednosno, ukupan prihod) ;
R= angažovani i utrošeni rad (radnici, radni časovi i dr.).

Rentabilnost korišćenja sredstava moguće je računati po sljedećem primjenjivanom obrascu:

$$R = D/S$$

Gdje je:

R = rentabilnost;
D = dohodak (proizvod);
S= angažovana i utrošena (osnovna i obrtna) sredstva.

Ekonomičnost poslovanja moguće je numerički računati sljedećim, verifikovanim, metodom:

$$E = UP/T$$

Gdje je:

E = ekonomičnost;
P = ukupan prihod;
T = troškovi (fiksni i varijabilni i dr.) poslovanja i privređivanja.

Tehno-ekonomsku efikasnost, možemo računati, jednim od mogućih i primjenjivanih, metoda:

$$e = DP/K$$

Gdje je:

e = koeficijenat efikasnosti;
DP = bruto (ili čisti, neto) društveni proizvod;
K = kapital (vrijednost osnovnih, ili i obrtnih sredstava).

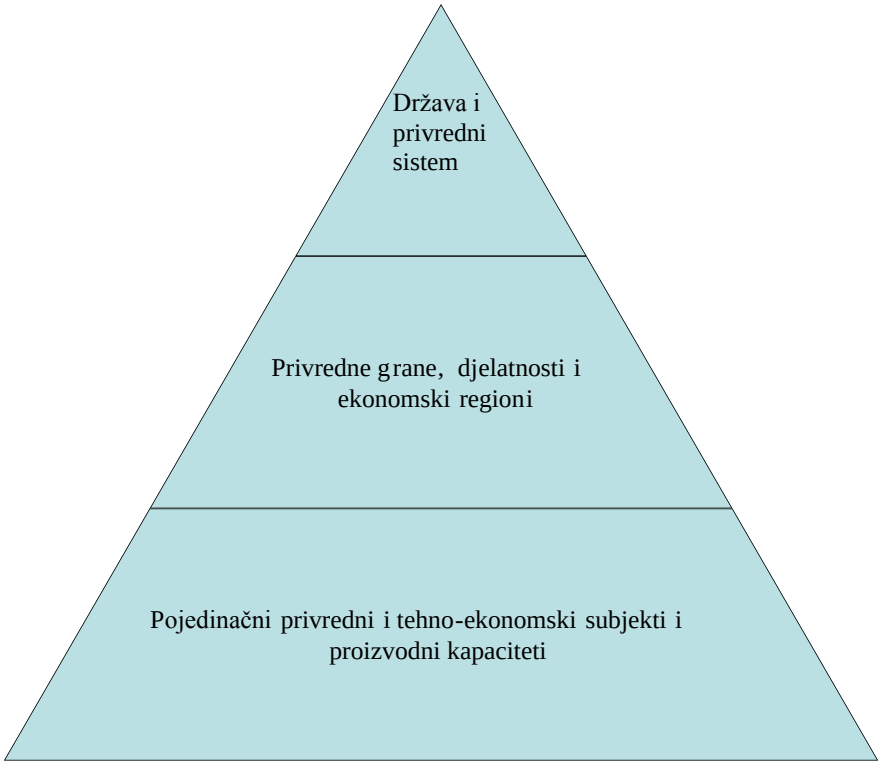
Efektivnost možemo numerički računati na više metoda. Jedan od mogućih metoda je sljedeći:

$$Ef = UP/Vor$$

Gdje je:

Ef = koficijenat efektivnosti;
UP = ukupan prihod (učinak i cijena);
Vor = Vrijednost opreme i rada (obim, cijena).

Kod efektivnosti; akcenat se posebno pridaje minimiziranju troškova po jedinici proizvoda i na bazi i sinergetskih efekata savremene tehnologije. Efekat sinergije podrazumijeva da je: kumulativ efekata na nivou cjeline (tehno-ekonomskog sistema) viši od prostog zbira efekata i rezultata pojedinih djelova, elemenata. Stremi se inventivno-inovativnoj i efektivnoj organizaciji rada i proizvodnje, posebno investiranju u djelatnosti viših, visokih i najviših tehnologija. Bitni uzroci efektivnosti tehnologija su: a) adekvatna tražnja za proizvodima kao rezultat primijenjene tehnologije; b) savremenost postojeće i nove tehnologije; v) tehnološke prednosti u upoređenju sa dometima konkurencije i dr. Protivrječnosti (konfliktnosti) efikasnosti i efektivnosti ne postoje, jer pod efektivnošću ne podrazumijevam samo i isključivo inovativnost. Ovo su povezani pojmovi i kategorije. Nova tehnološka „paradigma" zasniva se na fleksibilnosti i dinamičnim promjenama.



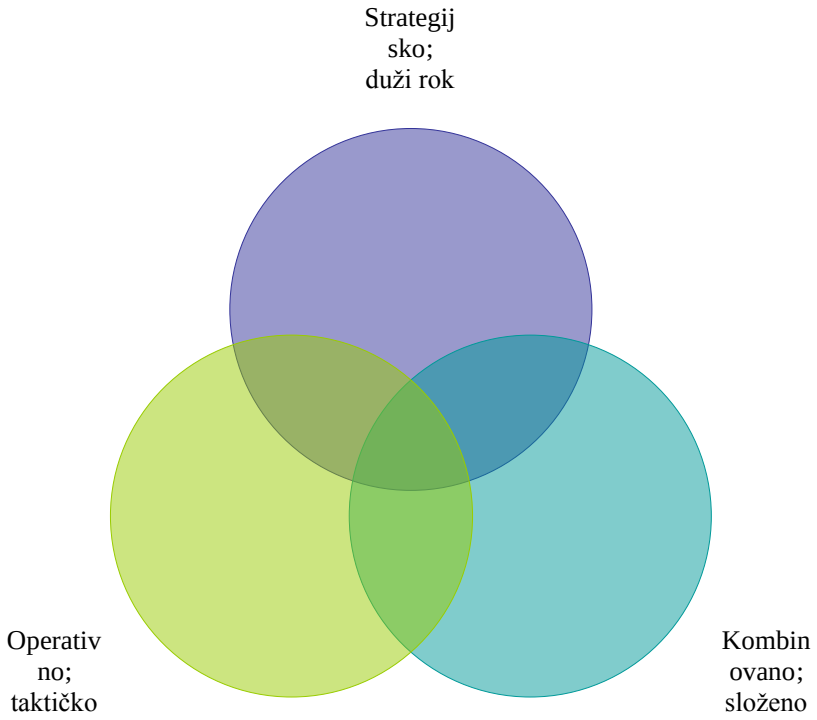
Dijagram 4.: Nivoi utvrđivanja organizacionih, tehničko-tehnoloških i proizvodnih strategija

Strategija tehničko-tehnološkog rasta i razvoja; predstavlja pristup i model, metod razvoja, eksploatacije i primjene savremene tehnologije. Povezana je sa privrednom i čini dio (segment) poslovne strategije. Nalazi se pod djelovanjem velikog broja 1. tehnoloških; 2.

netehnoloških i 3. kombinovanih faktora (sredstava i predmeta rada, kadrova; grane, djelatnosti, regiona, tržišta, vojno-strategijskih i dr.). Fizička; materijalna sredstva (imovina) su bitna. Međutim; dolaze sve više do izražaja nematerijalni resursi: znanje, ideje, pronalasci, informacije. U proteklom periodu; favorizovan je značaj velikoserijske i masovne, homogene, proizvodnje. U savremenim uslovima; razvija se maloserijska, fleksibilna i heterogena produkcija. Ali; elastičnost nužno treba da je optimalne mjere; a ne neograničena. Svjetsko tržište; ispunjeno je besprekornim kopiranjima, imitacijama proizvoda, bez oznaka i porijekla (proizvodni „efekat ugledanja", „demonstracioni" i „domino" efekat); koji su značajno niže prodajne cijene u upoređenju (komparaciji) sa originalima.

3. TEHNIČKO-TEHNOLOŠKO, PROIZVODNO I MATERIJALNO UPRAVLJANJE

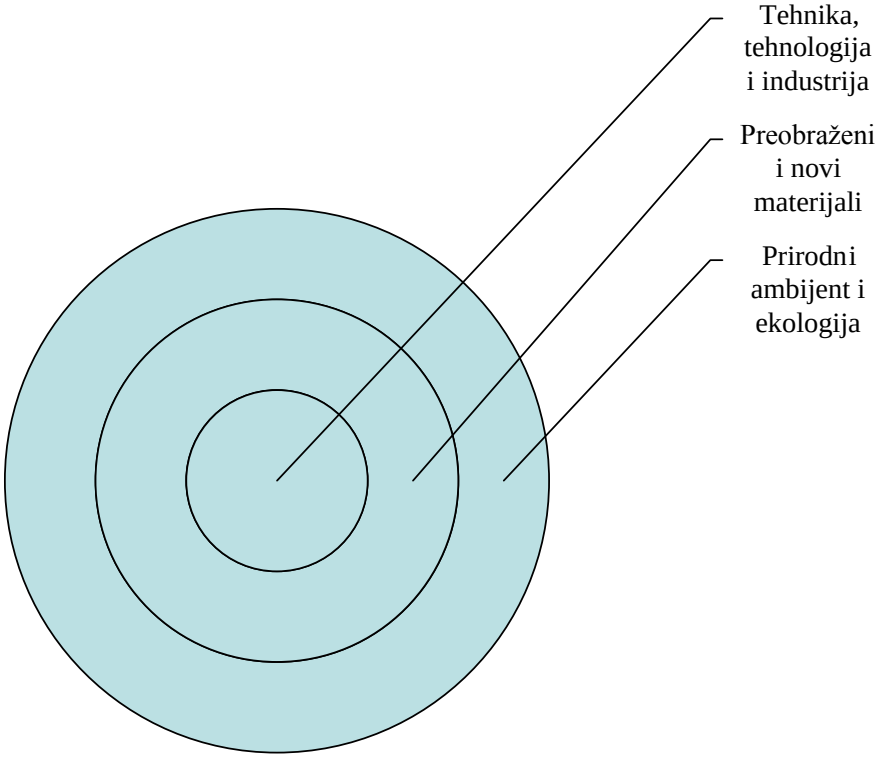
Osnovne oblike, tehničko-tehnološkog upravljanja; proizvodnjom i posebno industrijskim; materijalnim i sintetičkim, proizvodima i supstancama; posmatrano sa stanovišta kraćeg, srednjeg i dugog vremenskog horizonta; moguće je, preglednije, predstaviti i dijagramskim metodom:



Dijagram 5.: Osnovni oblici i modaliteti; tehnološko-proizvodnog i materijalnog upravljanja

Strategijsko (perspektivno) upravljanje obilježja je srednjoročnog i dugoročnog vremenskog horizonta; a operativno (taktičko) determinanti je je kratkog i kraćeg perioda. U

ovim upravljačkim i kombinovanim oblicima; nema suštinske konfliktnosti, već povezanost, usklađenost, balans, relativiziranje i logički slijed. Teži se očuvanju i konkurentne sposobnosti i na tržištu; na osnovi komparativnih prednosti: 1. prirodnih; 2. stečenih (formiranih, oblikovanih) i kombinovanih. Postoji otvorenost sistema ka promjeni, kao optimalno otvorenih (a ne zatvorenih) tehnoloških i proizvodnih sistema. Ovo podrazumijeva: 1. inovativnu organizaciju; 2. otvaranje tehno-ekonomskog sistema; 3. usmjerenje privrednog subjekta za uvođenje tehničko-tehnoloških transformacija koje mu omogućavaju strateško tehnološko vođstvo. Opredjeljenje za stratešku ulogu tehnološkog sljedbenika (imitatora i modifikatora) podrazumijeva da privredni subjekat slijedi lidera (vođu) u tržišnim nastupima. Ali; osim: 1. tehno-ekonomskih i 2. proizvodnih ciljeva nužno je voditi računa i o 3. ekološkim interesima. Zagađenost okruženja; sve je više alarmantna. Nužno je naći optimalan odnos: 1. produkcije energetike i materijala; 2. ekonomije; 3 ekologije.



Dijagram 6.: Tehnologija i industrijska proizvodnja; sintetički materijali i ekološka stabilnost

Povezano sa ovim; postoje sljedeće strategije, pristupi i relacije organizacije i tehnologije: 1) „technology push"; predstavlja model sa davanjem primata novoj tehnologiji, koja će obezbijediti tržište, tražnju, konkurenciju, ekološku zaštitu i dr.; 2) „market pull"; podrazumijeva metod koji primat daje tržištu, kupcima, tražnji, konkurenciji, sklonostima i preferencijama potrošača; 3) „strategy pull"; čini koncept utemeljen na principima strategijskog upravljanja (menadžmenta), sa uvažavanjem specifičnosti i

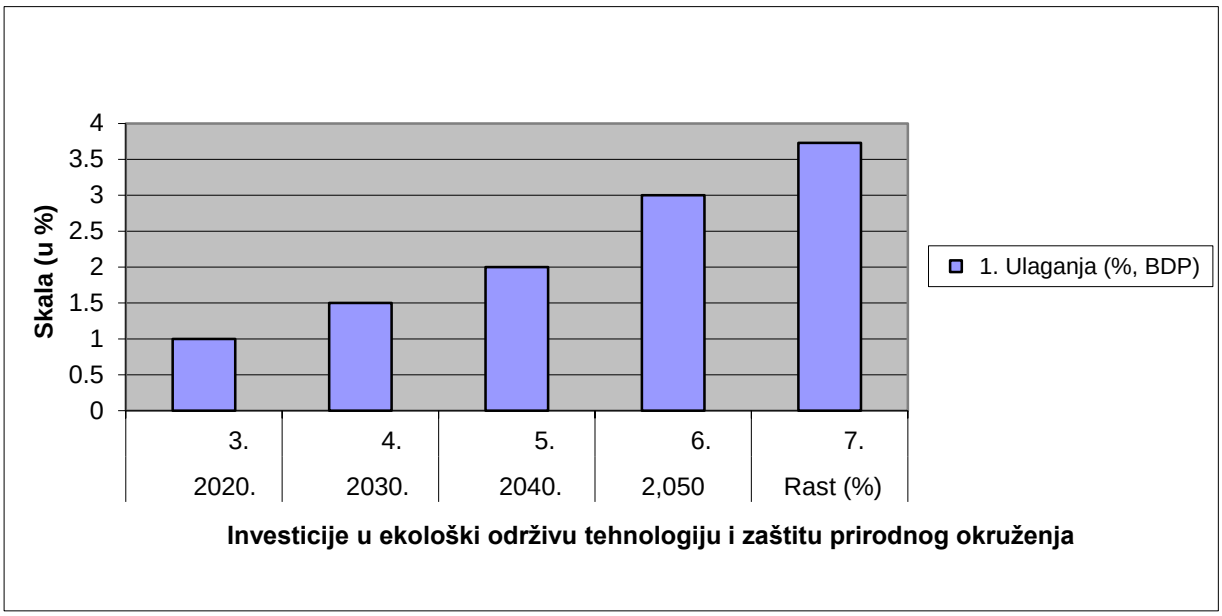
posebnosti mikro, mezo (srednji nivo) i makro okruženja i predstavlja kombinovanje prethodnih projekata i modela; tj. sopstvenog utvrđivanja smjerova tehnološkog razvoja i istraživanja i praćenja tržišta i posebno novih potreba kupaca, krajnjih potrošača. [8; 477].

4. VAŽNOST UVAŽAVANJA EKOLOŠKIH ASPEKATA

U domenu očuvanja ekološke stabilnosti; nužno je ulagati u ekološki „održive", posebno, industrijske „čiste" tehnologije. Hipotetičku; varijantu investicija u Srbiji; prikazaćemo u pregledu:

Tabela 1.: Hipotetički model ulaganja u Srbiji; u ekološki „čiste" tehnologije i očuvanje okruženja

Red./broj:	Elementi	2020.	2030.	2040.	2.050	Rast (%)
1.	2.	3.	4.	5.	6.	7.
1.	Ulaganja (%, BDP)	1,0	1,5	2,0	3,0	3,73



Grafikon 1.: Dinamika; tokova, ulaganja u Srbiji; u „čistu" tehnologiju i očuvanje okruženja

Povezano sa prethodno navedenim; tehničko-tehnološke transformacije; jedan su od glavnih pokretača i generatora konkurencije. Svaka aktivnost; koja stvara vrijednost i novu i dodatu vrijednost, primjenjuje pojedinu tehnologiju, koja omogućava organizaciji (tehno-ekonomskom sistemu i privrednom subjektu) da kombinacijom: 1. nabavljenih, kupljenih ulaza („inputa", sredstava i predmeta rada) i 2. ljudskih i kadrovskih resursa; 3. proizvede

izlaz („autput"). Tehnologija kupaca i dobavljača; utiče na tehnologiju tehno-ekonomskog sistema i privrednog subjekta. Dalje; postoje tehnološki modeli, prenosi, transferi: 1) vertikalni (sopstveni, unutrašnji interni resursi, sposobnosti, tehnologija i inovacije); 2) horizontalni (kupovina, nabavka znanja i opredmećenog znanja, pronalazaka, poboljšanja, proizvodnog iskustva, procesa i metoda, organizacije i upravljanja, izvora energije, opreme, materijala, proizvoda; umijeće primjene i korišćenja tehnlogije i dr.); 3) kombinovani metodi („mješovite"; a ne „čiste" strategije, vlastita unapređivanja; kao i primjena nove tehnologije iz spoljnih tj. eksternih izvora). (5; 477-479). Pored ovog; u literaturi, pominju se talasi promjena: Prvi, agrarni; Drugi, industrijski; Treći, uslužni i Četvrti informatički talas. Privrede; Drugog talasa, uzrokuju narušavanje prirodnog ambijenta: a) serijskom, velikoserijskom i masovnom produkcijom industrijskih dobara; b) visokim utroškom energije, po jedinici proizvoda; v) velikom količinom sirovina, materijala, primarnih proizvoda i polufabrikata, za dalju, fabričku, proizvodnju, viših i visokih faza obrade, dorade i prerade, tj. finalizaciju industrijske proizvodnje; na koji način, u visokom ili najvišem stepenu, zagađuje se prirodno okruženje [11;195-211]. Čovjek nužno mora da čuva prirodu kao dar od Boga.

5. BITNE ZAKLJUČNE KONSTATACIJE

Naučnim dostignućima, tehnikom i tehnologijom; posebno primjenjenom u oblasti industrije, proizvode se i koriste predmeti rada, sintetičke materijalne supstance, koje su nesumnjivo proizvodni i ekonomski interes, kao supstitut, ili kompenzacija prirodnih resursa. Tako npr. umjesto prirodnog kučuka, proizvodi se sintetički, vještački, kaučuk (sa primjenom u proizvodnji gume, odjeće, obuće, djelova za industriju i dr). Isto tako; dobijaju se razne plastične mase; brojni hemijski materijali, primarni proizvodi i polufabrikati. Nastaju složena hemijska jedinjenja iz: 1. prostijih materija; 2. direktno iz elemenata; 3. kombinovano. Države; posebno industrijski najrazvijenije, nastoje da: 1) smanje emisiju gasova, npr. ugljendioksida (CO_2) i dr. u atmosferu; 2) potrošnju „prljavog" uglja koji zagađuje okolinu; 3) broj automobila, koji izduvnim gasovima, u znatnoj mjeri deluju na zagađivanje; 4) primjenjuju „čiste", umjesto „prljavih" tehnologija (sa uređajima za prečišćavanje i dr). Egzistencja i opstanak celokupnog stanovišta Planete podrazumijeva: korišćenje zdrave vode (koja postaje dragocjeni resurs); zdrave hrane; očuvanje opštih proizvodnih i prirodnih uslova i resurse, tj. zemljište; vodporivredni potencijal; vazduh, šume, klimu, reljef; ostvarivanje racionalne eksploatacije obnovljivih i posebno neobnovljivih resursa i dr. U ovom smislu; efikasno ekološko upravljanje i investiranje (menadžment i preduzetništvo), od prioritetnog je značaja. Prirodni resursi; imaju veliku vrijednost i korisnost, upotrebnu vrijednost i (pojedini; nematerijalnu) cijenu. Nužno je dugoročno relativizirati konfliktnost ekonomskog i ekološkog interesa; u strategijama tzv. 1.„održivog"; 2. uravnoteženog i 3. intenzivnog razvoja. Prostorni razmještaj privrednih kapaciteta i stanovništva potencira ekološki problem. Prirodni činioci (voda, vazduh i dr.) zagađuju se obilježjima: a) fizičkih, hemijskih i mehaničkih procesa u industriji; b) upotrebom mineralnih đubriva i pesticida u poljoprivrednoj proizvodnji; v) produktima ostalih oblasti. Ekonomski, u užem smislu privredni razvoj; pretpostavlja određeni stepen poremećaja okoline. Privredni subjekti treba da imaju obavezu da: 1. prostornim i planskim dokumentima; 2. kadrovskim

jačanjem i dr.; 3. obezbijede zakonski i minimalni stepen zašitite okruženja. Tržište u oblasti ekologije nesavršeno djeluje, ili uopšte ne djeluje. Nužna je: 1) usmjeravajuća i kontrolna uloga države, 2) sa obezbjedjivanjem normativno-pravne regulative; 3) optimuma materijalno-finansijskih sredstava. Postoje raznovrsna shvatanja: a) prioritetan je najviši stepen zaštite prirodnog okruženja; stvaranjem nacionalnih parkova i eliminisanjem izgradnje, favorizujući aktivnosti i potrebe koje se ne postižu pretežno materijalnim dobrima (smatraju biolozi, arheolozi, istoričari, kulturni radnici i dr.); b) dominantna je proizvodna i ekonomska aktivnost; kao kriterijum i mjerilo, za realizaciju investicionih i poslovnih odluka; odrednica pozitivnog „ekonomističkog" tumačenja; npr. izgradnja hidro i termo elektrana, proizvodnih kapaciteta i sl. (shvataju ekonomisti, inženjeri, preduzetnici i dr.); v) mješovita. Ove konfliktnosti nužno je dugoročno relativizirati. Poznato je: narušava se, emisijom gasova, ozonski omotač oko Zemlje; dolazi do pojava „kisjelih kiša", klimatskih promjena, efekata „staklene bašte", globalnog zagrijavanja, porasta nivoa vode u morima i okeanima, ekstremnih tempetatura i dr. Govori se o modernim naučnim i vojnim programima i projektima (npr. „Harf"), sa: 1. eksperimentalnim djelovanjem na klimatske transformacije, zemljotrese, padavine, ogromne talase, poplave, požare, nestabilne vremenske prilike, satelitsko navođenje oblaka; 2. mentalnim aktivnostima, na psihičko stanje i zdravlje stanovništva; 3. mješovitim ogledima i sl. Ovo je jedna od najvećih prijetnji za opstanak civilizacije na Zemlji. Nužna je prvenstveno svijest i volja, najvećih zemaljskih i vojno industrijskih sila da se sačuva prirodna i elementarna sredina čovjeka.

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