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UMWELT-CAMPUS BIRKENFELD
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8th International Symposium on Environmental and Material Flow Management

EMFM 2018

BOOK OF PROCEEDINGS

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APPLICATION OF NOVEL SWOT-QFD-MCDM MODEL FOR ENVIRONMENTAL MANAGEMENT IN PROTECTED AREAS**

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ABSTRACT

The strategy is a comprehensive action plan which purpose is to achieve specific and clearly defined objectives. Numerous challenges which modern way of managing of protected areas is facing, such as competitiveness, environmental change and visitors' opinions readily available online, induce decision-makers to form strategic development plans. SWOT analysis is a useful tool for strategic planning which serves to define strengths, weaknesses, opportunities and threats in the company's business. While this technique is very useful, there are some shortcomings in its use. The main problem occurs is the quantification of the SWOT sub-factors. This paper presents a way of overcoming this problem through the development of an integral SWOT-QFD model, with the support of multi-criteria methods for its quantification. The proposed model was applied on the case study of the National Park Djerdap, which is the largest national park in Serbia. The obtained results will enable defining a strategic development plan for this protected natural area that will attract more visitors with the preservation of natural ecosystems. Therefore, visitors' requests are very important part of the strategic decisions that are used in the proposed model as the starting parameter.

Keywords: SWOT analysis, house of quality, multi-criteria methods, strategies, national park

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1. INTRODUCTION

The strategy is a comprehensive program which determines main approaches of an organization and suggests appropriate ways of resource distribution in order to help organization to achieve its long-term goals. Environmental changes, competitiveness and customer attitude ensured that managers must have strategic business plan. Client demands are constantly changing, which is why managers must pay special attention on achieving long-term goals through defining new strategies. Nowadays, business decisions in many organizations include products and services which provide high customer satisfaction in order to fulfill multiple goals at the same time.

Managing of social and ecological issues and their need for connection with economic factors in parallel, represent nowadays, priority for managers and decision makers in many sectors such as business development, manufacturing, managing of protected areas [1, 2]. Such synthesis of economic, ecologic and social development represents sustainable development which is a key factor of success in managing protected areas, which is the subject of this research.

In strategic planning, SWOT analysis is a useful tool which can be used for analyzing strengths and weaknesses within organization, and opportunities and threats outside of an organization. Although SWOT analysis is very practical tool, some shortcomings can occur in usage of that tool [3]. For example, there are no tools for determination of importance of factors, because determination of weights is done mostly based on personal preferences [4]. Considering this, this shortcoming is eliminated by upgrading SWOT analysis with modified Quality Function Deployment (QFD) method. In this research, the weights of SWOT factors were calculated using QFD, and afterwards proper strategies were defined for the organization which are achieved by House of Quality (HOQ) [5].

Decision making often depends on opposed opinions of various factors which have an effect on managing of a company, which is why decision makers must consider great number of factors with influence on management. Consequently, there is a gap between theory and practice in terms of harmonizing all parties of interest in decision making process. For that reason, there is the need for defining a model which includes large number of factors which have influence on management. The goal of this research is to define an innovative model of decision making which is based on application of modified QFD method for ranking of SWOT factors in combination with ANP method of multi-criteria decision making. This defined model will help decision makers to perceive objectively all the factors in management and help in making the right decision. In suggested model, which is described in details and applied on example of national park Djerdap, first of all, ANP method will be used to rank customer requirements, which represent input in House of Quality. Then, the ranking of SWOT factors will be done, related to customer requirements, which will give priority of sub-factors within each SWOT factor. In last stage, based on results, which include interdependences from the roof of House of Quality, strategies will be generated and ranked using ANP method of multi-criteria decision making. When defined in such manner, this innovative model of decision making can be applied on other topics of research and serve to decision makers in various areas of management, due to universality of its application.

In the next part of this research five sections were presented. Section 2 represents overview on current scientific literature on this topic, while section 3 represents applied methodology of this research. Section 4 represents analyzed case study on example of National park Djerdap and obtained results from it, and last section 5, contains main conclusions of study and suggestions for further research.

2. THEORETICAL FRAMEWORK

Making business decisions is a very complex task which requires the fulfillment of large number of user requests. According to a study conducted by [11], companies use different methods to determination importance rating of customer requirements. Some of the most common methods used are: conjoint analysis [12], point scoring scale [13], value analysis [14]; Quality Function Deployment [11, 15]; Analytic Hierarchy Process (AHP) [16, 17]; fuzzy AHP [18, 19]; analytic network process (ANP) [2, 22, 23, 29]; fuzzy ANP [20, 21]. In Table 1 are present application of QFD, SWOT analisys [24, 30] and MCDM methods.

Table 1. Application of QFD, SWOT analisys and MCDM methods

Method	Fuzzy (literature)	Traditional-crisp (literature)
SWOT and QFD	Pur & Tabriz, 2012	
ANP and QFD	Zaim et al., 2014; Kahraman, Ertay, Buyukozkan, 2006	Abbasi, Hosnavi, Tabrizi, 2013; Tavana, Yazdani, Caprio, 2017
SWOT and ANP	Daroudi & Daroudi, 2015; Grošelj, Hodges, Stirn, 2015; Arsić et al., 2018	Dağdeviren & Yüksel, 2010; Lin & Hsu, 2011; Görener, 2012; Živković et al., 2015;

Based on the review of the presented literature it can be concluded that the combination of QFD, SWOT analysis and MCDM methods in recent years is becoming more and more important and is being applied to the most diverse research subjects.

3. RESEARCH APPROACH

Considering that conducting business nowadays is done in terms of measured uncertainty, or in other words, in highly risky conditions caused by numerous global economic problems, the significance of complexity of multi-criteria decision making over the last decade becomes apparent [17]. Consequently, that kind of problem in management of protected areas, which is the topic of this research, requires application of complex methodology.

In order to gather and represent in a better way, various connections between customer requirements and technical characteristics, key factors of business and relative weights of customer requirements in this study SWOT-QFD-ANP methodology was used.

3.1. Methodology

To establish the foundation for the proposed methodology, this section aims to briefly describe the applied methodology which integrates SWOT analysis, QFD technique and ANP method. The novel SWOT-QFD-MCDM model of this paper (Figure 1) is based on the following steps:

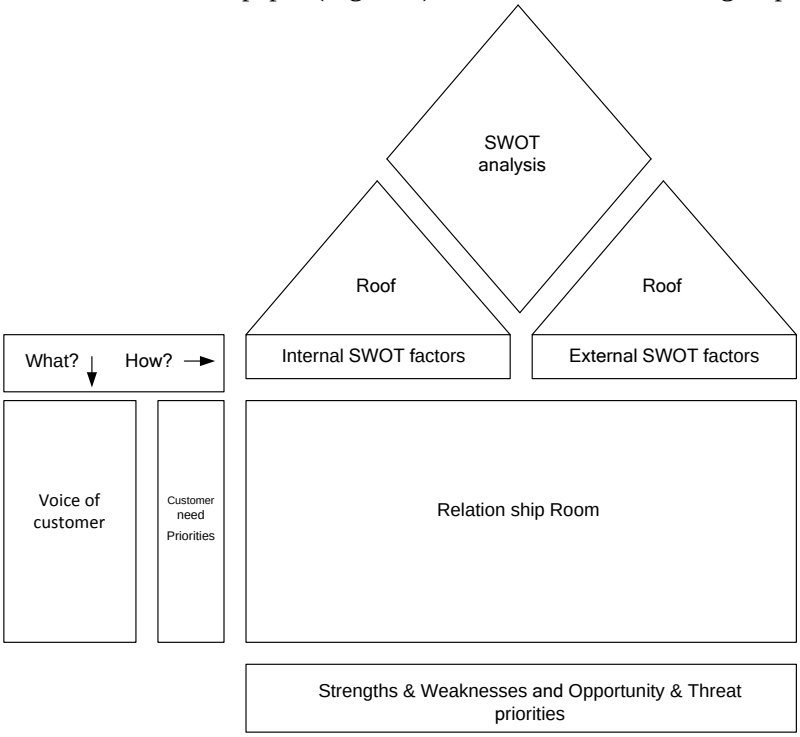

Figure 1. Research methodology

Step 1. Preparation of data for analysis. Within the first phase, choice of team of experts is done, which will generate customer requirements by conducting detailed analysis of market situation, analysis of reports and company's business. Afterwards, by detailed scanning of organization's business, members of expert team generate internal and external business factors, i.e. strengths, weaknesses, opportunities and threats to organization.
Step 2. Implementation of QFD. Procedure is divided into several steps, so that each step comes down to filling out a matrix in the House of Quality (Figure 1). After collection of data, ranking of customer requirements is done, using multi-criteria ANP method which was explained in details in section 3.2. Obtained results are used as input in the second phase of the House of Quality (relationship room). Based on obtained rank of customer requirements (F) and assigned weights of each sub-factor within SWOT factors, ranking of SWOT sub-factors is done by using following formula:

$$K_j = \sum F \cdot M_{ij} \tag{1}$$

Step 3. Completing the top of the House of Quality. There is another matrix within the roof, which should appoint to eventual conflict goals between two characteristics, in this case between internal and external factors of the company. Regarding the method of this study in completing the top of House of Quality, SWOT analysis is applied to the top of HOQ. All effective factors which have influence on defining of strategy are located in individual roofs. Therefore obtained results are much more efficient and objective. Correlations between pairs of sub-factors, within both internal and external SWOT factors, which are determined based on the set goal values, are presented in the roof matrix.
Step 4. Generating strategical actions (strategies) and their ranking. According to obtained weights based on SWOT analysis and by applying QFD method strategies are generated, which can be then ranked using the multi-criteria ANP method. By comparing internal strengths and weaknesses and external threats and opportunities, it is possible to generate great number of strategies and also to prioritize them.

3.2. Quality Function Deployment (QFD) technique

Product quality improvement is a key factor in acquiring and maintaining competitive advantage on the market. The Profit Impact of Marketing Strategy (PIMS) claims that improvements in the quality of products or services follow customer loyalty, higher market share and higher profits [5, 25].
There are many production and design techniques and company strategies that are used to develop new products or services [26, 27]. Quality Function Deployment is a multifunctional tool for planning the development of products and services that was found in 1966 by Akao (1990) [28]. The goal in QFD technique is to identify what customers' demands and complaints are about a certain product, service, or process; and then to determine what technical specifications should be developed in order to meet those needs of the customers. QFD also provides interrelationships and other prominent information about DOE and Statistical Process Control (SPC), both of which may be executed after the product development process. QFD is often applied using participation of people from variety of departments and backgrounds. QFD not only considers the „needs of customers", but also regulates the processes according to „capabilities of the firm". The first uses of QFD methods were related only to the design and development of new products, but today it is increasingly used in various business operations [5].
Lately, the application of the QFD is increasingly linked to the improvement of a process in the company's business [6], as will be the case in this paper.

3.3. ANP method

ANP method is advanced version of AHP method, which defines more precisely relations of complex models which use given criteria, feedback information and interdependencies of criteria itself. Analytical network process as extension of analytical hierarchy process is used in solving of choice

problems in uncertainty conditions, or as instrument of prediction [7, 8]. AHP method, as well as ANP method was developed by Tomas Saaty in 1996. ANP method serves to create functional interaction between actions and clearly defined criteria in model ie, stable results are achieved [9]. This method which contains structure of reverse connections, enables network defining of problems, which is different from AHP method because it doesn't represent linear hierarchy but it's modeling influences between network elements. Reverse connections itself represent more precise determination of priorities and bringing more quality solution of a problem.
The ANP procedure is realized through four steps [9, 10]. First, the defining of the model and structuring of the problem are performed. The interpretation of the problem is done through a system similar to a network. The next step includes the comparison of the elements of decision pairs in each cluster and determination of the priority in regard to the control criterion. Interdependence between the cluster criteria is also examined and compared using the Saaty scale shown in Table 2. The matrix form is used for the comparison of the elements of decision pairs [9].

Table 2. Saaty's 1-9 scale for AHP preference [9]

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgement slightly favor one over another
5	Strong importance	Experience and judgment strongly favor one over another
7	Very strong importance	Activity is strongly favored and its dominance is demonstrated in practice
9	Absolute importance	Importance of one over another affirmed on the highest possible order
2, 4, 6, 8	Intermediate values	Used to represent compromise between the priorities listed above 1, 3, 5, 7 and 9

In following part of this research innovative model for decision making for environmental management in protected areas is defined, which is using customer requirements as input parameter for QFD, and compares them with SWOT factors, which is the base for generating strategies and determination of priorities using ANP method of multi-criteria decision making because of practical application it possess. Suggested model is applied on case study of National park Djerdap.

4. CASE STUDY

National Park Djerdap (NP Djerdap) is located in the northeastern part of Serbia. It stretches along the right bank of the Danube River from the Golubac Fortress in the west to Diana Kartash in the east, along the Djerdap gorge on the Danube. The Danube represents the natural boundary between this national park in Serbia and the Parcul Natural Porțile de Fier in Romania. In order to achieve the mission of NP Djerdap, the SWOT-QFD-ANP model was applied.

For implementation of steps in the defined model, firstly, the team of experts was formed, which consist of representatives from the management of NP Djerdap, local municipality, tourist organizations, scientific organization and associations for nature protection. They were detailed familiar with the methodology of applying the proposed model. They generated customer requests first after a detailed analysis of the obtained results of interviewing users of their services. Of many requests, the most important ones are extracted according opinion of the majority, which were generated in five categories: the attractiveness of natural and cultural-historical values (nature's beauty, cultural-historical monuments, cultural manifestations); quality of accommodation and food (accommodation in hotels, accommodation in households, quality of domestic traditional food); the content of recreational activities (sightseeing, pedestrian tours, cycling, hunting and fishing, Danube ride, wine tours); availability of information about NP Djerdap content (website, travel agencies, social networks). Geographical accessibility to the locality (proximity to the airport Nikola Tesla in Belgrade, corridor VII, the river Danube, arranged paths within the National Park).

Within the first phase of the defined model, the members of the expert team, through brainstorming, defined key business factors using brainstorming: strength (S), weaknesses (W), opportunities (O) and threats (T). Within this four factors, the following 25 sub-factors were identified: S1-Unique ecosystems and international importance of the protected bio and geo diversity values; S2-Cultural - historical heritage of world values; S3-The favorable geographical position in the pan-European corridor VII and easy arrival from Belgrade airport; S4-Large forest wealth; S5-The hydropower potential of the Danube; S6-Favorable conditions for organic production; W1-Lack of knowledge in the field of tourism and promotion of NP potential; W2-Insufficient investment in infrastructure in the wider area of the NP; W3-Poor cooperation between Management of NP and the most important stakeholders from surrounding municipalities; W4-Degradation of biodiversity; W5-The lack of a Management Plan for visitors; W6-The low level of economic developement of Municipalities; W7-Inadequate wastewater treatment and Communal landfills; W8-Poor demographic situation; W9-Insufficient education of the population on the development of environmental awareness; O1-Creation of unique tourist product (brand); O2-The potential of the Danube, which is an integral part of the NP; O3-The development of partnership with SMEs in the region; O4-Cross-border cooperation in order to realize projects from EU funds; O5-Product offers of local character (organic foods); O6-Investments of Diaspora; O7-Development of energy production from renewable sources; T1-Slow Serbia's EU bid and disrespect of EU standards; T2-Unfavorable economic situation in the country; T3-Disrespect of regulations to protect sensitive sites and biodiversity in NP; T4-Inefficient fight against the gray economy; T5-Creating a bad image due to poor visitor experience with infrastructure of NP; T6-Unplanned use the resources of NP; T7-The lack of interest of investors to invest in this region.

After gathering related information, House of Quality was constructed based on the research methodology as mentioned below (Table 3).

WHAT? ↓	
Customer requirements	Weight (F)
Attractiveness of natural and cultural-historical values	0.392
Quality of accommodation and food	0.120
Content of recreational activities	0.120
Availability of information about content of NPDJ	0.072
Geographical accessibility to the locality	0.296

After specifying priorities and weights of customers' requirements, the weight of internal and external factors was calculated using Eq. (1). Then preliminary weights of sub-factors, within the internal and external factors of the organization, are ranked (Figure 3).

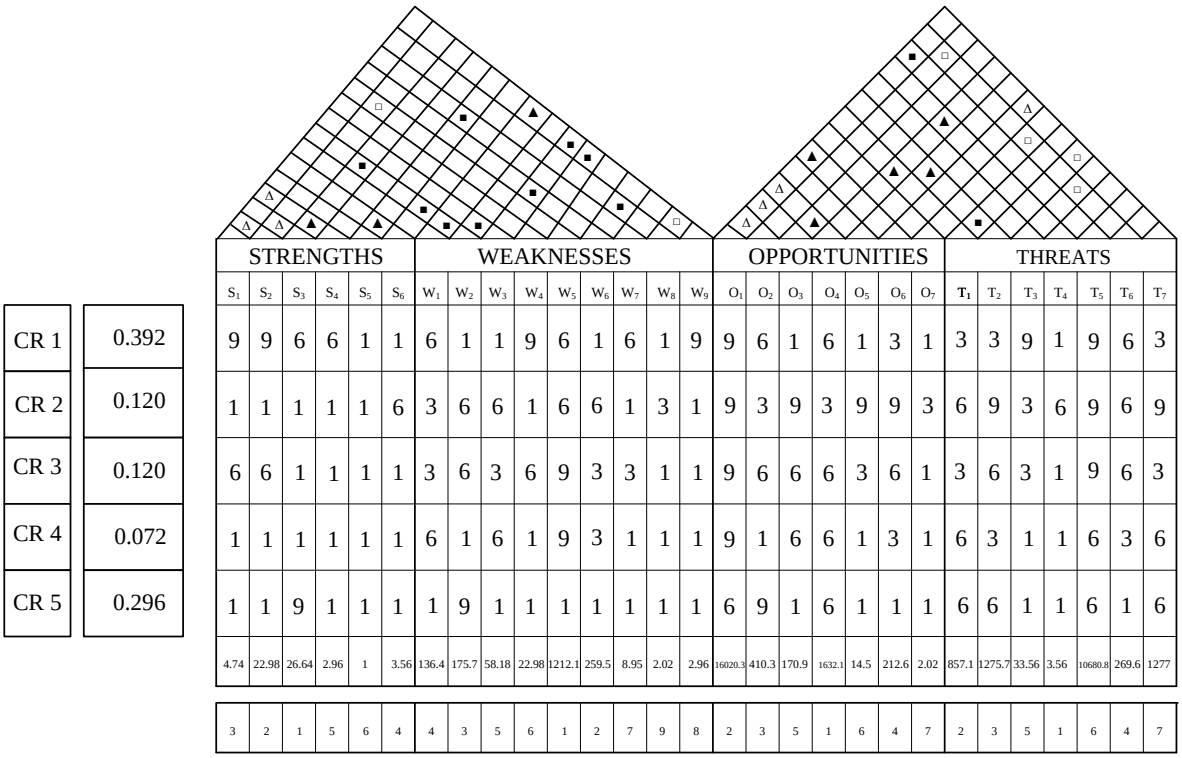

Figure 3. Weighing of internal and external factor

Figure 3 shows obtained rank of SWOT factors. Symbols used in the roof matrix present the following types of correlation between SWOT sub-factors:
Δ - very positive correlation; ▲ - positive correlation; ■ - negative correlation; □ - very negative correlation.

Obtained results show that best ranked SWOT sub-factors are: S5, W5, O4 i T4. Based on obtained weights of SWOT factors following development strategies were generated: SO – "Maxi-Maxi" strategy (How to use strengths in order to maximize and utilize opportunities - attack strategy); ST – "Maxi-Mini" strategy (How to use strengths in order to minimize real and potential threats – defensive strategy); WO – "Mini-Maxi" strategy (How to minimize weaknesses in order to utilize opportunities –boost of strengths for attack strategy); WT – "Mini-Mini" strategy (How to minimize weaknesses in order to avoid threats – ultimate defensive strategy) [31].
In total, it is possible to generate 225 strategies by combining internal and external SWOT factors. Table 3 shows 7 most important strategies according to experts. SO1-Developing ecotourism brand with the involvement of internal and external stakeholders; SO2-Creating joint eco-tourism offer with the partners from the Romanian side supported by EU funds; WO1-Education in the field of content ecotourism offer and its promotion; WO2-Arranging NP infrastructure to EU standards; ST1-Promotion and implementations of the EU standards regarding NP through engagement of scientific institutions and NGOs; ST2-Effective control of fulfilling environmental regulations and requirements in the National Park and his surroundings; WT1-Professionalization of management.
Using ANP method ranking of generated strategies was performed, and the obtained results are shown in Table 3.

Table 3. Priority of Strategy formulation

Strategies	**SO1**	**SO2**	**WO1**	**WO2**	**ST1**	**ST2**	**WT1**
W	0.149	0.163	0.138	0.135	0.183	0.129	0.104
Rank	3	2	4	5	1	6	7

5. CONCLUSION

The choice of strategies for achieving sustainable development in protected areas can be seen as a classical problem of decision making. One of the main problems which decision makers in protected areas are facing is how to structure and implement efficient process of strategy selection [24]. This paper presents an innovative model of decision making, which is based on integration of SWOT analysis, QFD and ANP methods.

SWOT-QFD-MCDM model removes shortcomings of classic SWOT analysis, which were modified using QFD technique in this research. Obtained results show that quantification of customer requirements, internal and external factors, which were considered in the House of Quality, have influence on obtained weights of SWOT factors, relation between customer requirements and internal and external factors and also their influence on defining the strategy. By quantification of SWOT elements using QFD, obtained results were objective, and they served for generating development strategy.

Suggested model of decision making has universal character, so it can be applicable for various research topics. The obtained rank of generated strategies can be useful for decision makers in National park Djerdap during the formation of strategic development plan, considering the fact that representatives of national park participated in analysis of the results. In further research initial data will be processed in fuzzy environmental for credibility of obtained results and the additional comparisons will be done.

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RECYCLING OF FERROUS BY-PRODUCTS IN IRON AND STEEL PLANTS

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ABSTRACT
Due to rising energy prices and stringent environmental regulations, energy efficiency, resource saving and climate protection are becoming more important than ever. Primetals Technologies ECO Solutions offers a wide range of services and technologies to increase energy efficiency, reduce the environmental impact of steel production plants and to ensure efficient water and by-product management
Primetals Technologies ECO Solutions provides processes and solutions along the entire iron and steel production chains, which meet the strictest emission regulations and also help producers achieve substantial cost savings. In response to these ecological and economic challenges, Primetals Technologies offers energy-efficient solutions and services along the entire process chain, with a clear objective: saving resources, creating value.
The optimized consumption of energy and raw materials, the application of advanced technological processes and the maximum application of recycling solutions lead to major energy savings, reduced emissions, improved water and by-prooduct management. Saving resources • Minimized emissions • Minimized use of raw materials • Minimized energy consumption • Optimized by-product recycling Creating value • Reduction of conversion costs • Increase performance • Improve quality

Keywords: Recycling of By-Products, Cold Briquetting, Midrex, DRI

1. INTRODUCTION

Significant amounts of by-product fines are produced and collected in steel plants at all steps of iron & steelmaking. It can be assumed that per ton of steel produced around 60 -150 kg of particulate by-product is generated. Considering that these by-products have an average iron content of >50%, this is 3 up to 7,5% of the total steel production.
Primetals Technologies has developed several recycling technologies for treating particulate by-products. Cold briquetting is one of the favorable solutions to transform fine material into recyclable agglomerates.

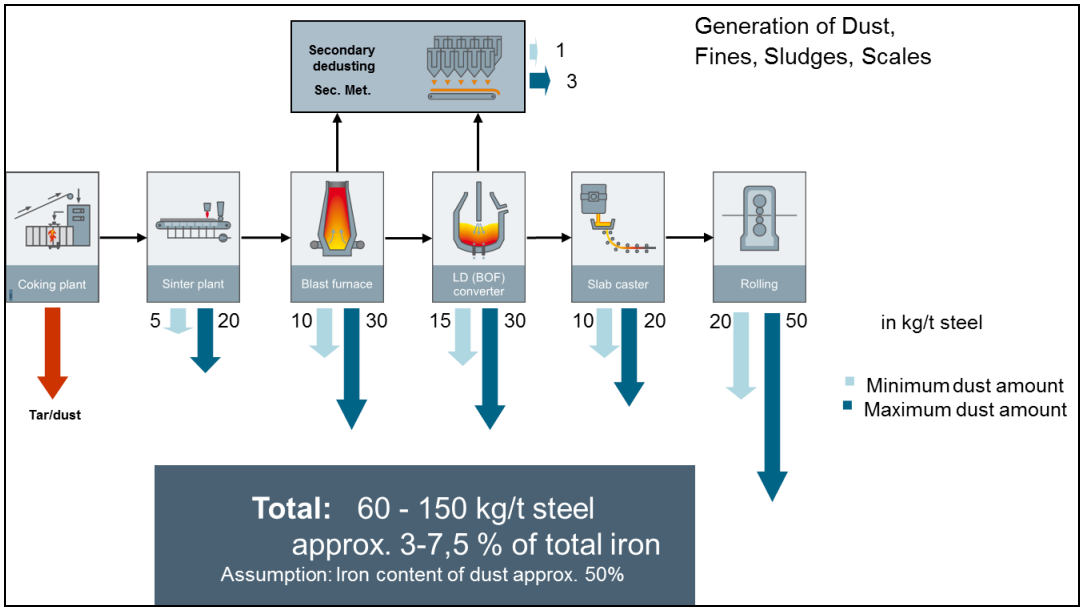


Figure 1: Typical by-product fines generation in an integrated steel mill

2. RECYCLING OF FINES – COLD BRIQUETTING

Recycling of only a part of the by-product stream to the sinter plant is very common. In many cases the addition of mainly unconditioned by-products may be possible, in some cases with a negative impact on the plant operation, such as increase generation of fines and reduction of productivity, and leaving still a large amount of by-products unused.

In order to include most or all of the generated by-products, cold briquetting of various dusts and sludges allows integrated recycling within existing primary production units. After pre-treatment of the residues, including drying, screening and mixing, binders are added and following the mixture is briquetted using roller-type presses. The selection of the binder system is dependent on desired metallurgical route for the respective recycling.

In Figure 2 a block diagram of a cold briquetting process including pre-treatment of the waste material is shown.

In the first step of the cold briquetting process the wet by-products are dried. Then the dried materials as well as other dusts are mixed while adding the binders. Afterwards the material is directly fed to a briquetting press. In a final step the product briquettes are screened and then conveyed to the curing and storage yard. Approximately 10% fines are internally recycled after the screening. Final product screening is done just before loading to the trucks.

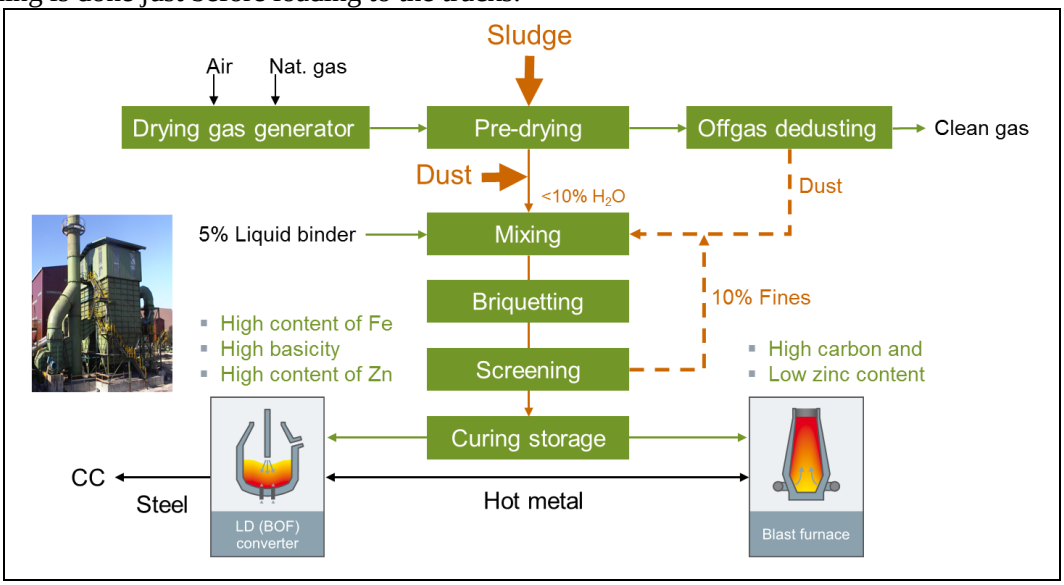


Figure 2: Cold briquetting process – Reference ILVA Taranto

The reference plant at ILVA Taranto was designed as 2-line briquetting arrangement for a yearly production of around 240,000 tons. The briquettes were foreseen to be recycled to the LD converter (BOF) and blast furnace (BF) up to certain defined amount.

LD approx.	4 t per heat (approx. 8 kg briquettes/t_{steel})
BF	approx. 1% of burden

A combination of molasses and hydrated lime is used as binding agent. Following input materials are treated in this briquetting plant:

- Converter fine sludge 30%
- Converter coarse sludge 10%
- BF sludge 10%
- Mill scale sludge 25%
- Sec. LD-dust 5%
- Dust catcher dust (BF) 10%
- Separation iron fines 10%

Briquettes with a high iron content and high basicity can be charged directly into LD converter (BOF), replacing cooling scrap or ore. Briquettes rich in carbon but with limited alkali and zinc contents can be charged into the blast furnace.

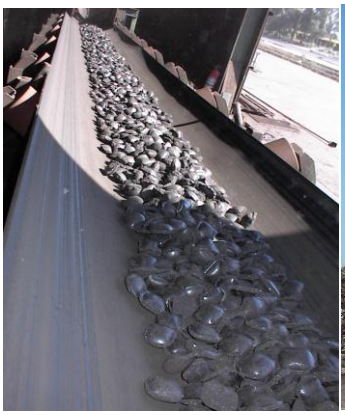


Figure 1a and 1b: Product briquette

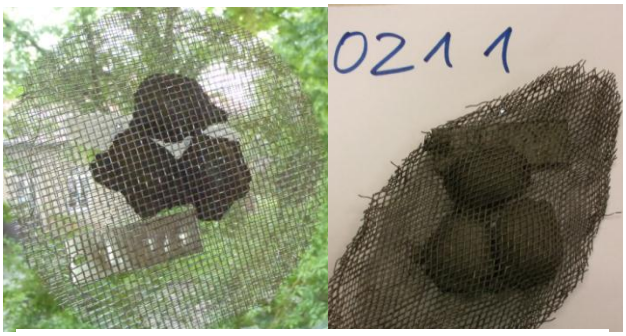
Figure 2: Briquetting plant, ILVA Italy

The main benefits of this system are:

- Less raw materials utilization due to recycling of by-products (ore, scrap, coke) and therefore reduced operating costs
- Minimization of landfilling costs and volume
- CO2 reduction
- Sinter saving up to 5% (BF)
- Short payback period

Similar to the example of recycling of fines in an integrated plant described above, the recycling of fines in an DRI based plants can be applied using cold briquetting technology. In DRI based steel mills there is normally no agglomeration plant such as the sinter plant available which offers the possibility to recycle the generated fine by-products. In many cases it is not economical or generates little added value to sell and transport the materials to other plants for recycling. For these plants, the best recycling concept is to agglomerate the by-products, which reach approximately 10% of mass of the produced DRI capacity, such as dust from the material handling systems, oxide fines, HBI fines and DRI slurry by briquetting with an inorganic binder system. The cold briquetting process itself is similar to the process shown in Figure 2. The produced briquettes are directly fed into the direct reduction plant (e.g. MIDREX) and may replace ferrous materials like iron ore or pellets in the reduction shaft.

New developments: The recycling concept for by-products generated in DRI plants is not yet commonly used on a large scale. The great economic value of such a project is determined by the high iron ore and pellet costs, compared to a relatively low operating cost and investment cost for such a plant.
Primetals, based on its experience from similar applications with cold briquetting plants, has invested considerably in laboratory testing to verify the briquetting properties and selection of appropriate binders and process parameters. To verify the right recipe for briquetting such materials and their combinations, several tests on laboratory scale as well as reduction tests simulating gas atmospheres of DRI plants were carried out.
In Figure 5 the oxide briquettes before and after passing the DRI shaft under reduction gas atmosphere are shown. The results fulfill the requirements of a direct reduction shaft concerning the low temperature disintegration (550°C). In Figure 6 the promising results are summarized and compared with iron ore pellets.



a) before b) after

Figure 5: Soft basket tests in reduction shaft [2]
a) before test; b) deformed soft basket after test

sample no.	test no.	briquette size [cm³]	comp. Strength [N]		shatter strength [%]		basket test results				
			+0h	+24h	+0h	+24h	executed	metallization [%]	percentage "whole briquettes" [%]	RDI+6,3mm [%]	porosity [%]
T02	18624b	10	215	361	96,2	92,1	yes	90	90	76,0	25,3
T10	18624b	10	150	491	97,7	96,5	yes	81	100	77,4	-
T15	18624b	10	338	655	95,3	90,7	yes	87	93	77,8	25,5
T16	18624b	10	194	399	97,2	95,3	no	-	-	76,3	-
T21	18624b	5	185	517	91,5	83,3	no	-	-	80,7	25,8
T06	18665b	5	250	718	84,4	78	yes	94	89	88,0	-
T07	18665b	5	250	670	92,3	82,5	yes	95	100	86,9	27

Figure 6: Summary of test results

These results are promising in the sense that briquettes were produced that are stable under the reduction conditions. The actual basket tests results agreed well with the laboratory tests results, so that conclusion from the laboratory tests can be applied to the actual plant conditions.

3. ADVANTAGES OF PRIMETALS COLD BRIQUETTING

- **Saving of Raw Materials,** substitution of pellets or lump ore
- **Compact plant layout,** easily integrated in integrated plant or DRI plant layout
- **Avoid Depositing of By-Products,** avoid cost of depositing, save space
- **Low overall CAPEX**, low investment cost, short payback time
- **Minimize Handling,** use of materials directly in the main process
- **Low OPEX** compared to cost of pellets or lump ore
- **Environmental compatibility:** 100% recycling of by-products, processing of in-plant waste materials
- **Fully automated** process control and plant operation

4. CONCLUSION

Many iron and steel plants already practice recycling of by-products to a certain extent, however there is still room for increasing the value creation by optimizing the recycling concept and finding new innovative applications. One of these applications is recycling of by-products in DRI plants by cold briquetting and using the briquettes as iron ore or pellet substitute. A similar concept is used in integrated plants by cold briquetting of by-product fines and recycling the briquettes in blast furnaces and BOF converter plants.

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IMPLEMENTATION OF LIFE CYCLE ASSESSMENT TOOLS INTO THE FIELD OF ARMOUR STEEL PRODUCTION

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ABSTRACT

Within the framework of the conducted study, the material balance, energy consumption, waste generation, and emissions into the air during the production of high-quality steel for armour protection PROTAC 500 were analysed in industrial environment of SIJ ACRONI d.o.o. production plants.

The production stages included in the evaluation were: steel smelting in electric arc furnace together with slab continuous casting, reheating of slabs in pusher-type furnace, and slab hot rolling.

Emissions are logically relatively high and, of course, directly related to the amount of steel produced.

Keywords: armour steel, plate, emissions, analysis

1. INTRODUCTION

Armoured vehicles must provide sufficient safety without significant loss of driving performance. When selecting or developing the appropriate materials for the armour it is necessary to achieve the best possible compromise between the required mechanical properties of materials, its density and the final price of the product [1,2]. With the appropriate production technology, which includes synthesis, hot forming, heat treatment, etc. [3], high strength low alloy steel of good functional properties at affordable prices can be produced. By improving the strength and toughness of the steel, the required thickness and the weight of the armour can be reduced.

Steel PROTAC 500 belongs to the group of high strength low alloy (HSLA) steels. It is made in Slovenian steelwork SIJ ACRONI d.o.o. by standard industrial procedures. The relevant mechanical properties, shown in Table 1, are achieved by quenching and tempering [4].

Table 1. Mechanical properties of steel PROTAC 500 (at ambient temperature) [4]

Yeald strength $R_{P0,2}$	1200 MPa
Tensile strength R_m	1600 MPa
Elongation A_5	8 %
Impact toughness	20 J
Hardness	480 – 530 HB

Tests of the mechanical properties of the steel have indicated the possibility of using steel PROTAC 500 for light armoured vehicles.


Beschussamt Ulm

Staatliche Prüf- und Zertifizierungsstelle für Waffen- und Sicherheitstechnik

Zertifikat - Certificate

S 12 0009 01 / Z

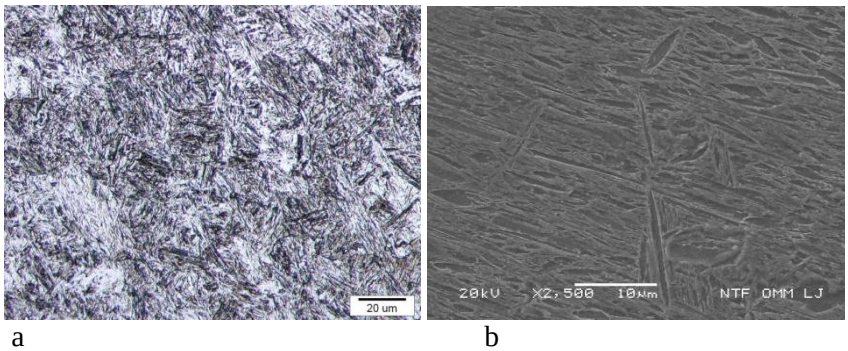
Durchschusshemmendes plattenartiges Material

Bullet resistant plate material

Antragsteller	ACRONI d.o.o. SI - 4270 Jesenice
Hersteller	ACRONI d.o.o. SI - 4270 Jesenice
Ort und Datum der Prüfung	89081 Ulm, 13.02.2012
Gültigkeitsdauer bis	13.02.2022
Prüfanforderung und Verfahren	Prüfrichtlinie PM 2007
Gegenstand der Zertifizierung	Stahlblechplatte / Steel plate 500 x 500 x 4,20 mm
	Schmelz-Nr. / Charge-no.: 275419
Typenbezeichnung	PROTAC 500
Zugeordnete Widerstandsklasse	VPAM - PM 2007 Klasse 6 NS
Details siehe Prüfbericht-Nr.	S 12 0009 01 / B

Ulm, den 13.03.2012

Figure 1. NATO certificate for steel PROTAC 500.



a b

Figure 2. The microstructure of steel PROTAC 500; tempered martensite (a - (OM), b - (SEM)).

In Figure 2 there is the microstructure of the steel PROTAC 500 before the ballistic test. The microstructure consists of tempered martensite (Figure 2a). In Figure 2b there are the lighter particles of cementite, which is eliminated during the tempering.

2. PRODUCTION OF STEEL PROTAC 500

The amount of produced PROTAC brandmark steel increases rapidly [5]. Figure 3 shows the amount of manufactured PROTAC 500 semi-products during the period from 2010 to 2017, produced by SIJ ACRONI d.o.o.. The industrial production started eight years ago in year 2010.

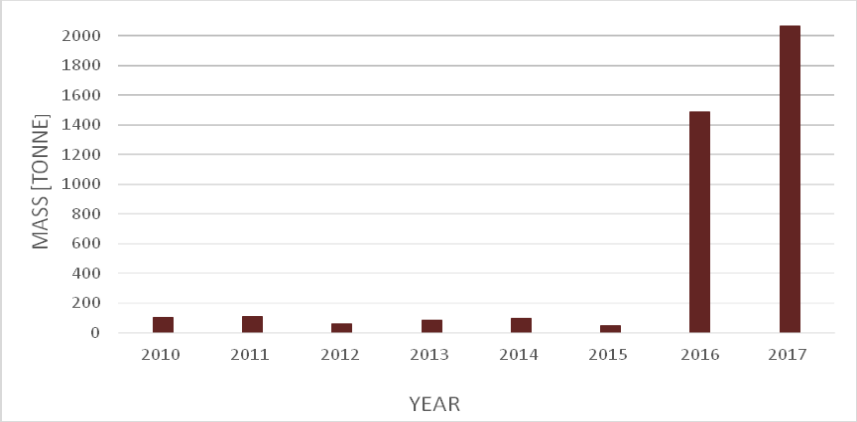


Figure 3.The amount of PROTAC 500 semi-products, produced by slovenian largest steel producer SIJ ACRONI d.o.o..

3. ASSESSMENT AND ANALYSIS OF STEEL PROTAC 500

In the material and energy balance analysis [6] we included main production stages: scrub melting in electric arc furnace (EAF) and slab continuous casting, slab reheating, and hot rolling to the final thickness between 6 and 25 mm.

Table 2: Material inputs in EAF steel making process

INPUT		
Inorganic intermediate	kg/t	
Argon	kg/t	10.32
Nitrogen	kg/t	52.76
Oxygen	kg/t	66.43
Metals	kg/t	
Ferro chromium	kg/t	281.88
Ferro molybdenium	kg/t	5.81
Ferro nickel	kg/t	12.90
Metal (recovered)	kg/t	48.21
Molybdenium trioxide	kg/t	24,33
Nickel	kg/t	5.96
Nickel oxyde	kg/t	4.08
Minerals	kg/t	
Dolomite	kg/t	15.83
CaO	kg/t	92.74
Limestone	kg/t	25.21
Recovery	kg/t	8.90
Waste for recovery	kg/t	
Stainless steel scrap (external)	kg/t	123.25
Stainless steel scrap (internal)	kg/t	409.48
Carbon steel scrap (external)	kg/t	305.88

Table 3: Energy inputs used in EAF steel making process

Energy input		
Electricity	MJ/t	2354.89
Fuel	MJ/t	398.06
Crude oil products	MJ/t	86.30
Coal	MJ/t	0.03
Natural gas	MJ/t	311.74
Propane	MJ/t	0.02

Table 4: Material outputs in EAF steel making process

OUTPUT		
Slab	kg/t	1000
Waste for disposal	kg/t	
Slag	kg/t	58.17
Waste for recovery	kg/t	
Grinding dust	kg/t	0.07
EAF dust	kg/t	23.04
Slag	kg/t	191.16
Stainless steel scrap (internal)	kg/t	36.41

Table 5: Outputs of flue gases emissions into the air during EAF steel making process

Emissions to air		
Inorganic intermediate products	kg/t	
Carbon dioxide	kg/t	112.79
Carbon monoxide	kg/t	5.72
Nitrogen oxides	kg/t	0.19
Sulphur dioxide	kg/t	0.11

The study does not take into account the more detailed analysis of the emissions of dust particles and the emissions of heavy metals which are also present during steel smelting [7]. Their indicative quantities per ton of manufactured high-strength wear resistant steel are: 0.04 kg/t of dust particles, 7.8×10^{-6} kg/t Cd, 2.6×10^{-3} kg/t Cr, 7.6×10^{-4} kg/t Pb, 1.6×10^{-3} kg/t Mn, 7.2×10^{-4} kg/t Ni, 2.0×10^{-3} kg/t Mo and 2.1×10^{-4} kg/t Cu.

The energy consumption (natural gas) during the reheating the slabs in pusher type furnace is approximately 46.69 m^3/t of steel.

Table 6: Material inputs of hot rolling process

INPUT		
Inorganic intermediate products	kg/t	
Nitrogen gaseous	kg/t	5.57
Oxygen gaseous	kg/t	75.79
Metals	kg/t	
Rolls (Alloyed steel)	kg/t	0.87
Slab (from EAF)	kg/t	1131.53

Table 7: Energy inputs during reheating before hot rolling process

Energy input		
Electricity	MJ/t	352.34
Fuel	MJ/t	1965.14
Natural gas	MJ/t	884.06
Propane	MJ/t	1081.08

Table 8: Products and material outputs of hot rolling process

OUTPUT		
Metals	kg/t	
Black quarto plate	kg/t	1000.00
Black hot rolled coil	kg/t	0.00
Used rolls (alloyed steel)	kg/t	0.06
Only hot rolling mill scales	kg/t	0.01
Waste for incineration	kg/t	
Used oil (without water)	kg/t	8.12×10^{-3}
Oily rolls grinding sludge	kg/t	5.17×10^{-4}
Waste for recovery	kg/t	
Stainless steel scrap	kg/t	125.32

Table 9: Outputs of flue gas emissions into the air during slab reheating

Emissions into the air		
Inorganic intermediate products	kg/t	
Carbon dioxide	kg/t	111.10
Carbon monoxide	kg/t	0
Nitrogen oxides	kg/t	0.14

The study does not take into account the more detailed analysis of the emissions of dust particles and the emissions of heavy metals which are also present during slab reheating. Their indicative quantities per ton of hot rolled high-strength armour steel PROTAC 500 are approximately 0.003 kg/t of dust particles, and 2.3×10^{-5} kg/t Cr, while the emissions of other heavy metals are practically negligible.

4. CONCLUSIONS

Within the framework of the conducted study, the material balance, energy consumption, waste generation, and emissions into the air during the production of high-quality steel for armour protection PROTAC 500 were analysed in industrial environment of SIJ ACRONI d.o.o. production plants.

The quantities of steel plates manufactured in years from 2010, when the industrial production of PROTAC 500 steel started, to 2015 were up to a maximum of 100 tons per year. In 2016, production increased to 1487 tonnes, and in 2017 it already exceeded the 2000 tonnes on an annual level. The production stages included in the evaluation were: steel smelting in electric arc furnace (EAF) together with slab continuous casting, reheating of slabs in pusher-type furnace, and slab hot rolling. Emissions are logically relatively high and, of course, directly related to the amount of steel produced.

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NEW METHODS OF TREATMENT OF INDUSTRIAL WASTE IN THE PRODUCTION OF FLOTATION REAGENTS

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ABSTRACT
In this paper are presented the methods of industrial waste treatment, which arises in the process of production of flotation reagents - xanthogens. Waste can be generated by the projection of damage in production or by the long time storage of the product. Production errors can be caused by a distortion of the process parameters, resulting in a scratch. Also, if the product is exposed to the warehouse for finished products for a long time, waste may occur. It has been shown that treatment in both cases produces a commercial product - thioncarbamate. Thioncarbamates are derivatives of thiocarbamic acid thus N-alkyl- and N,N-dialkyl thioncarbamates represent N-alkyl and N,N-dialkyl-O-alkyl esters of thiocarbamic acid. Wide application of these selective collectors in flotation of copper and zinc ores is well known. Treatment procedures are optimized at the laboratory level and proven in industrial production conditions.

Keywords: *xanthate, treatment, thiocarbamate.*

1. INTRODUCTION

Chemical Industry "Župa" Kruševac produces various xanthates which can be used in the processing of non-ferrous metal ores. The company has in its stock waste xanthate, which needs to be immediately treated. Namely, because of package corrosion, cracking and damages, the waste xhantates can degrade with emission of harmful substances under the moisture, temperature and oxygen from the air.

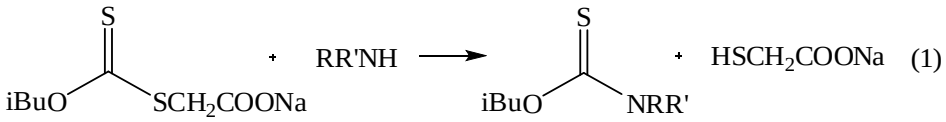
The treatments can transform waste xanthate into commercial products such as thiocarbamates used as selective flotoreagents. Registered thiocarbamate flotoreagents can be obtained from appropriate amine and sodium hypochlorite. The by-product in this reaction is sulfur, while water contains dissolved sodium chloride after filtration.

Thiocarbamate, as derivative of thiocarbamic acid [1], presents salts and esters of thiocarbamic acid [2,3]. Structural features, such as a direct bond between thioacyl and nitrogen, have significant influence on their biological activity [4]. These compounds have found industrial application and can be used as fungicides [5-7], bactericides [6-8], herbicides [9, 10], germicides [11], pesticides [12-14] and insecticides [15-16]. Also, alkyl thiocarbamates can be used as selective flotoreagents and as accelerators in reaction of polymerization [17]. The goal of this research is the optimization of a laboratory waste xanthate treatment. To define these conditions, it is necessary to determine the chemical composition of the waste and transform it into a commercial product. As a result of experimental research in this paper, the parameters of the waste xhantate treatment were determined as well as corresponding thiocarbamates. In fact, after the initial separation of waste xanthate components, the obtained dixanthogenate reacts with primary and secondary amines using as a

suitable oxidant sodium hypochlorite [18]. The waste xanthate produces xanthate which is transformed into appropriate alkyl thiocarbamate during the reaction with sodium chloroacetate, and with addition of amine in sodium alkylxanthogenate [19].

Also, in this paper the optimal laboratory synthesis of *N*-alkyl-, *N*,*N*-dialkyl- and *N*-cycloalkyl-*O*-isobutyl thiocarbamate selective flotoreagents from industrial waste xanthate and the corresponding amines in the presence of various oxidizing agents: peroxide, sodium hypochlorite and potassium peroxodisulfate were presented. Waste xanthate from production of potassium isobutyl xanthate (KiBX) and potassium ethyl xanthate (KEtX) consists of starting xanthate and dixanthogenates [20]. Innovative procedure relate to optimal technological treatment which provided efficient conversion to thiocarbamate products. Second part of the work was related to synthesis of the *N*-alkyl and *N*,*N*-dialkyl-O-ethyl thiocarbamate from diethyl dixanthogenates in presence of sodium hypochlorite at laboratory and semi-industrial level. Moreover, the comparative study on flotation efficiency of the synthesized and commercial thioncarbamates for copper isolation from real mineral copper ore sample was performed.

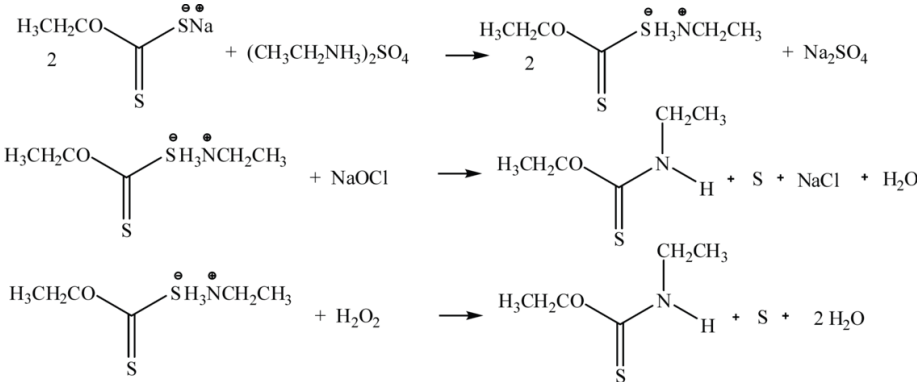
A classic procedure for the synthesis of thiocarbamate with xanthogenic acetate amonolysis is carried out by the reaction of the aminolysis of sodium isobutylxanthogenacetate (NaiBXAc) using primary our secondary alkylamines. NaiBXAc is formed by the reaction of potassium isobutylxantate (KiBX) and sodium monohloroacetate (NaClAc). NaClAc is obtained by neutralizing monochloroacetic acid and sodium carbonate. Sodium thioglycolate is produced as a by-product, which is converted to thioglycolic acid (TGK) by acidification with hydrochloric acid, which is extracted with dipropylter and packaged as a commercial product.



where are: R and R ': R = alkyl, isoalkyl or cycloalkyl and R' = H in reaction with monoalkyl amines, R = alkyl and R '= alkyl in reaction with dialkyl amines.

The scheme of the technological procedure for the production of isobutylcarbonate at the industrial plant is shown in Figure 1.

The synthesis process is optimized of N-alkyl- and N, N-dialkyl-O-ethyl- and O-isopropylthiocarbamate which is carried out by oxidation of the amine salts of ethyl and isopropylxanthogenic acids using sodium hypochlorite and hydrogen peroxide. Alkylamine salts of ethyl and isopropylsanthoic acids were obtained by reaction between alkylammonium sulfate and sodium ethyl xanthate or sodium isopropylxanthate. The reactions are carried out according to the following reaction scheme shown in Fig. 2. Innovative process for the production of liquid xanthates provides the possibility of using the thus obtained xanthate in the form of aqueous solutions in this synthesis.



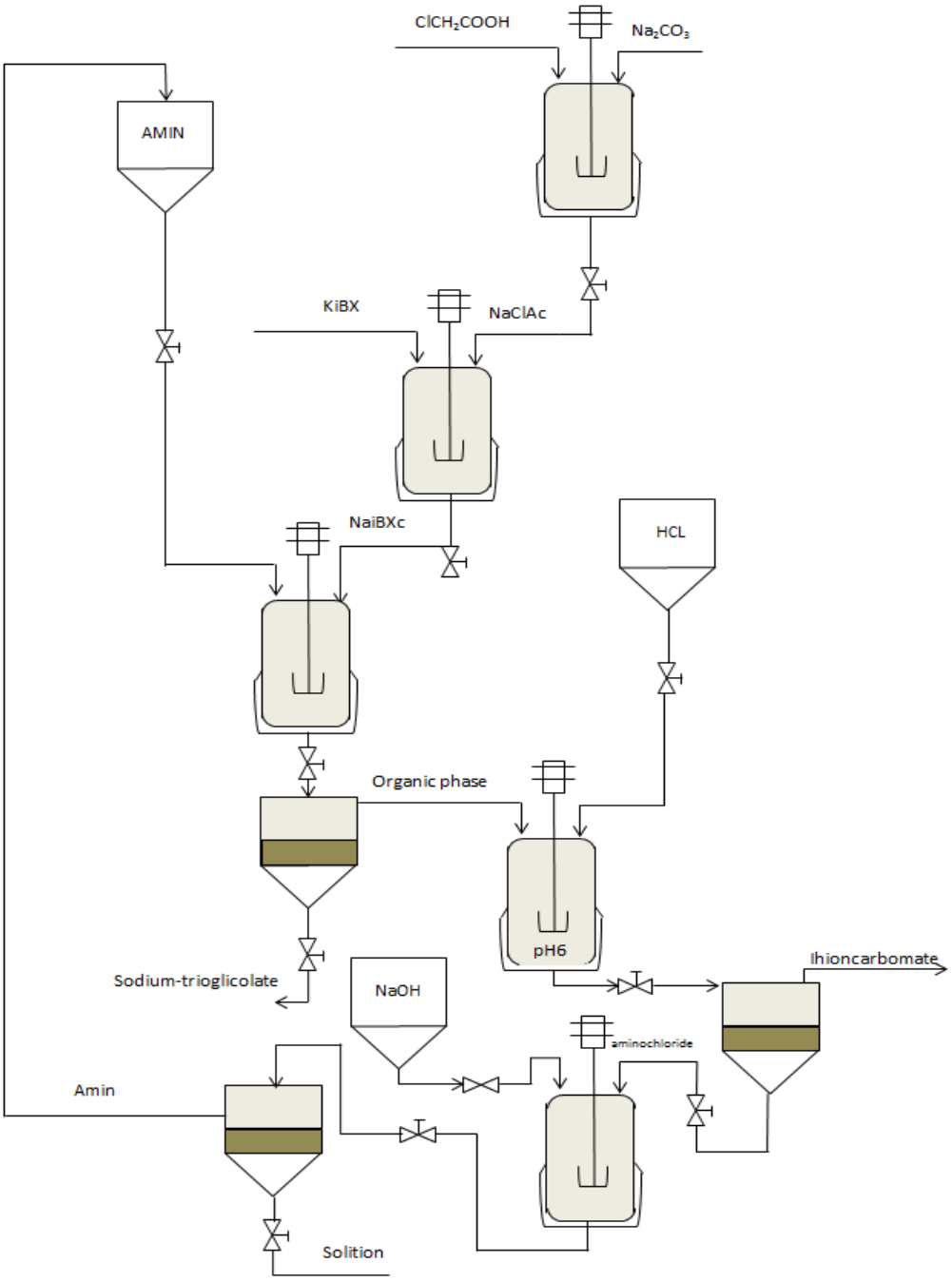


Fig. 1: *Scheme of the technological procedure for the production of isobutyl-thiocarbamate on industrial plant*

2. EXPERIMENTAL PART

a) Laboratory Procedure for Separation of Waste Xanthate Components

Fill a 1 dm^3 beaker with 100 g of waste xanthate and 400 cm^3 water and stir for 30 minutes with magnetic stirring. Filter the product on Büchner funnel, wash with 200 cm^3 water and dry in vacuum dryer at 30 ^{0}C (10 mm Hg). The yield of gained ethyldixanthogenate was 80 g, and its structure was confirmed using elemental microanalysis, as well as, FTIR, 1H NMR and MS methods. The filtrate was moved to a separation funnel. The upper layer which represented the organic phase of isobutylalcohol was separated from the aqueous phase (1.5 cm^3 of isobutanol was separated). The aqueous phase was analyzed volumetrically to determine the quantities of present xanthate and alkalis.

Based on the standard volumetric method of analysis, it was found that aqueous phase contained 0.4 g of sodium hydroxide and 5.0 g of potassium isobutylxanthate. All samples of waste xanthate were treated by the same procedure.

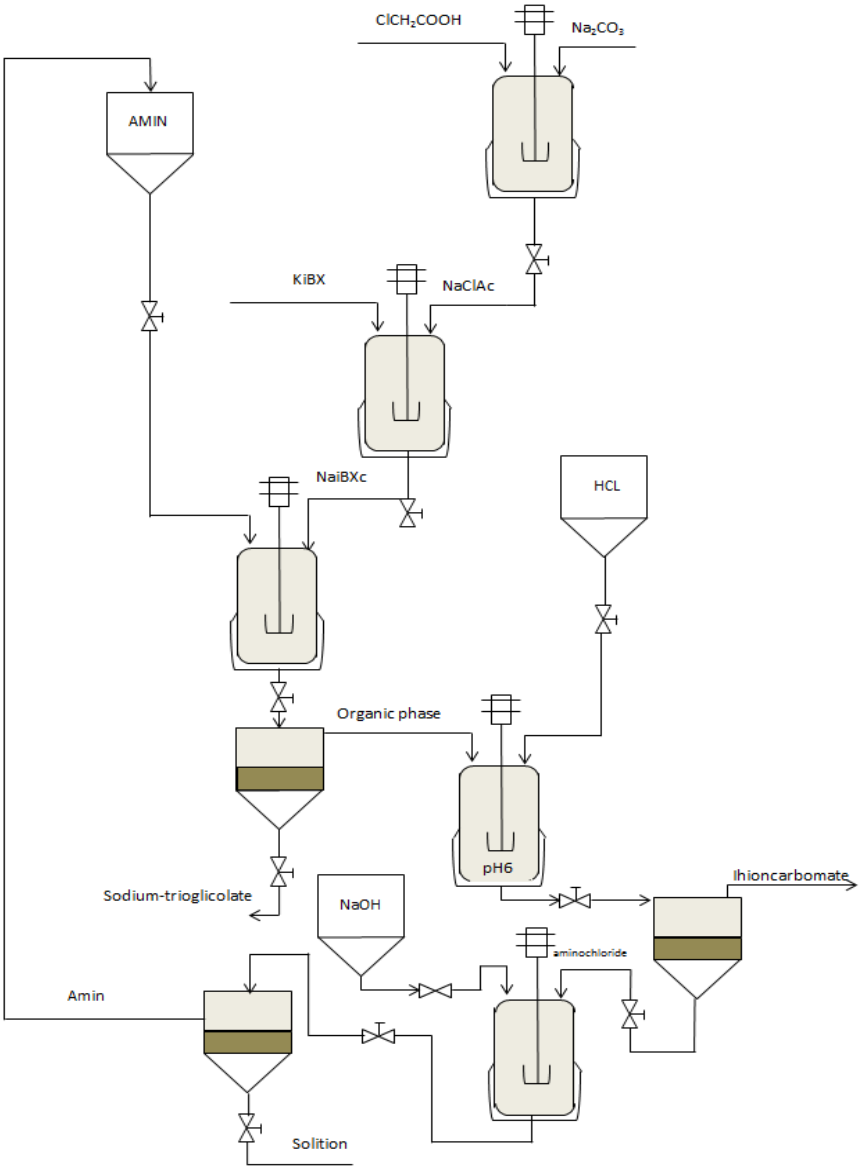


Fig. 2: *Synthesis of N-ethyl-O-ethylthiocarbamate in the presence of sodium hypochlorite and hydrogen peroxide as oxidizing agents*

b) Laboratory Procedure for Separated Dixanthogenate

In a three-necked flask (250 cm^3), equipped with a magnetic stirrer, a dropping funnel, a condenser and a thermometer, 100 cm^3 of water and 20.65 g (0.075 mol) of 98 % diethyl dixanthogenate were added. A solution of 12.25 cm^3 (0.15 mol) of 68 % ethyl amine was added for one hour with a vigorous stirring. In that way an increase in temperature to 30 ^oC occurred. After that period, 20.50 g (0.075 mol) of sodium-hypochlorite (130 g of active chlorine/1000 cm^3) was added drop-wise. The temperature of reaction mixture gradually rose to 45 ^oC during one and a half hour, after that time the reaction was completed.

The reaction mixture was filtered on Büchner funnel, the precipitated sulfur was separated as a filtration cake from the aqueous emulsion phase of *N*-ethyl-*O*-ethylthionocarbamate. The product was isolated from the filtrate by two ethereal extractions and dried with sodium-sulfate. Then, ether was distilled off at the atmospheric pressure. The pure product was obtained by fractional vacuum

distillation at 105 ^{o}C/(6.6 mbar). 21.50 g of *N*-ethyl-*O*-ethylthionocarbamate was obtained, representing the yield of 93.5 %. The GC purity was 97.7 %.

c) Synthesis of isobutyl thiocarbamate from KiBX and amines in the presence of potassium peroxodisulfate

Synthesis of isobutyl thiocarbamates was performed according to literature procedure [20].The yield and purity of the products are determined by the GC method.
In a manner analogous to the procedure described above, the synthesis of thiocarbamate in the presence of hydrogen peroxide and sodium hypchlorite) as an oxidizing agents was carried out [21], and the yields and purity of the products, determined by the GC method.

d) Synthesis of ethyl thiocarbamates from waste diethyl dixanthogenates

Synthesis of thiocarbamates from waste dixanthogenates, separated from waste xanthates, was carried out by reaction of the corresponding alkyl amines in the presence of sodium hypochlorite [22]. All other ethyl thiocarbamates are synthesized in an analogous manner to the procedure above, using the appropriate amines under reaction conditions.

3. RESULTS AND DISCUSSION

The laboratory treatment of waste xanthate, which resulted in initial components for producing commercially important alkyl thiocarbamate, is described in the experimental section. Separation and identification of present components is the first phase in waste xanthate treatment, and the results obtained at this stadium are given in Table 1.

Table 1: *Xanthate composition toxic*

No.	Dixanthogenates		Alkalines		Xanthates		Alcohols	
	name	quantity %	name	quantity %	name	quantity %	name	quantity %
1	Izobutyl	80,0	NaOH	0,40	K-iButyl	5,0	Izobutyl	1,5
2	Ethyl	10,0	NaOH	0,45	Na-Et	43,0	-	-
3	Ethyl	85,0	NaOH	0,65	Na-Et	-	-	-
4	Izobutyl	81,0	NaOH	0,80	K-iButyl	11,0	Izobutyl	2,1
5	Izobutyl	86,0	NaOH	0,85	K-iButyl	10,0	Izobutyl	1,8

According to the results shown in table 1, the composition of the waste xanthate in treated samples varies depending on the selected sample. The mostly present component is dixanthogenate (80 to 86%), except in sample 2 (10%). However, sample 2 contains 43% sodium ethylxanthate, indicating that there was no significant oxidation and degradation of commercial package. Other samples, based on the results shown in Table 1, undergo oxidation (presence of dixathogenate) and partial degradation of products (presence of alcohol and alkali).
Dixanthogenate separated from the waste xanthate, treated according to the described procedure, gave an appropriate alkylthioncarbamates. Ethyldixanthogenate separated from waste xanthate and various alkylamine in the presence of oxidant sodiumhypochlorite gave ethylthioncarbamate. The results of this synthesis are shown in Table 2 and Fig. 3.

Table 2: *Yields and purity of thioncarbamates obtained in ethyldixanthogenate treatment*

Compound	**Reaction time (h)**	**Temperature (oC)**	**Yield (%)**	**GC[a] (%)**
EtOC(S)NHMe	2.0	30-45	89.2	97.9
EtOC(S)NMe$_2$	2.0	30-45	90.0	97.8
EtOC(S)NHEt	2.0	30-45	88.0	97.0
EtOC(S)NEt$_2$	2.0	30-45	88.8	97.6

EtOC(S)NHPr	2.0	30-45	88.2	98.0
EtOC(S)NPr$_2$	3.0	40-50	84.5	98.4
EtOC(S)NHi-Pr	3.5	40-55	82.1	99.6
EtOC(S)Ni-Pr$_2$	4.5	40-55	75.0	98.9

[a] GC purity

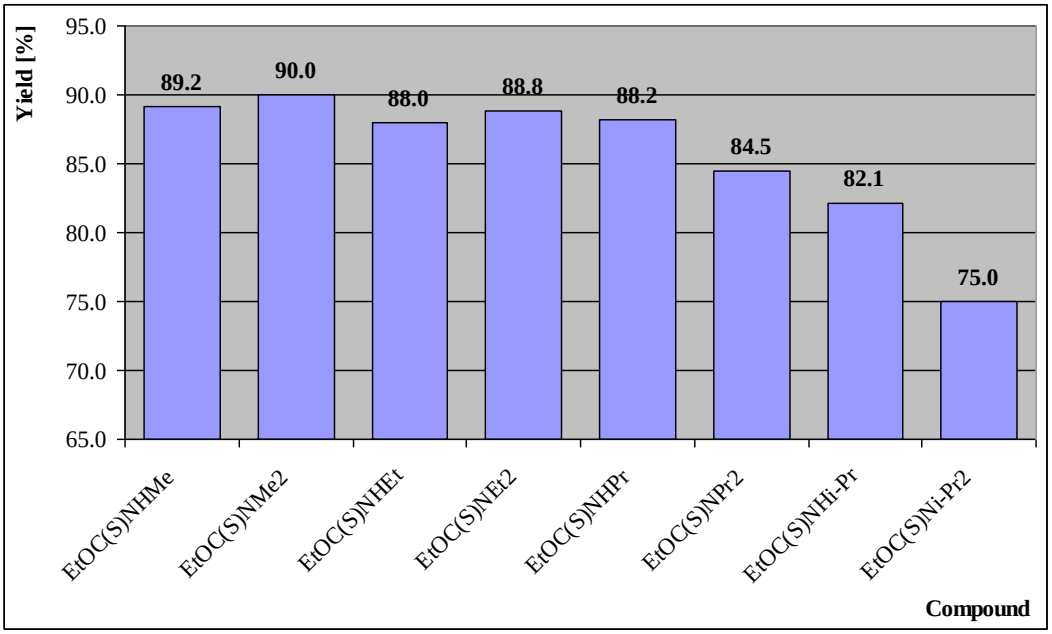


Fig. 3: *Graphic presentation of dependence Yield [%] compound*

Based on the results presented in Table 2, it can be seen that the optimal synthesis conditions in this paper, result in high yields and purity of *N*-alkyl and *N, N*-dialkyl-*O*-ehyllthioncarbamate. The yield of the reaction products depends directly on the structure of the amine. Voluminosity of di-*n*-propyl, isopropyl, and di-isopropyl group contributes significantly to steric repulsion with ethyldixanthogentes atoms. This prevents amine to performed an effective nucleophilic heterolysis of S-S bonds in the first step of the reaction. Amine structure has essential impact on the nucleophilicity of amine[20] and further kinetic studies can provide more information about the reaction mechanism and reaction rate. Lower yields were obtained in synthesis of *N,N*-di-*n*-propyl-*O*-ehyllthioncarbamate (84.5%), *N*-isopropyl-*O*-ehyllthioncarbamate (82.1%). The lowest yield was achieved in synthesis of *N, N* -diisopropyl-*O*- ehyllthioncarbamates (75.0%).

MS, FTIR, ^{1}H and ^{13}C NMR data are in accordance with literature, confirming the structure of of synthesized *N*-alkyl and *N, N*-dialkyl-*O*-ehyllthioncarbamates [23].

Scheme of semi-industrial treatment of waste xanthate developed on reproductive results is shown in Figure 4.

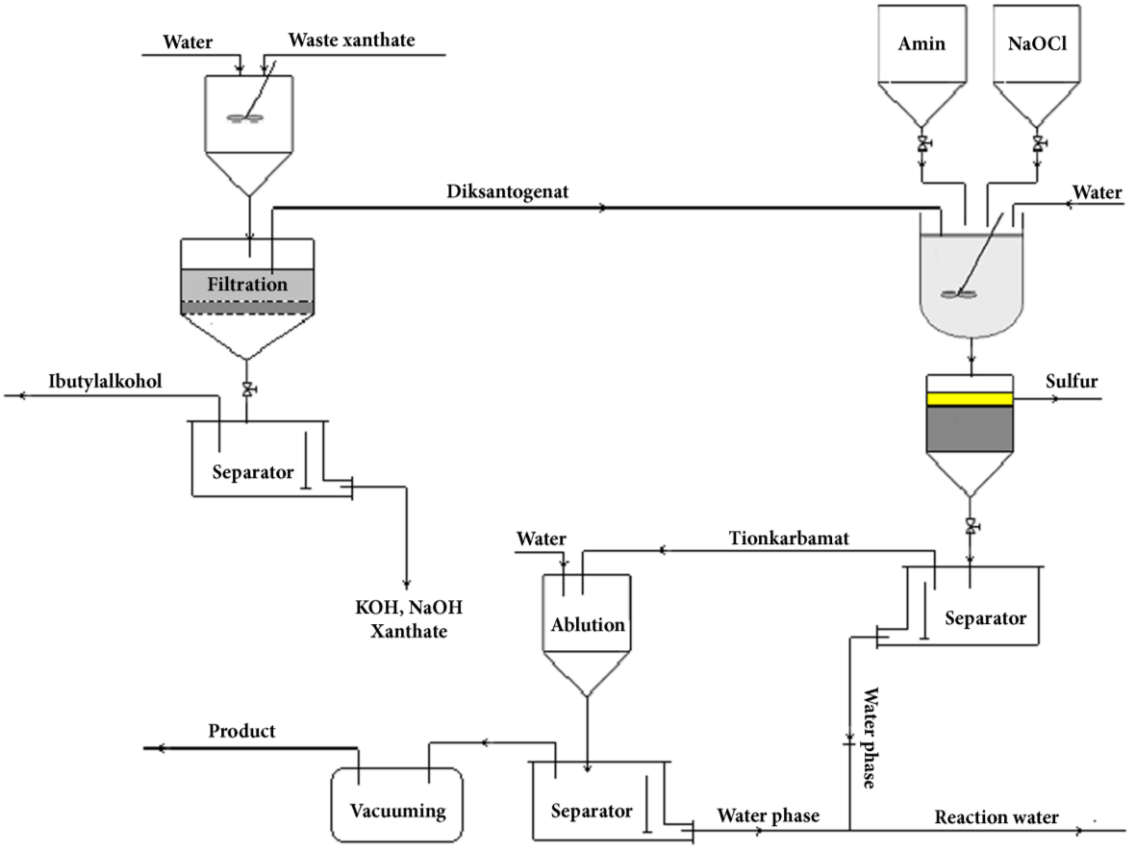


Fig. 4: *Scheme of semi-industrial treatment of waste xanthate*

Synthesized *N*-alkyl, *N*,*N*-dialkyl- and *N*-cycloalkyl-*O*-isobutyl thiocarbamate are characterized by FTIR, ^{1}H and ^{13}C NMR results, and obtained results are in accordance to literature data [20, 22].The purity is determined by the GC method and confirmed by elemental microanalysis. The yields and purity of the synthesized thiocarbamate, obtained by methods 1, 2 and 3, are shown in Table 3.

Table 3: *Yields and purity of synthesized isobutyl thiocarbamate*

Compound	**Yield** [%]			**GC purity** [%]		
	H_2O_2	**NaOCl**	**$K_2S_2O_8$**	**H_2O_2**	**NaOCl**	**$K_2S_2O_8$**
iBuOC(S)NHEt	87,2	85,1	90,3	98,5	98,3	98,6
iBuOC(S)NHPr	88,6	86,5	91,7	97,3	97,5	97,2
iBuOC(S)NhnBu	89,5	86,8	92,6	99,0	99,1	99,2
iBuOC(S)NHsBu	89,3	87,2	92,4	99,4	99,3	99,1
iBuOC(S)NHiPr	87,1	85,0	90,2	99,2	99,0	99,2
iBuOC(S)NHiBu	93.6	92,5	96,7	97,0	97,2	97,8
iBuOC(S)NHiPent	94,1	92,0	97,3	97,5	97,7	97,9
iBuOC(S)NHcPr	77,4	75,6	80,2	97,8	98,0	98,6
iBuOC(S)NHcPent	83,6	82,4	86,7	98,0	98,1	98,5
iBuOC(S)NHcHeks	87,7	85,6	90,8	97,0	97,2	97,9
iBuOC(S)N(Et)2	93,8	91,7	96,5	97,4	97,6	97,5
iBuOC(S)N(Pr)2	95,2	94,0	98,0	98,0	98,1	98,8
iBuOC(S)N(Bu)2	95,9	95,1	98,2	97,0	97,2	97,9

Based on the yields of the reactions products (Table 3), the most significant oxidation agent is potassium peroxodisulfate, and the yields are relatively similar and somewhat higher in oxidative processes than in those obtained by applying the conventional synthesis process of aminolysis of sodium isobutyl xanthogenacetate [20].

Waste diethyl dixanthogenates treated with various alkylamines in the presence of sodium hypochlorite oxidant gave ethyl thiocarbamate product.
Hgh yields and purity of *N*-alkyl and *N*, *N*-dialkyl-*O*-ethyl thiocarbamate were obtained, and depends on the structure of the amines used. Voluminosity of di-*n*-propyl, isopropyl, and di-isopropyl group contributes significantly to steric repulsion which prevents amines to performe an effective nucleophilic heterolysis of S-S bonds in the first step of the reaction. Amine structure has essential impact on the nucleophilicity of amines [24]. Lower yields were obtained for *N*,*N*-di-propyl-*O*-ethyl thiocarbamate (84.5%), *N*-isopropyl-*O*-ethyl thiocarbamate (82.1%), while lowest for *N*-diisopropyl-*O*-ethyl thiocarbamates (75.0%). MS, FTIR, ^{1}H and ^{13}C NMR data are in accordance with literature[24].The amount of sulfur produced after the filtration of the reaction mixture corresponds to the theoretical stoichiometric value in relation to the starting quantities of the reactants.
In accordance to optimal laboratory synthesis semi-industrial production was carried out at H. I. Župa Kruševac plant. It was found that the reaction products are not present in waste water, while the concentration of dixanthogenates is below the maximum contamination limit, Table 4 [23]. Necessary wastewater treatment is also very simple. An innovative method could be widely used for the synthesis of thiocarbamate starting from various raw materials: ammonium salts and alkaline salts of *O*-alkyl xanthic acid [21], as well as waste or commercial diethyl dixanthogenate [24]. The results of the implementation of the defined method at the semi-industrial level are shown in Table 4.

Table 4 *Results of semi-industrial synthesis of N-ethyl-, N-propyl and N,N-dipropyl-O-ethyl thiocarbamate*

Thiocarbamates	Reactants								Reaction conditions		By-product	Product		
	Amine		H_2SO_4		Sodium ethyl xanthate		NaOCl		t	T	Sulfur	Yield		GC
	kg	kmol	kg	kmol	kg	kmol	m^3	kmol	h	°C	kg	kg	%	%
EtOC(S)NHEt	35.4	0.55	28.1	0.28	144	1.0	0.66	1.5	2.5	30.0	25.0	126.5	95.0	99.0
EtOC(S)NH(nPr)	33.2	0.55	28.1	0.28	144	1.0	0.66	1.5	2.8	30.0	24.0	135.2	92.0	98.6
EtOC(S)N(nPr)$_2$	54.4	0.55	28.1	0.28	144	1.0	0.66	1.5	4.0	30.0	20.0	161.0	85.2	98.1

The technological scheme of the semi-industrial process for the synthesis of thiocarbamate is presented in Figure 5. Results of determination of isobutyl dixanthogenate in wastewater in the process of semi-industrial production are presented in Table 5.

Table 5 *Concentrations of ethyl dixanthogenate in waste water*

Compound	Sample amount [cm^3]	Concentration of ethyl dixanthogenate	
		c $\cdot 10^3$ [mmol dm^{-3}]	**c $\cdot 10^2$ [**mg dm^{-3}]
EtOC(S)NHEt	70.00	21.36	58.00
EtOC(S)NHnPr	85.00	20.09	53.80
EtOC(S)NHiPr	85.00	19.98	54.31
EtOC(S)NHBu	80.00	18.45	50.29

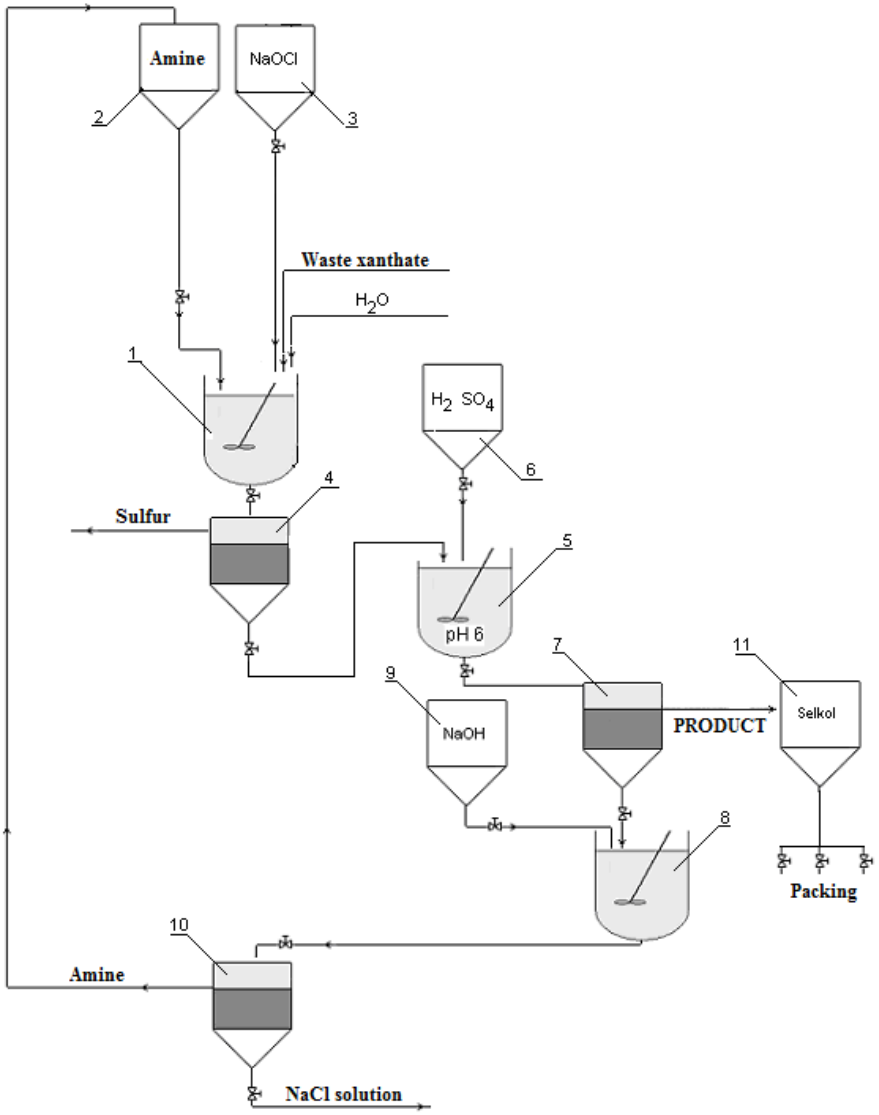


Fig. 5: *Technological scheme of the semi-industrial synthesis of ethyl thiocarbamate*

4. CONCLUSION

According to the lab testing in this work, it can be concluded that industrial waste xanthate can be used for the synthesis of thioncarbamate, which are widely used in the flotation of minerals as selective flotoreagents. A high degree of reactants conversion to products (over 80%) and high degree of purity of the product is also achieved. Considering the importance of the synthesized compounds as selective flotoreagents, the application of new optimal procedure for the synthesis of dixanthogenates obtained from waste xanthate, the significant improvements are achieved. Among them, the most important is yield and purity of the obtained compounds, simplicity of procedure, low environmental impact and the short raction time of synthesis, compare to the others well-known.

On the basis of the reproductive results, which is characterized by a high degree of conversion, semi-industrial solution of defined lab procedure for the synthesis of thioncarbamates from dixanthogenate obtained from waste xanthate is represent.

Synthesis of *N*-alkyl-, *N*,*N*-dialkyl- and *N*-cycloalkyl-*O*-isobutyl thiocarbamate from amine salts of xanthic acid obtained from KiBX separated by waste xanthate treatment with potassium peroxodisulfate, hydrogen peroxide and sodium hypochlorite. Highest yields in presence of $K_2S_2O_8$ (80.2-98.2%), lower in the presence of H_2O_2 (77.4-95.9%), and the lowest in the presence of NaOCl (75.6-95.1%). The process for the synthesis of *N*-alkyl and *N*,*N*-dialkyl-*O*-ethyl thioocarbamate from waste diethyl dixanthogenates and amines in the presence of sodium hypochlorite was developed at

the laboratory level and applied at the semi-industrial level. The structures of all synthesized thiocarbamates were confirmed by FTIR, ^{1}H and ^{13}C NMR spectroscopy, as well as MS spectrometry. The purity was determined using GC chromatography and elemental analysis. This new environmentally acceptable process represents a favorable possibility for existing methods, and offere a significant contribution to environmental protection. The results of comparative studies related to flotation efficiency from copper ore samples showed higher percentage of flotated copper using synthesized thiocarbamates in comparison to commercial one.

ACKNOWLEDGEMENTS

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NEW MATERIALS BASED OF AROMATIC POLYPHENYLENE SULFIDE

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ABSTRACT
New carbon plastics on the basis of polyphenylene sulfide are developed. Influence of carbon fibers on thermal resistance and physical mechanical characteristics of polyphenylene sulphide, which are criterion of an assessment of operational properties of polymers and composites on their basis is shown.

Keywords: *polyphenylene sulfide, thermo resistance, carbon fibers, carbon plastics, strength.*

1. INTRODUCTION

Polysulfides include polyalkylene sulfides of general formula $[-CH_2-CH(R)-S]_n$, where R – H or alkyl, and polyarylene sulfides $[-Ar-S]_n$, Ar – C_6H_4, dyphenyl, flake camphor etc. From the last mentioned poly-1,4-phenylene sulfides is the most important.
Polysulfides are characterized by high heat stability which increases with growth of chain branching and doesn't depend on polymer molecular weight. They have good mechanical properties, heat stability, radiation resistance, immunity to different aggressive substances (for example, polyphenylene sulfide (PPS) is second only to polytetrafluoroethylene by chemical resistance). PPS belong to non-combustible materials, they possess good adhesion to metals [9]. Products of polyphenylene sulfide can be used at 260°C temperature for a long time, saving its thermoplasticity.
To increase heat stability linear PPS are crosslinkeed according to thermal or chemical methods (for instance, with sulfur, metal oxides) or it's possible to inject restraining agents of thermal-oxidative degradation [12].
To improve operational properties discrete carbon fibers are injected in PPS make-up (CF) [2-6, 11]. Thus, filled polymer compounds containing 5-20 mass. % CF were elaborated on the base of aromatic PPS.
In consideration of the foregoing, the objective of research was to study impact of CF on PPS strength and heat stability, which are criteria of evaluation of polymers properties and composites based on their ground.

2. SUBJECT AND METHODS OF RESEARCH

Polyphenylene sulfide is meta-polymer from oxidized sulfide groups to sulphite and sulphate groups, which in clear sample of bind, influence C-H bonds in positions 2 – and 4- (connection with 1 – and 3-displaced).

As a result of rigid-chain compound, narrow temperature window of carbon plastics (CP) transition on base of PPS into viscous-flow state bordering with decomposition temperature, certain difficulties may appear in its treatment with extrusion technique and die casting method. Taking this into account, compression moulding method was chosen to retreat PPS and based on its ground CP into products.

Moulded impregnated wood make-up: PPS + 5-20 mass. % of carbon fibers brand «Toreyka» were made by combining components in revolving electromagnetic field with ferromagnetic particles. The blend made in such way was retreated into products with compression moulding method.

Physical-mechanical characteristics: strength ($\sigma_{compr.}$), relative deformation (ε) and elastic modulus (E) under compression were determined by device SANS (according to NSS of China GB/T 2569-1995) on loading 10 ton and at speed 2 mm/min. Operational speed range – 0,05-500 mm/min. For researches were used samples 10 mm in diameter and 12 mm high.

Thermogravimetric experiments were conducted on a thermo-microbalance TG 209 *F3 Tarsus* manufactured in Germany, with heating rate 10 degrees / min.

IR-spectrum analysis was conducted on spectrometer VERTEX 70 (Germany, Bruker Company).

3. DISCUSSION OF RESULTS INVESTIGATION

The physical-mechanical research. Considering fact that machinery is one of the main branches of using elaborated carbon fiber-reinforced plastic, in particular details of movable connections – special attention during studying of its physical-mechanical properties was paid to compression strength ($\sigma_{compr.}$), because this parameter allows to suggest load-bearing capacity of friction knot completed with details from carbon fiber-reinforced plastic. The physical-mechanical characteristics are shown in fig. 1 and table 1.

Table 1: *Strength characteristics of polyphenylene sulphide and carbon plastics of its based*

Indicate	Containing of carbon fiber «Toreyka», mass. %				
	0	5	10	15	20
$\sigma_{compr.}$, [MPa]	147	203	174	219	247
ε, %	15	16	10	9	12
E, [MPa]	3059	4011	5102	4625	3008

Rate of curves is shown in the fig. 1: relative deformation (ε) – compression strength ($\sigma_{compr.}$). Curves 1, 2, 3, 4, 5 according to Herzberg's classification [8] belong to II type: all curves have straight-line section before compression point corresponding to proportional limit; a section where one can observe certain deviation from Hooke's law related to development of macromolecules segmental mobility [1], parabolic section of curve characterizing homogeneous viscous deformation can be observed further.

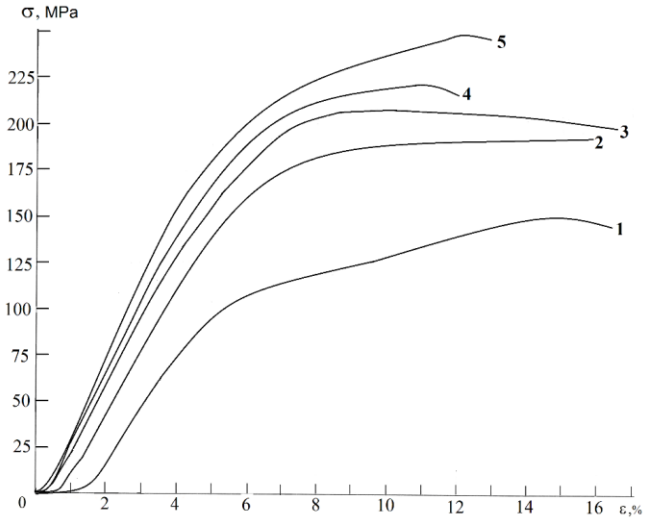


Fig. 1: *Curves σ-ε of polyphenylene sulfide (1) and CP of it based, containing 5 (2), 10 (3), 15 (4) u 20 (5) mass. % of CF*

It is found that compression limit of initial polyphenylene sulfide increases directly proportional to carbon fibers content (in 1,2 – 1,7 times). Especially significant compression strength improvement is observed in injection of 15-20 mass. % CF. As to elastic modulus, it increases only in 5-15 mass% percentage content, further it decreases.
This increase may be explained by inter-compound filling effect, when fiber particles are placed on the boundaries of super molecular formations in drawback sections and influence flexibility of super molecules. Nearby filler surface there is limitation of mobility super molecular structure, which doesn't depend on polymer and filler nature. It leads to a certain change of material elasticity [8].

4. INTERPRETATION OF IR-SPECTRUMS

Taking into account that intermolecular interaction in phases boundaries polymer – fiber filler is related to main factors, defining basic CP operational properties, structural transformations at molecular level were studied by IR-spectrum method.

The IR-spectrum analysis results of initial polyphenylene sulfide (fig. 2, table 2) showed that it:

- contains S atomes in 1,3-displacement of benzene nucleus;
- doesn't have end groups S-H, but it has H-connections, probably, by means of R-SO_3H;
- comprises sulfide groups (thiosulfoxides) S=O and sulphate groups (SO_2);
- probably contains halogen atom (Br, Cl): $\nu_{(C-Br)}$=680-500 cm^{-1}; $\nu_{(C-Cl)}$=850-800cm^{-1} [7]; in our sample 478,85 $см^{-1}$ (strong, narrow) and 552,08 (medium, narrow); 806,85 (very strong, narrow);
- comprises sulfuric acid hydrates, also its salts R-SO_3^-: $\nu_{(S=O)}$, as. and s., 1250-1150 (s.) and 1100-1000 (s.) [7], in our sample 1260,37 (weak) and 1006,76 (strong, narrow) cm^{-1}.

Table 2: *Reference of strips in IR-spectrum of polyphenylene sulfide, [cm^{-1}]*

Aromatic rings			Polymer	The characteristic vibrations of the replaced benzene		Vibrations of Sulfur atoms		
$\nu_{(C-H)}$, p.	$\nu_{(C=C)}$, a., n. Pulset-sionny fluctuations of a ring	$\nu_{(C=C)}$, a. Pulset-sionny fluctuations of a ring, interface	H- bonds and π - electron cloud in aromatic cycles	Obertone and combina-tional strips	Out-of-plane fluctua-tions C-H 1,3-repla-cements	$\nu_{(S-Ar)}$, $\nu_{(C-S)}$	$\nu_{(S=O)}$, (as and s), st. in $(Ar)_2$-SO_2	$\nu_{(S=O)}$, st., in R-S(=O)-R
Reference data [7]								
3070–3030, p.	1580–1600, a., n.	1450–1500, n., a.	3600-3500, n., a.	1667-2000	810-750 and 710-690	600, a.	1360-1335 (as) and 1170-1160 (s)	1108-1095
In our simple								
3065,5, p.	1569,75, a., n.	1468,36, n., st.	3448,6, st., w.	1638,69, a., w. 1859,52, p., w.	806,85, v.st., n. and 739,82 p., n.	552,1 a., n.	1384, a., n., (as) and 1177,8, p., n., (s)	1089,8 a., n. 1071,8 st., n.

Note: Esignations of vibrations: st. - the strong; a. – average; p. – the poor; v. p. – the very poor; v.st. – the very strong; w. – the wide; n. – the narrow; ν - stretching vibrations.

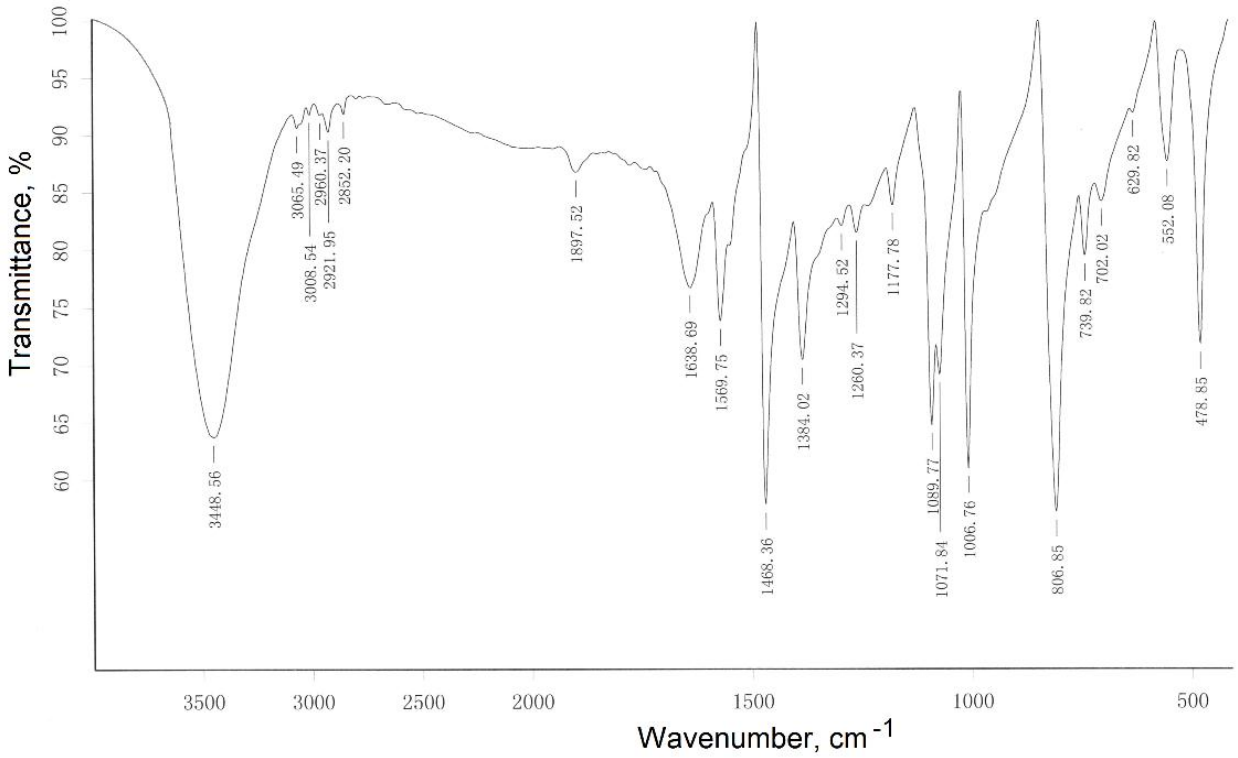


Fig. 2: *IR-spectrum of initial polyphenylene sulfide*

As to IR-spectrum research of carbon fiber-reinforced plastics (fig. 3-6, table 4) based on polyphenylene sulfide, containing 5-20 mass.% carbon fiber «Toreyka», it's possible to mention some common patterns: 1. Between PPS bind and fiber "Toreyka" there are interactions of type:

- weakening impact of SO- and SO_2-groups on proper benzene nucleus and strengthening of intermolecular and interpolymer H-connections;
- particular importance has the impact of $R\text{-}SO_3^{\ominus}H^{\oplus}$ group, which is used in the process of expansion of filler amount $\nu_{(S=O)as}$=1006,76 (s., narrow) cm^{-1} - reduction of its intensity from strong to very weak (20%);
- necessary to mention fiber reducing action on bind, when S-H groups and symbate increase of intermolecular H-connections in KM are observed in composite materials;
- on the side of fiber ether oxygen which was connected before with inter molecular H-connection and interfaces with benzene nucleus participate in intermolecular interaction, in CP is connected with intermolecular interaction.

The biggest interaction is observed for CP samples containing 5 and 10 mass % fiber, the smallest is for a CP sample with 20%.

Table 3: *Reference of strips in IR-spectrum of CP on the basis of polyphenylene sulfide and carbon fibre "Toreyka"*

Wave numbers, cm^{-1} / contain	Fluctuations of sulphur atoms in compounds					Other fluctuations			
	$\nu_{(S-C)}$ in S-Ar	$\nu_{(S=O)}$ in R-SO-R	$\nu_{(S=O)_2}$ as and s) in $R-SO_2-R$	$\nu_{(S=O)_2}$ (as и s) in $R-SO_3^-$ (H)	$\nu_{(S-H)}$	H- bonds and π - electron cloud in aromatic cycles	Ester fluctuations in Ar-O-Ar $\nu_{(C-O-C)}$		Stretching vibrations $\nu_{(C=C)}$ in aromatic compounds
							1075-1020 ν_s	950-810 ν_{as} [1]	
Pure PPS	552,08 (a., n.)	1089,77 (st., n.) 1071,84 (a., n.)	1384,02 (a., n.) 1177,78 (p., n.)	1260,37 (p., n.) 1006,76 (st., n.)	–	3448,56 (st., w.)	+ (v. p.); it is blocked $\nu_{(S=O)}$ in $R-SO_3H$	–	+
PPS + 5 mass. % CF	551,76 (p., w.)	1089,78 (p., n.) 1071,94 (v. p., n.)	1384,30 (p., n.) 1177,78 (v. p., n.)	1260,91 (v. p., n.) 1007,08 (a., n.)	2022,29 (v. p., w.)	3461,29 (v. st., w.)	+ (v. p.); – "–	–	1546, 23 (v. p.)
PPS + 10 mass. % CF	551,77 (p., w.)	1089,98 (p., n.) 1071,86 (v. p., n.)	1384,25 (p., n.) 1177,55 (v. p., n.)	1260,92 (v. p., n.) 1007,74 (a., n.)	2066,00 (v. p., w.)	3459,35 (v. st., w.)	+ (v. p.); – "–	–	+ (v. v. p.)
PPS + 15 mass. % CF	551,70 (p., n.)	1089,72 (p., n.) 1071,61 (v. p., n.)	1383,36 (p., n.) 1177,18 (v. p., n.)	1261,02 (p., n.) 1006,94 (a., n.)	2043,00 (p., w.)	3461,04 (v. st., w.)	+ (v. p.); – "–	–	1545, 59 (v. p., n.)
PPS + 20 mass. % CF	553,22 (p., w.)	1088,64 (v. p., w., with a brachium)	1385,08 (v. p., n.) 1173,30 (v.v. p., n.)	1262,51 (v. v. p., n.) 1007,59 (v. p., n.)	2067,01 (p., w.)	3436,28 (v. st., w.)	1045,06 (a., n.) ν_s	878,30 (p., n.) ν_{as}	1544, 43 (v. p., n.)

Note: Esignations of vibrations: st. - the strong; a. – average; p. – the poor; v. p. – the very poor; v.st. – the very strong; w. – the wide; n. – the narrow; ν - stretching vibrations.

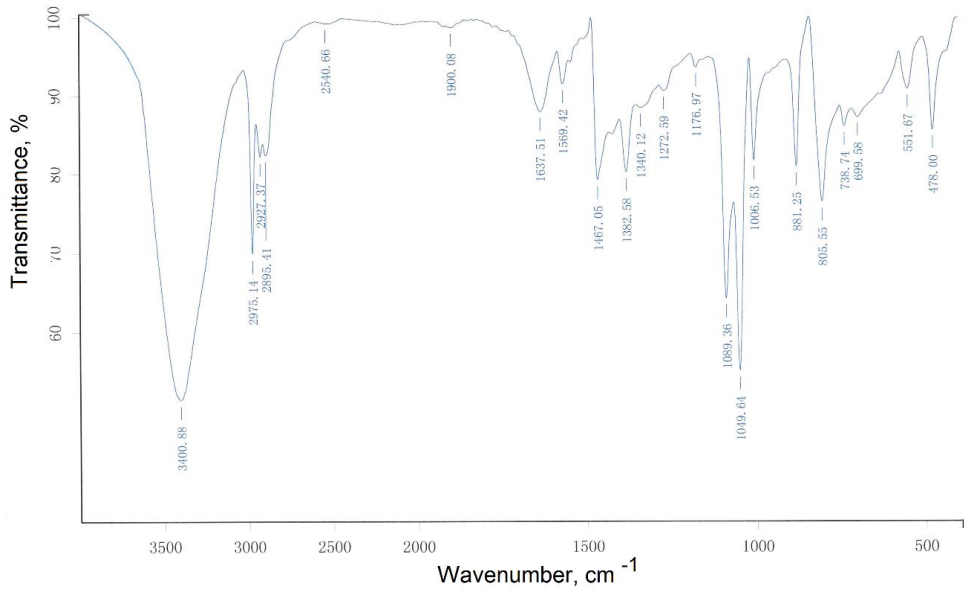


Fig. 3: *IR-spectrum of carbon plastic based of polyphenylene sulphide, containing of 5 mass.% CF*

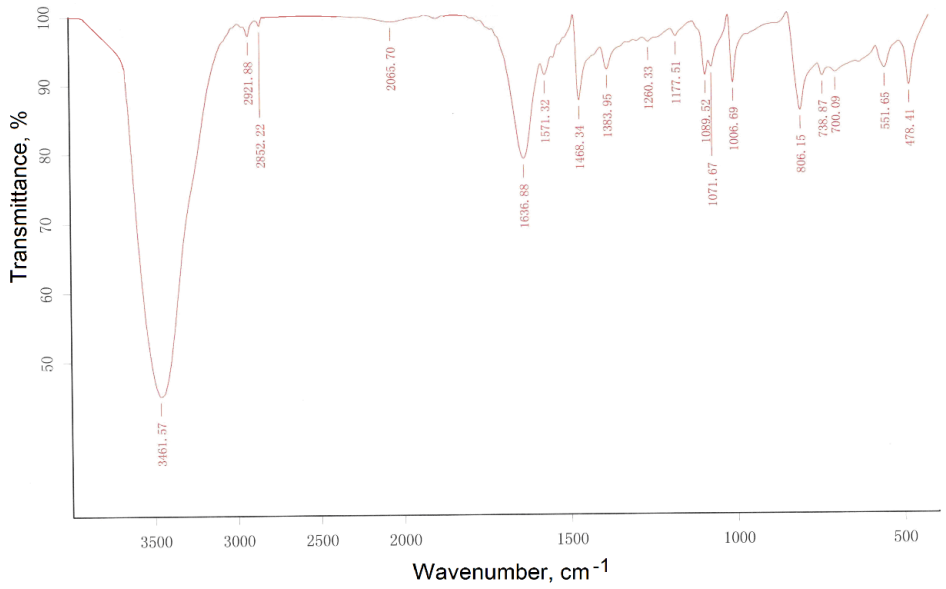


Fig. 4: *IR-spectrum of carbon plastic based of polyphenylene sulphide, containing of 10 mass.% CF*

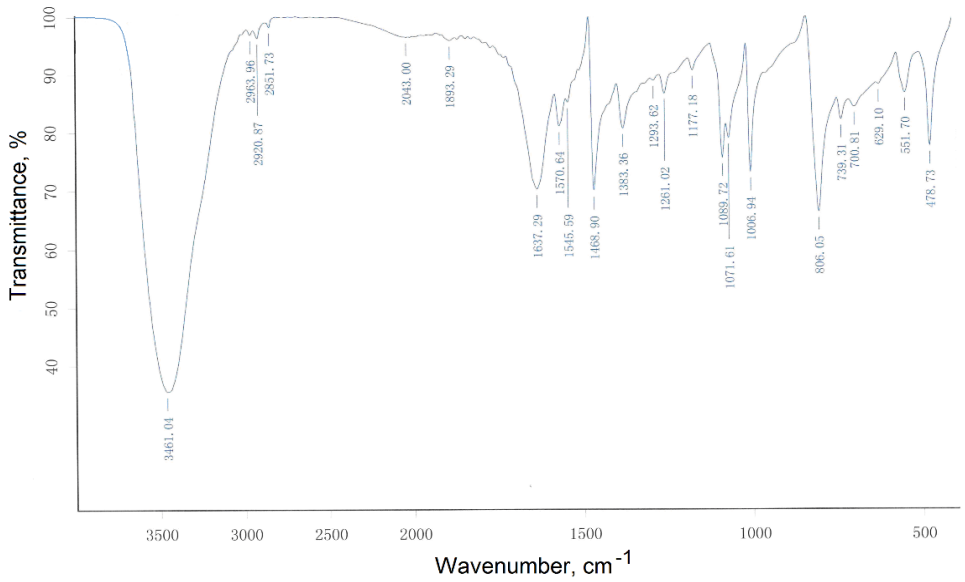


Fig. 5: *IR-spectrum of carbon plastic based of polyphenylene sulphide, containing of 15 mass.% CF*

5. THE RESEARCH OF CARBON FIBER ON AROMATIC POLYPHENYLENE SULFIDE THERMO-RESISTANCE

The results of thermogravimetric analysis (table 4, fig. 7-8) indicate high thermo-resistance both of initial PPS and of CP on its base [10]. Reinforcement of polymer bind with carbon fiber almost doesn't change thermo-resistance of the initial bind, only in a case of 5-10 mass% is possible to observe its insignificant rising.

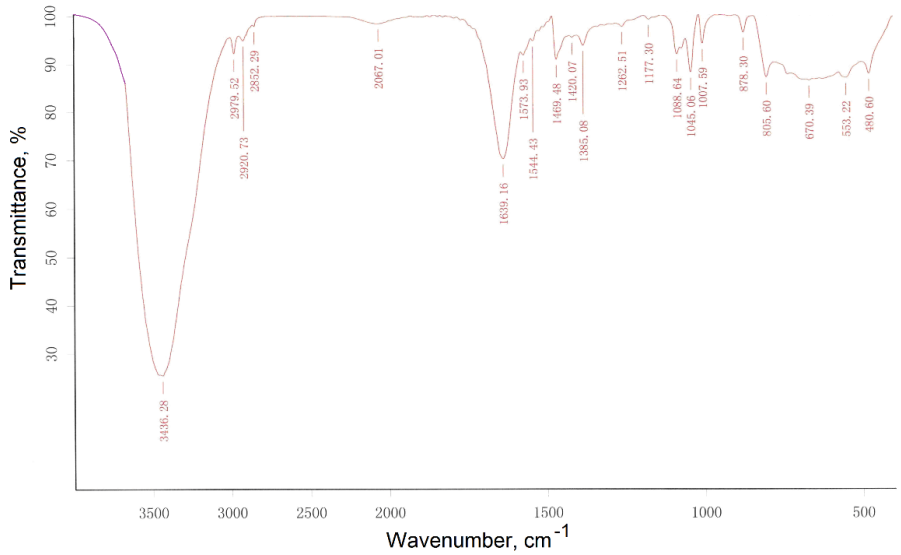


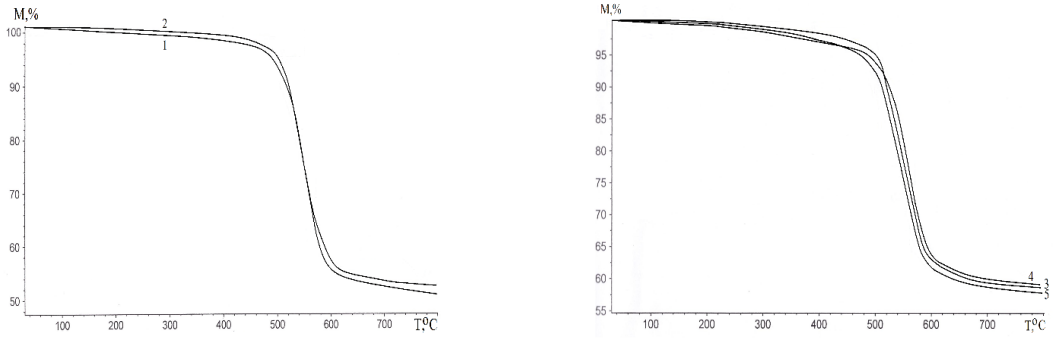
Fig. 6: *IR-spectrum of carbon plastic based of polyphenylene sulphide, containing of 20 mass.% CF*

Table 4: *Thermal resistance of carbon plastics on the basis of polyphenylene sulfide, [°C]*

Material	T_5	T_{10}	T_{20}	T_{vmax}	T_{ex}
PPS	491	520	540	505	557
PPS + 5 mass.% CF	496	525	550	508	558
PPS + 10 mass.% CF	494	522	542	504	556
PPS + 15 mass.% CF	468	518	540	495	551
PPS + 20 mass.% CF	471	520	540	499	552

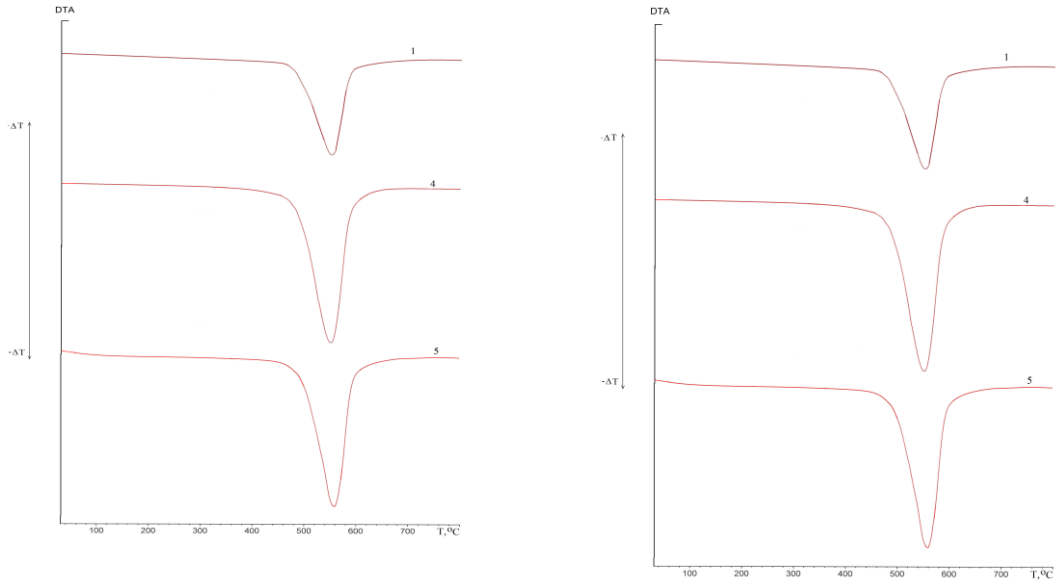
Note: T_5, T_{10}, T_{20} - temperatures of 5, 10 and 20% of mass loss; $T_{v\ max}$ – temperature at which the speed of loss of mass of an exemplar is maximum; T_{ex} - temperature at which the exothermic peak corresponding to a depolymerization is observed.

Fig. 7 shows that contours of all curves "weight loss – temperature" are similar, i.e. dissolution of filled PPS occurs like the one of unfilled PPS. At the first stage gradual mass decrease (2-4%) by dehydration is observed for all studied materials in temperature range 250-350°C, at the same time one may observe smooth curve running DTA without significant changes (fig. 8). Intensive destruction of both initial PPS and CP on its base followed by significant mass weight can be observed in range 500-558°C. On the DTA curves in this area narrow intensive peaks at high temperatures (551-558°C) are observed which characterize thermal material destruction (fig. 8).



a) **b)**

Fig. 7: *Curves of a thermogravimetric analysis (a, b) polyphenylene sulfide (1) and CP on its basis, containing 5(2), 10 (3), 15 (4) and 20 (5) mass. % of CF "Toreyka"*



a) **b)**

Fig. 8: *Curves of a differential thermogravimetric analysis (a, b) polyphenylene sulfide (1) and carbon plastics on its basis, containing 5 (2), 10 (3), 15 (4) and 20 (5) mass. % of CF "Toreyka"*

6. CONCLUSION

As a result of conducted experiments was found that reinforcement of polymer bind with carbon fiber almost doesn't change thermo-resistance of the initial bind, only in a case of 5-10 mass. % its insignificant rising is observed.

IR-spectrum analysis showed that between polyphenylene sulfide bind and carbon fiber “Toreyka” there are interaction of weakening impact type of SO- and SO_2-groups on proper benzene nucleus and strengthening of intermolecular and interpolymer hydrogen connections;

It was discovered that in injection of 15-20 mass.% of carbon fiber in PPS one may observe significant rise of compression strength, in 1,5-1,7 times. As to elastic modulus, it increases only in 5-15 mass. % filling, further it starts to decrease.

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ATTRIBUTIONAL VERSUS CONSEQUENTIONAL LIFE CYCLE ASSESSMENT MODELLING IN METALWORKING PRODUCTION SYSTEM

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ABSTRACT
Two different system modelling can be distinguished in life cycle assessment: attributional and consequential. Attributional modelling is used to describe the present state of the examined system and is characterised with use of allocation, no substitutions, market average suppliers, and cut-off principle. Consequential modelling is used to describe the consequences of changes in the demand within the system and use of substitutions, marginal suppliers, and system expansion. Although the ISO 14040 standard does not make a clear distinction between attributional and consequential modelling, it does provide basic instructions on how to deal with allocations and supports both types of modelling systems. Therefore, it is important to specify within the goal and scope of life cycle assessment study which modelling is used. This research applies attributional and consequential modelling in life cycle assessment to analyse a case of metalworking production system. The aim of research is to identify if the application of different system models can lead to different conclusions and interpretation of life cycle assessment results. The obtained environmental impacts from life cycle assessment show that two system models provide different results. However the choice which one to use depends on: if investigation has to separate the product from the rest of technosphere and environment, if inputs and outputs need to be attributed to the functional unit, or if there is need for comparative analysis of products and focus on the long-term effect of the changes.
Keywords: attributional modelling, consequential modelling, life cycle assessment, environmental impact

1. INTRODUCTION

Life cycle assessment (LCA) is a comprehensive tool for evaluation of environmental impacts in all product and process life cycle stages [1]. Despite the fact that LCA takes the entire life cycle into account, still many assumptions and methodological choices have to be made throughout a study, which can lead to different outcomes [2]. The ISO 14040 [3] standard does not make a clear distinction between attributional and consequential LCA modelling (ALCA and CLCA), but it provides basic rules how the allocations in LCA should be performed. Therefore, it is important to specify in goal and scope of LCA study if ALCA or CLCA modelling is used. One of the first publicly published documents where ALCA and CLCA are being distinguished is Curran et al., 2005 [4]. ALCA, also called "accounting", "retrospective", or "descriptive", evaluates the system as it is or was. On the other side, CLCA focuses on the consequences of changes in the demand within the system. Table 1 provides description and general differences between the ALCA and CLCA.
The International Reference Life Cycle Data System (ILCD) handbook [5], developed by the European Joint Research Centre, is one of the frequently cited documents in field of LCA. This

handbook, which comprises several volumes, provides guidelines on how to perform LCA. ILCD handbook also defines ALCA and CLCA, however, recent research by [6] showed that it needs revision as some guidelines are found to be inconsistent with previous research on ALCA and CLCA. According to research presented in [7], changes to attributional systems have consequences beyond the system boundaries, i.e. in the parts that have been allocated away, or made less important through averaging.

Ecoinvent, one of the most used LCI databases, since version 3.0, contains three model systems that correspond to ALCA and CLCA [8], namely: cut-off, allocation at the point of substitution, and consequential. These system models describe how activity datasets are linked to form product systems. Within these system models ALCA [8] can be divided into:

- value chain (economic or revenue allocation) - where a producer is fully responsible for the disposal of its wastes, and that he does not receive any credit for the provision of any recyclable materials;
- supply chain (mass allocation) attributional approach in which burdens are attributed proportionally to specific processes.

Table 1. Description of the ALCA and CLCA

ALCA	CLCA	Reference
Attributional LCI aims to answer how are environmentally things (pollutants, resources, and exchanges among processes) flowing within the chosen temporal window.	Consequential LCI aims to answer how will flows change in response to decisions.	[4]
System modelling approach in which inputs and outputs are attributed to the functional unit of a product system by linking and/or partitioning the unit processes of the system according to a normative rule.	System modelling approach in which activities in a product system are linked so that activities are included in the product system to the extent that they are expected to change as a consequence of a change in demand for the functional unit.	[9]
Economic, revenue or mass allocation; Average suppliers; No specific requirements to the functional unit; Market averages - Current relative production volumes of suppliers.	System expansion; Substitution; Functional unit reflects the conditions for substitution; Marginal, unconstrained suppliers - modern, competitive suppliers, when the product demand is generally increasing, old, uncompetitive suppliers, when the product demand is generally decreasing.	[7]
LCI modelling frame that inventories the inputs and output flows of all processes of a system as they occur. Modelling process along an existing supply-chain is of this type.	LCI modelling principle that identifies and models all processes in the background system of a system in consequence of decisions made in the foreground system.	[5]

There is a increased number of researches that involve comparison of ALCA and CLCA. Buyle et al. [2] performed a screening LCA of an apartment with ALCA and CLCA approach in order to identify and compare possible differences in results between the two approaches when applied on the same case. Their results showed that there is a shift of proportion between the environmental impacts per life cycle phases. Kua et al. [10] used ALCA and CLCA to evaluate and compare substitution of concrete with bricks on Singapore case study. Their results showed that for ALCA approach, the environmental impacts of replacing concrete with bricks may be increased, while using a CLCA approach, replacing concrete with bricks may result in small reduction of GWP. Parajuli et al. [11] evaluated environmental impacts of producing bioethanol and bio based lactic acid from standalone and integrated biorefineries using ALCA and CLCA. They concluded that for producing bio based products from an integrated system ALCA and CLCA approaches had similar impact pattern for most

of the impact categories. In general, ALCA is more used than CLCA modelling, but one of the problems that occurs in some studies is that it is not defined if ALCA or CLCA is used.
Previously discussed show that LCA community has increased interest in distinguishing the ALCA and CLCA modelling choices. Following this trend, this investigation applies ALCA and CLCA modelling in order to analyse a case of metalworking production system. The aim of the research is to identify if two system models can lead to different conclusions and interpretation of LCA results.

2. MATERIALS AND METHODS

Differences between ALCA and CLCA modelling will be shown on simple example with production of aluminium parts by milling. In this example joint production of A and B products is investigated. The functional unit is defined as production of one kilogram of product A that is made from aluminium alloy. System boundaries for ALCA and CLCA are different and shown in figures 1 and 2. The use of workshop building, milling machine, cooling fluid, and other consumables is not considered in system boundaries because of the negligible environmental impact.

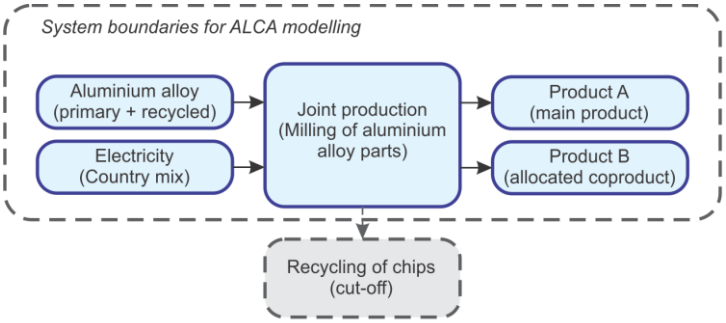

Figure 1. System boundaries for ALCA modelling

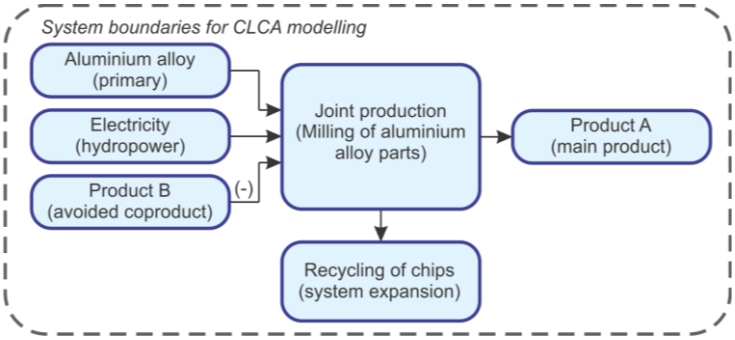

Figure 2. System boundaries for CLCA modelling

In ALCA modelling aluminium alloy is produced from primary (virgin) aluminium, and recycled aluminium. Electricity needed for production is from country mix that consists of electricity mainly from burning of lignite in power plants (66%) and hydropower (32%). Mass allocation was used for allocating the environmental impact between the products A and B. Recycling of waste chips is not included in ALCA modelling because of cut-off criteria.
Situation with increase in demand for product A where average supplier cannot satisfy the increase in demand is considered in CLCA modelling. Therefore, increase in demand for product A is compensated with marginal suppliers of aluminium alloy and electricity. In consequence of increased demand, only primary aluminium is used for production of aluminium alloy and hydropower is used instead of country mix. System expansion was used for allocation of environmental impacts between the products A and B. Recycling of waste chips is included in CLCA modelling because of system expansion.
Inventory for ALCA and CLCA modelling of aluminium parts production is shown in tables 2 and 3.

Table 2. Inventory for ALCA modelling of aluminium parts production

Activity	Name of the activity in Ecoinvent database	Amount	Note
Input flows			
Aluminium	Aluminium, cast alloy {GLO}| market for | Alloc Def, S	1.62 kg	1 kg (A product) + 0.5 kg (B product) + 0.12 (metal chips from milling 8%)
Electricity	Electricity, medium voltage {RS}| market for | Alloc Def, S	0.036 kWh	0.3 kWh is consumed for removal of 1 kg of metal chips
Output flows			
Product A	-	1.0 kg	Main product
Product B	-	0.5 kg	Environmental impact of coproduct is allocated with mass allocation

Table 3. Inventory for CLCA modelling of aluminium parts production

Activity	Name of the activity in Ecoinvent database	Amount	Note
Input flows			
Aluminium	Aluminium, cast alloy {GLO}| market for | Conseq, U	1.62 kg	1 kg (A product) + 0.5 kg (B product) + 0.12 (metal chips from milling 8%)
Electricity	Electricity, high voltage {RS}| electricity production, hydro, reservoir, alpine region | Conseq, S	0.036 kWh	0.3 kWh is consumed for removal of 1 kg of metal chips
Output flows			
Product A	-	1.0 kg	Main product
Product B	Product A (Avoided)	0.5 kg	Coproduct is avoided product with positive impact on the environment
Aluminium recycling	Aluminium, primary, ingot {GLO}| market for | Conseq, S	0.12 kg	Avoided product with positive impact on the environment

For life cycle impact assessment (LCIA) ReCiPe midpoint method was used [12]. ReCiPe expresses environmental impacts through the following 18 midpoint impact categories: climate change, terrestrial acidification, freshwater eutrophication, human toxicity, photochemical oxidant formation, particulate matter formation, freshwater ecotoxicity, marine ecotoxicity, natural land transformation, metal depletion, fossil depletion, ozone depletion, marine eutrophication, terrestrial ecotoxicity, ionising radiation, agricultural land occupation, urban land occupation, and water depletion. For purpose of investigation of differences between the ALCA and CLCA, and simplification of interpretation, only the results from climate change midpoint impact category will be analysed as climate change is most used as a single environmental indicator on midpoint level.

3. RESULTS

The results from ReCiPe midpoint method for climate change midpoint impact category are shown in figures 3 and 4 for ALCA and CLCA modelling.

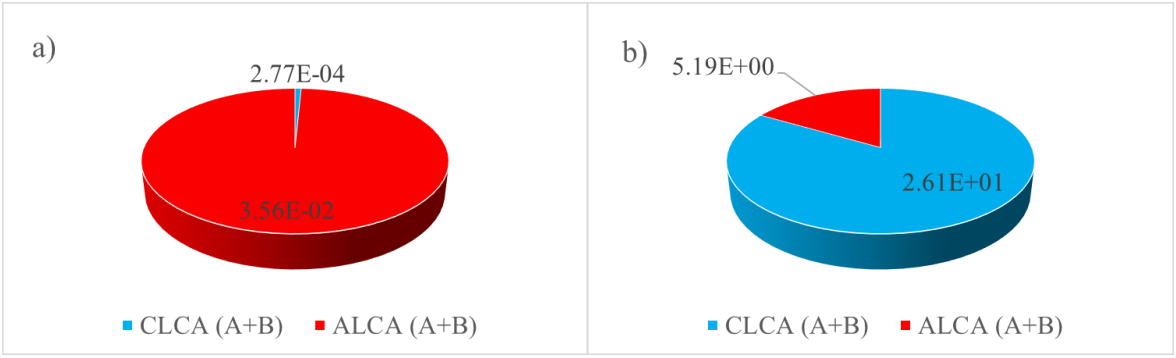

Figure 3. Impact on climate change in kg of CO_2 eq. for: a) consumption of electricity for joint production of products A and B, b) consumption of aluminium alloy for joint production of products A and B

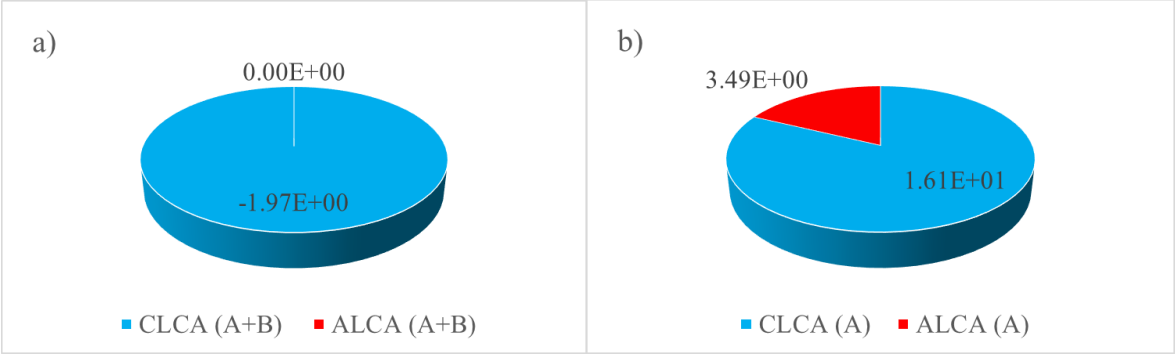

Figure 4. Impact on climate change in kg of CO_2 eq. for: a) Recycling of aluminium for joint production of products A and B, b) product A

4. DISCUSSION

As can be expected, ALCA and CLCA modelling provide different results (figure 4b). Although the environmental impact of electricity consumption for joint production of A and B products is much lower than the impact of aluminium consumption, the difference between results from ALCA and CLCA (figure 3a) is more than 100 times (2.77E-04 versus 3.56E-02). Reason for such results lies in the different source of electricity. The electricity in ALCA is from Serbian electricity mix, while the electricity used in CLCA is only from hydropower which is the cleaner energy source. The main differences in results of two modelling approaches are related to consumption of aluminium alloy (figure 3b). Considering the fact that use of virgin material has larger impact on the environment, aluminium alloy in CLCA modelling had larger environmental impact (5.19E+00 kg CO_2 eq.). Here one can easily see the difference between the two modelling approaches in Ecoinvent 3 LCI database where activity "Aluminium, cast alloy {GLO}| market for | Conseq, U" uses primary aluminium (marginal supplier) while activity "Aluminium, cast alloy {GLO}| market for | Alloc Def, S" uses primary and recycled aluminium (average supplier) for production of aluminium alloy. In ALCA modelling mass allocation was applied and result is same as in CLCA modelling where system expansion was applied with use of negative flows of product B (figure 2). If economic (revenue) allocation was applied instead of mass allocation, different results could occur. Including the recycling of aluminium chips in CLCA modelling provides environmental benefit (figure 4a). On the other side, recycling is excluded in the system boundaries of ALCA and therefore in CLCA benefits from recycling of aluminium for joint production of products A and B are -1.97E+00 kg CO_2 eq. Finally, when environmental impacts of product B are allocated, the product A generates impact on climate change of 3.49E+00 kg CO_2 eq. for CLCA, and 1.61E+01 kg CO_2 eq. for ALCA (figure 4b). Another point of interest would be different modelling of coproduct B flow. In general, for this example, results from CLCA produce larger environmental loading then ALCA.

5. CONCLUSIONS

This research represents an attempt to draw attention to differences between the ALCA and CLCA modelling where significantly different results can occur. Therefore, it is very important to address the modelling choice in goal and scope of LCA because it will impact the choice of activities in LCI, allocation rules, and finally, obtained LCA results. The main differences between the ALCA and CLCA can be identified as following: differences in activities included in within the system boundaries, differences in activities from Ecoinvent LCI database, differences in linking the activities within the system boundaries. It can be concluded that the choice which one to use depends on following: if investigation has to separate the product from the rest of technosphere and environment, if inputs and outputs need to be attributed to the functional unit, or if there is need for comparative analysis of products and focus on the long-term effect of the changes. Direction for future research is that experts in field of LCA should focus their efforts towards development of international guide for ALCA and CLCA. The new guide for ALCA and CLCA should be compatible with present ISO 14040 standard, gather proven findings of previous research, include all possible situations of ALCA and CLCA modelling, and it has to define how practitioners should select whether ALCA or CLCA is the right choice.

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THE DEVELOPMENT AND THE USE OF THE BALL BEARINGS WITH THE ANTIFRICTIONAL PROTECTIVE LAYER FROM POLYMERIC COMPOSITE MATERIAL

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Abstract

The presented article deals with the issues of environmental safety since the annual consumption of oils in the world is about 50 million tons of which only a quarter are reused, are disposed of or at least burned, the rest is merged into water bodies, soil, sewage, and is dispersed in the atmosphere. By estimates of ecologists more than 40% of the world's water is covered with a film of used oils. The purpose of the work was to develop a lubricant for rolling bearings that would not require replacement during the entire service life, and also withstand high temperatures of up to 250 °C while being environmentally safe. As a result of the work, it was proved that the use of a protective polymer layer based on polytetrafluoroethylene and antifriction fillers in ball bearings ensures a 1.7 to 3.5-fold increase in the durability of the products, prevents jamming of the ball, and also eliminates the use of lubricants that pollute the environment.

Keywords: *polytetrafluoroethylene (PTFE), bearings, oil, litol, cup grease, graphite, disulfide of molybdenum, polymers.*

1. Introduction

Machines and mechanisms have been playing an important role in human life for a long time already. But the problem with wear in frictional units still remains, beginning from the first mechanisms, which were made of wood, and till the present ones, which are developed by means of computer modeling with the use of modern composite materials (metals, polymers).

We use different liquid (oil), plastic (cup grease, LITOL) or solid (graphite) lubrication agents for reduction of wear and decrease of friction forces.

Lubricants can leak getting into the ground and polluting the environment. Also there are troubles with utilization or processing of lubricants after the termination of service life.

2. The problems of utilization of the fulfilled oils

About 50 million tons of engine oils are consumed all over the world every year, but only a quarter from them is reprocessed, utilized or at least burned. The rest is merged in reservoirs, the soil, the sewerage; it's sprayed in the atmosphere. A huge environmental problem concerns each of us. Because the fulfilled oils (transmission, engine, hydraulic, industrial, etc.), which get into the environment, pose a great danger for a human health [1].

By estimates of ecologists more than 40% of the water surface in the world is covered with a slick of the fulfilled oils. There is another one unpleasant detail besides the poisonous properties of the fulfilled engine oils: they are also dangerous, because such liquid represents the favorable environment for reproduction of bacteria. Utilization of the fulfilled mineral and synthetic oils is a big problem. High-quality and safe utilization demands some investments. It requires forces, time, and finance. Most of manufacturers prefer just merge the fulfilled hydraulic, industrial, and engine oils in reservoirs or leave them on the dumps instead of appeal to the special processing companies [2].

A large amount of lubricants is used for greasing of rolling bearings (see fig. 1). 90% of them are plastic lubricants which, unlike oils, aren't reprocessed and are just dumped or burned.

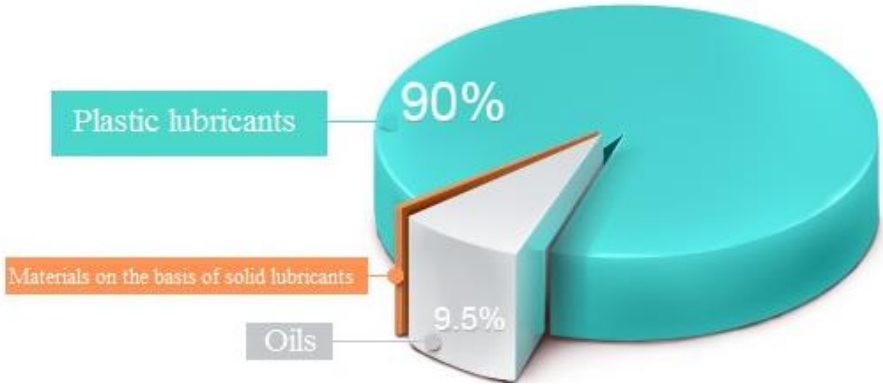

Fig. 1: The use of lubricants for greasing of rolling bearings

Taking into account the above, the purpose of this work has been consisted in development of the lubricant for rolling bearings which wouldn't demand replacement throughout all term of exploitation and also could withstand high temperatures to 250°C.

In light of the above, only solid lubricants were suitable for the solution of the objective.

Graphite, disulfide of molybdenum and tungsten, and polytetrafluoroethylene usually act as solid lubricants in the world practice.

Graphite has good lubricant ability under atmospheric conditions. Its coefficient of friction increases at the high temperature, however, the coefficient of friction decreases to value under normal conditions at a temperature over 427 ºC (f = 0,25). It is also important to say that graphite loses lubricant ability and both chemical and radiation stability at high vacuum.

The disulfide of molybdenum MoS_2 has good lubricant properties under atmospheric conditions and at a temperature up to 450 ºC. It saves them at high vacuum, in hydrogen or in the environment of inert gas up to the temperature of 1100 ºC too. The friction coefficient (f = 0,05) decreases at elevated pressure. This material differs in firmness against chemical and radioactive influence, has good adhesive ability in relation to the majority of metals that provides his economical expense.

The disulfide of tungsten WS_2 has properties like a molybdenum disulfide has. It differs in good lubricant properties up to the temperature of 510 ºC at the normal atmosphere.

Firmness of lubricant increases up to the temperature of 1300 ºC in vacuum and in the environment of inert gases.

Politetraftoretilen PTFE is used as dry lubricant at temperatures up to 200... 300 ºC. It has a lower friction coefficient than inorganic lubricants have. In addition, it has very high stability against a hostile environment [3].

Choosing the material of protection we always pay attention to its antifrictional and physicomechanical properties, thermal stability, resistance to a hostile environment, and technological effectiveness of processing.

Analyzing the listed above lubricating materials, we have developed bearings with antifrictional filler (AFF) on the basis of PTFE, and we've put them into exploitation. They are filled with carbon fiber Ural and are as high-quality as world brands are, at the same time they're much cheaper.

It is possible to draw the following conclusions on the basis of the conducted researches and production tests of bearings of the developed design:

- bearings with protection on the basis of PTFE, which are reinforced with CF, can withstand heavy dynamic loadings in process of long work at a temperature up to 270 and for a short-term to 370 °C;
- the time of running-in and final torque in the bearing increases with increase of percentage of fiber from 10 to 40 masses. %, which is independent of its type;
- experimental bearings have 1,8-3 times higher durability than serial bearings with classical lubricant have [4];
- lubricant keeps the properties and doesn't demand replacement throughout all service life of the bearing.

Table 1 Influence of content of carbon fiber on properties of carbon fiber reinforced plastic on the basis of a politetraftoretilen.

Table 1: Content of carbon fiber on properties of carbon fiber reinforced plastic on the basis of a politetraftoretilen

Content of CF, %.	Coefficient of friction	Impact strength, kJ/m^2	Compressive strength, MPa	Vicat softening temperature, K
PTFE	0,4	40	26	303
5	0,25	32	50	341
10	0,18	26	64	370
15	0,16	20	76	396
20	0,17	16	82	417
25	0,16	13	84	431
30	0,15	10	83	439
35	0,14	8	76	441
40	0,13	7	64	439

Bearings with antifrictional filler (AFF) have shown good results in tests in agricultural and metallurgical industry of Ukraine [3].

Bearings with AFF № 62203-2RS and 62204-2RS have been installed on disk coulters for seeders of KINZE-7600 and MF 543 (see fig. 2).

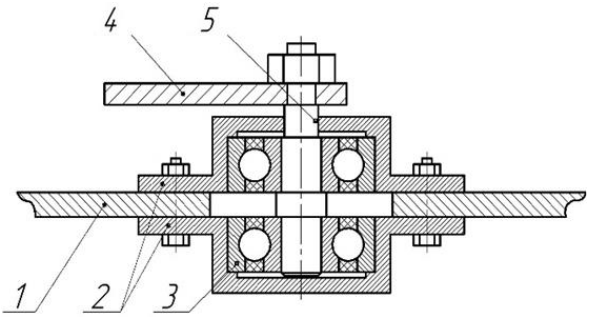

Fig. 2: Section of bearing knot: 1 –hiller; 2 –cover; 3 –bearing with AFF; 4 –holder; 5 –axis.

The Seeder MF 543, which had been completed with experimental details, passed field tests in CJSC "Agro-Soyuz".

During tests the seeder seeded 600 hectares of grain, failure of experimental details wasn't observed, and also durability of ball-bearings was 1,8-3 times higher in comparison with standard.

In metallurgy bearings have found application in the running rollers of caking trolleys (fig. 3), in the equipment of the agglomerative and burning cars.

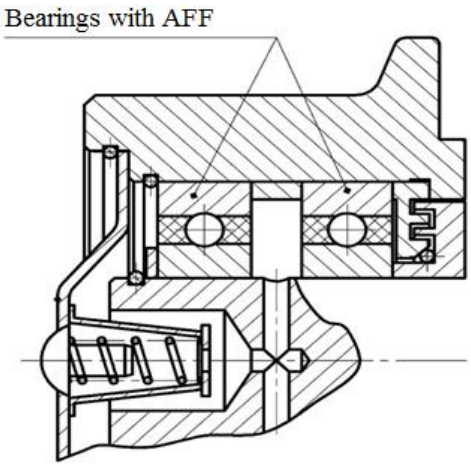

Fig. 3: Running roller of the caking trolleys

Trolleys work at temperatures about 200 ºC, and even dustiness isn’t a problem. Our production has shown high reliability in such conditions.

Our filler has found also the place in modernization of inch bearings R24Z which are used on the line of galvanizing of a wire.

Ball-bearings have been installed on rollers after galvanic bathtubs (fig. 4) which work in the conditions of the increased humidity and contact to alkaline solution that leads to lubricant washing away, corrosion and then to the jamming of the bearing. Installation of the ball-bearing with AFF has considerably increased an operating period and has reduced the cost of service of the line [5].

Thus, as a result of the conducted researches and natural tests, the following conclusions are established: using of a protective polymeric layer on the basis of a politetraftoretilen and antifrictional fillers in ball-bearings provides an increasing of durability of products by 1,7-3,5 times, excludes the jamming of a ball, and also excludes use of the lubricants which pollute the environment.

Fig. 4: Installation site of bearings R24Z

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RECYCLING OF POLYMER MATERIALS: TECHNOLOGY, ECONOMY, ECOLOGY

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ABSTRACT
Special attention in the world is paid to environmental problems, the need to maintain the state of the environment in relatively prosperous conditions in relation to human health. The aim of the study is to study the state of recycling of polymeric materials, the development of technological proposals, economic and environmental content, aimed at solving the problem of sustainable development. The object of scientific research is the processing of industrial and domestic solid waste. The theoretical basis of the study are the key concepts of economics, ecology, and also the rheology of polymers, chemical engineering, conceptual approaches to the study of the problems of globalization, sustainable development. The methodological basis for the study of selected issues was an integrated approach to technology issues, the assessment of the ecological and economic efficiency of polymer recycling, as well as general scientific and special methods of scientific knowledge. The article discusses the development trends of the chemical industry, the state and prospects for the production of polymeric materials. Attention is drawn to the excessive accumulation of waste materials from plastics on the planet, which represents a global environmental problem. It emphasizes the need to take effective measures to prevent further large-scale pollution of the environment with waste polymers. As one of the solutions to the urgent problem, the authors set out the technical and technological features of recycling synthetic plastics waste by extrusion. Recommendations for improving the ecological and economic efficiency of polymer recycling using public-private partnership as an effective mechanism for solving a pressing problem are proposed.

Keywords: *recycling, polymeric materials, technological innovations, ecology, economics*

1. INTRODUCTION

From the first days of the UN functioning, special attention is paid in its activity to the problems of ecology, the need not to worsen the state of the environment, but at least to support it in conditions that are relatively healthy in relation to human health. In 2015 World leaders with the participation of heads of state and government of many countries approved the Sustainable Development Agenda for the period 2016-2030. In the final document "Transformation of our world: an agenda for sustainable development for the period until 2030", 17 global sustainable development goals (SDG) and 169 relevant tasks were approved, which more fully reveal the essence of the formulated goals [1], [2].

From the standpoint of the subject of our study, we will draw attention to 2 of the 17 goals for future international cooperation in their close relationship. First, a task is formulated aimed at the development of industry, the introduction of innovations and the creation of a sustainable infrastructure (goal 9). Secondly, the achievement of the previous goal, undoubtedly, should result in full and productive employment of everyone, in every possible way to promote economic growth (goal 8). Thirdly, the previous two goals of technological and economic nature should not conflict with the objectives of the environmental direction (Fig. 1).

Technological, environmental and economic problems of recycling of secondary raw materials are reflected both in the UN documents, and economic unions (for example, the EU), various international organizations, as well as at the level of legislative and executive power of each and every state. In

Ukraine, this issue is also given special attention, as witnessed by such documents as the Law of Ukraine on Waste; order of the government on the National Waste Management Strategy until 2030; on the introduction of a system for collecting, sorting, transporting, processing and recycling of secondary raw materials, etc. [3].
Taking into account the intentions proclaimed by the UN "to save mankind from poverty and" to heal "the planet," we will formulate the goals, tasks, methodology, object and subject of our research. So, the goal of the study is to study the state of secondary processing of polymer materials in the world and in Ukraine, and to develop proposals for technological, economic and environmental content aimed at addressing the problem of sustainable development.

Fig. 1: Pollution of the planet by plastic is threatening [4]

Object of the study: the process of processing industrial and household solid waste. *The subject* of the research: a set of theoretical, scientific and methodological approaches and practical recommendations of a technological, economic and environmental nature regarding the secondary processing of polymer materials for their further use in industry and households. *The theoretical basis* of the study is the key provisions of economic science, ecology, as well as rheology of polymers, chemical engineering, conceptual approaches to the study of problems of geopolitics, globalization, sustainable development (sociology, economics and ecology). *The methodological basis* for studying selected issues has been a comprehensive approach to technology issues, assessing the environmental and economic efficiency of secondary polymer processing, as well as general scientific and special methods of scientific knowledge. The official materials of the United Nations, the EU, the IMF, the CIA, WHO, ILO, the State Statistics Service of Ukraine and the National Bank of Ukraine became an important help in the study of the problem under consideration. Consideration of the problem of secondary processing of polymeric materials from the standpoint of technology, economics and ecology, as well as the search for possible and effective ways to solve them, many foreign and domestic researchers pay attention to.
Topical issues of ecology and economics related to the processing of waste from polymeric materials in the world, the EU and in Ukraine are also reflected in the results of ongoing research (monographs, textbooks, articles, etc.). The introduction of the article will be concluded by the fact that one of its authors has a professional attitude to the problem in question from the mid-1960s onwards, from the historical period of "chemicalization" of the national economy, when the production of polymer materials on a large scale was just beginning in the world, and in Ukraine [5]. In this regard, an attempt is made to analyze the retrospective and prospects for the production, use and disposal of polymers at all stages of their life cycle.

2. POLLUTION OF THE PLANET WITH WASTE POLYMERIC MATERIALS AS A GLOBAL PROBLEM OF MANKIND

The development of civilization is inextricably accompanied by the development of science and technology. A special place is occupied by the chemical industry and in its composition – the production of polymeric materials. We are talking about the production of synthetic rubber, synthetic resins and plastics, as well as chemical fibers and their further processing for the needs of the industrial sector and widespread use in everyday life. Suffice it to recall that the development of the automobile industry is primarily due to the creation (G. Bushard, France, 1879) and further extensive use of synthetic rubber for tire production.

The main fields of polymer consumption are packaging and packaging (40%), construction (21%), automotive industry (8%), electronics (5%), aerospace, shipbuilding, transport and communications, light and food industry, technology, etc. (26%). Products and parts made of polyethylene (35%), polypropylene (25%), polyvinyl chloride (11%), polystyrene-6.5%, polyethylene terephthalate (6.5%) and polyurethane (7%) were the most widely used in the world production of polymer materials.

The production of polymeric materials in the world is developing quite dynamically: from 2.3 million tons in 1950, 162.0 million tons in 1993, and 448.0 million tons in 2015. Over the past 50-70 years, significant changes have occurred in the regional structure of the production of polymer materials. If in the beginning of the 50s of the last century the leaders in the production of polymers in the world were the USA and Canada (43% of the global output) and Western Europe (37%), then as of 2013. Leading positions are occupied by the countries of Asia (45,6%), EU (22,9%), North America (19,4%). The output of polymers in the countries of the Middle East and Africa is 7.3% of the world indices, South America – 4.8%. Among the countries producing plastics, China, the USA, Germany, Japan, as well as Belgium and the Republic of Korea are leaders.

The world's largest plastic companies are: Royal Dutch Shell (Netherlands), ExxonMobil Corporation (USA), Sinopec Corporation (China), Bayer (Germany), SABIC (Saudi Arabia), BASF SE (Germany), Dow Chemical Company (USA), Lyondell Basell Industries (USA, Netherlands), DuPont (USA) and Braskem (Brazil) [6].

According to the journal Science Advances, for the period 1950-2015 in the world produced 8.3 billion tons of products made of polymer materials. Half of this volume was produced in the first 15 years of the present 21st century. Polymers increasingly replace in the industry and household items made of metal, wood, etc., due to many advantages (strength, wear resistance, durability, non-adherence to corrosion, etc.). The volume of world production of polymers annually increases by 8.4%.

Against the backdrop of the enormous economic advantages of using an increasing volume of production of plastics and products from them, the world is gradually, step by step, approaching the ecological catastrophe associated with the huge accumulation of plastic waste. Unfortunately, almost the vast majorities of the world's population, after consuming plastic products, throws them out or replace them. If you do not change the attitude of the producer and the consumer to the collection and further processing of waste, then by 2100 their accumulation will approach the level of 11 million tons per day. Such volumes are three times higher than the current value. Experts predict that the greatest amount of waste, taking into account population growth rates and increased consumption, will be accumulated in the countries of the African continent to the south of the Sahara.

By the year 2050 the earth's surface can become contaminated with 12 billion tons of plastic debris, if the attitude to waste in general and to plastic waste, in particular, does not change. Most of the accumulated polymer waste (6.3 billion or 79%) was found in landfills and in reservoirs. According to the "WorldWatch Institute", annually from 9 to 18 million tons of plastic fall into the World Ocean. Every inhabitant of the planet now accounts for about 1 ton of waste.

Waste from plastics cause serious damage to the environment. It should be noted that the vast majority of plastic products are not classified as biodegradable materials. Because of the debris accumulated in rivers and lakes, seas and oceans, on the terrestrial surface, both flora and fauna suffer [7]. Projects for cleaning nets, robots, lasers, etc. are already being developed space debris, the total weight of which around the planet reaches more than 7 thousand tons. In many countries and regions, measures are being taken to reduce environmental pollution and include activities aimed at reducing the consumption of polymer products. Conditions of normative, organizational and incentive nature are created, aimed at collection and further processing of wastes for their disposal.

The Center for Environmental Policy and Law at Yale University (Yale Center for Environmental Law and Policy) in 2018 presented the next results of a global study of the world in terms of environmental performance (The Environmental Performance Index 2018). This index provides an opportunity to assess the achievements of countries around the world in relation to the state of ecology and natural resources management on the basis of processing 24 indicators in 10 categories. These indicators provide an objective picture of economic activity and its impact on the environment, the viability of its ecological systems, the conservation of biological diversity, the counteraction to climate change, the health status of the population, and the effectiveness of state policy in the field of ecology.
Out of 180 countries, the top ten leaders included Switzerland, France, Denmark, Malta, Sweden, the United Kingdom, Luxembourg, Austria, Ireland and Finland. Ukraine occupies the 109th place in the world rating. In 2018 the value of the index of Ukraine was 52.87 points. Of the 10 main categories, the worst indicator is the one that indicates large-scale loss of forest cover in the country due to unauthorized cutting in the Carpathians and other regions (14.08). The situation is not better in the category "climate change and energy" (37.59), "air pollution" (40.18), "biodiversity and habitat" (49.10), etc. [8].
Of particular concern is the presence of 6,500 registered and more than 35,000 spontaneous dumps. They occupy an area of more than 43 thousand square km (7% of the territory). More than 54 million cubic meters have already accumulated in Ukraine meters of waste (more than 12 billion tons). Annually 15-17 million tons of waste is exported to landfills, and only about 5% of them are spent for processing or incineration. The question of a well-functioning system for the collection and processing of secondary raw materials from polymers is under discussion. The existing plastic processing plants are under-utilized (by 40-60%) and largely operate on imported raw materials. It should be noted that in the EU, measures are being developed that foresee by 2030 to process the entire volume of packaging material after its use. Ukraine should also strive for this goal as an associate member of the EU.

3. COLLECTION, SORTING, TRANSPORTATION AND PRE-TREATMENT OF USED POLYMERIC MATERIALS FOR RECYCLING

Anyone who is involved in discovering new polymers or using the already known ones, including the final stage of their disposal, can not cover the solution of the problems that have arisen at all stages of the product life cycle (PLC). The initiator of novelties (innovator) can only write out methodical recommendations (projects, programs) for the development and use of innovation. The practical solution of all problems at all stages of the GPP should be within the competence of the power structures (legislative, executive and judicial), in the field of responsibility of all business process participants, and also each of us who are the end user of plastic products.
The state approach to the use of waste has a deep history, counted for centuries and millennia.
A comprehensive approach to planning and standardizing the level of collection and processing of the most important types of secondary raw materials was widely used in the country; incl. used products from polymers, with the development and implementation of appropriate targeted integrated programs (TIP). One of the mandatory requirements for developers of new types of materials or products was the requirement to develop technologies for processing end-of-life products and create the necessary capacity for the production of products from polymers and lines for the processing of polymer waste (LPPW).
At the same time, the economic side of the issue was taken into account, since collection and processing of polymer wastes was not a profitable process. The incurred "unprofitable" costs were included in the prime cost of the main products of enterprises, scientific and production associations (SPA) or industries / sub-industries. As a result, in the country the volumes of recycling of secondary raw materials grew more rapidly than the formation of waste from used plastic products.
It is pertinent to note that the mechanism of the expanded responsibility of the producer of the main products and products obtained as a result of secondary processing, developed in the country, was reflected in the relevant directives of the EU only 15-20 years later [5]. Unfortunately, during the period of "perestroika" a well-functioning mechanism of the state policy of recycling of polymer materials, its separate mechanisms did not improve, but liquidated. Important documents reflecting the

accumulated experience are not digitized. They are either lost or restricted. Today, the waste management system that has been developed for decades needs to be restored and improved taking into account the requirements of the time.

It should be noted that back in 1975, the EU Framework Directive 75/442 / EEU "On Waste" was adopted. The document stressed the need to create in each of the EU countries a structure responsible for implementing the provisions of the framework directive. Among the mandatory requirements were: the introduction of the "polluter pays" principle, the mandatory accounting and reporting of the number, types, sources of waste generation, etc. In the process of importance and necessity, additions and changes are made to the documents already adopted or new directives are approved.

Let us dwell on some possible and necessary actions of the manufacturer, intermediary, trade, final consumer, as well as other business structures and local authorities in ensuring environmentally friendly and economically profitable production and use of polymers.

Organization of research and development (R&D). Already at this stage, scientists, designers and technologists should have a schedule of actions at all stages of the GPP – from the idea to proven methods of utilizing used products. This is a one-time and multiple uses of polymers.

Production process for the production of plastic products. Manufacturers of plastic goods take care, above all, of their own profit. Various methods of advertising consumers are forced to buy more and more new products. However, few people are worried about discarded products in the landfill, where they can cause irreparable damage to the environment. The business sector must necessarily take responsibility for the recycling of used products. It is the producer (the production sector) that must monitor the movement of the goods produced by him through distribution channels (the sphere of exchange), through the sphere of consumption, in any place on the globe this commodity does not appear in the form of secondary raw materials.

A positive example of the recycling of own-produced waste is shown in Ukraine by Obolon Corporation. Back in 2003 the company invested UAH 10 million in a special innovative line for the recycling of PET waste. At one of the regional enterprises, more than 30 million units of used plastic bottles are processed annually for processing. About 10% of the volume of processing provides collection of used PET bottles on the territory of the regional enterprises of the company, and most of the raw materials are purchased from suppliers. During the period 2003-2016 the implementation of the innovative project allowed to ensure the recycling of more than 10.8 thousand tons of used PET bottles. Obolon demonstrates a successful business model with a closed production cycle: from ensuring the production of beverages for the consumer to processing the used PET packaging, and then manufacturing the same or new products [9].

Collection and sorting of secondary raw materials. In Germany, this process begins with six multi-colored containers installed in each yard for different types of solid household waste (SHW). In Italy there are three such containers. In Ukraine, calls for the creation of a network of ubiquitous MSW sorting have been sounding for many decades, but there have been no tangible changes in this issue. Although in 822 settlements of the country there is a separate collection of household waste, but this is only about 2.76% of their total number. Only in 20 settlements 25 rubbish sorting lines are set up, 6 of which are operated in Kiev.

In accordance with the Law of Ukraine "On Waste", responsibility for organizing separate collection, transportation and sorting of solid waste is on the local self-government bodies. Although from 01/01/2018 fines were imposed for unsorted garbage for business entities (from 850 to 1700 UAH), and for individuals (from 340 to 1360 UAH), however, the procedure for its collection is not worked out. The mechanism of the relationship between the industrial and environmental association of enterprises dealing with the waste of Ukrtvorma and local authorities regarding the sorting and processing of garbage is also not settled.

The mechanism of stimulating the collection and processing of secondary polymeric raw materials. In Germany, recycling of recycled materials is a fairly profitable business, which is engaged in both municipal and private enterprises. It employs more than 250 thousand employees. The annual turnover in the recycling industry is about 70 billion euros.

In Ukraine, recycling of secondary raw materials is a business with a high degree of risk. After all, for his organization, considerable expenses are required. They are associated with land leasing, purchase

of special equipment, installation of waste processing lines, pressing machines, containers, etc. In addition, for significant shifts in the collection of waste from plastic, there is a need to release their suppliers from VAT, as provided for collectors of waste paper. Such measures would make it possible to withdraw sufficient amounts of income from unregistered entities from the shadow business.
By creating in the state a mechanism of moral and material incentives for the collection, sorting and transportation of secondary raw materials, the next step can and should be punishment (penalty) for non-compliance with the adopted rules. An example can be the example of Kenya, where not only the ban on the use of plastic bags, but also imposed a penalty for its non-compliance. In case of further ignoring of the approved rules, more severe measures can be taken against the offender, up to imprisonment.

4. ORGANIZATION OF PROCESSES OF RECYCLING OF POLYMERIC MATERIALS BY EXTRUSION

In preparing this publication, our attention was drawn to the article by scientists from the Kazan Technological University, which noted the following: "The domestic complex line with a productivity of 115 kg / h has been developed for recycling polyethylene film waste, which includes waste grinding, compaction and subsequent granulation units. Crushing is carried out in a knife rotor crusher with a three-section rotor, after which the crushed waste is pneumatically conveyed through a metering feeder into a sealing cone-screw extruder with a granulating head and then after cooling it is cut into granules 3x4 mm in size. The compaction is carried out in extruders having vacuum suction zones, where the foaming agent and air are removed from the polymer waste in the melt. By adjusting the temperature of the extruder in the zones, throughput, vacuum, and also by repeated extrusion, it is possible to achieve complete removal of the volatile components from the extrudate, after which the granulate is subjected to grinding" [10].
We quoted this quotation for the simple reason that one of the authors of the publication of the [VG] proposed to the interested reader in 1975, (!?) directly participated in setting up one of the first lines in the country for recycling polyethylene film waste. The release of this line was preceded by the long-term work of the research team of UkrNIIplastmash (Kiev) under the supervision of the Doctor of Technical Sciences. V.A. Silina. The main goal of the research was to create a new type of high-performance extruder for processing thermoplastics into granules, pipes and sheets based on a cone-shaped plasticizer with a productivity of 200 kg / h. The most important direction of using the cone plasticizer (cone-screw extruder - CSE) was its use in the design of the line for processing waste polyethylene film. One of the first such lines was made at the Kiev scientific-production association (SPA) "Bolshevik" and installed at the Dorogomilovsk chemical plant (DCP) them. M.V. Frunze (Moscow). DCP was established in 1916 under the trusteeship of the Society of Russian Chemical Plants, and at present DCP is the central enterprise of the SPA "Plastic".
In the 70s of the XX century began the production of plastic film web width up to 12m. The task was to organize the recycling of polyethylene film waste on the principle of a closed cycle: "production - distribution - exchange - consumption - recycling". This is the essence of the concept of "recycling", i.e. repeated (twice, three times, etc.) use or return to circulation of industrial waste and / or household waste.
There are several classes or types of recycling: mechanical, hydrolysis, pyrolysis and incineration. In many ways, this or that type of recycling depends on the amount of recycling of used materials (products). With a mechanical method of processing, secondary raw materials are pre-treated (sorting, washing, drying). Then the crushing and feeding of raw materials into the bunker into the granulator (extruder) is carried out. The resulting melt of the plastic is cooled and granulated for further use already as an industrial raw material (Fig. 2).

Fig. 2: Line for processing in-dustrial and ho-usehold waste from plastic

The method of hydrolysis, like its variety – glycolysis, al-lows deploy-merization of plastic waste with aqueous-acid solutions under the influence of high temperature with the use of glycol and a set of catalysts. The scope of use of the raw materials obtained with this method is limited. In pyrolysis, the secondary raw material is heated in an inert medium. At the same time, raw materials gradually decompose into simple elements without access to oxygen, with the allocation of a large amount of energy, which can be used for the intended purpose. When using the incineration method, waste polymers are burned to produce thermal energy. Although this method can reduce the amount of collected waste, but its use in incineration plants requires high-cost technologies for cleaning toxic gases and carcinogens.

The most rational way of processing waste from plastic is mechanical recycling, which is carried out using the extrusion method. The line for processing secondary raw materials includes the following main elements (units): a crusher for grinding prepared (washing, drying) waste; bunker for loading of crushed raw materials; extruder; a head with a die (matrix); knives for cutting granules; cooling unit (bath); bunker for receiving finished products; remote control; power cabinet. The sequence of the main elements (aggregates) can vary with the variety of source material taken into account.

The productivity of the line for processing secondary raw materials from plastic depends primarily on the drive power, the diameter of the screw turns, the chemical and physical characteristics of the raw materials, etc. The technical characteristics of the remaining units are determined taking into account the characteristics of the extruder. The main working area of the polymer processing line is the extrusion zone. It is here that mixing, heating and degassing the melt of plastic occurs. The extrusion zone consists of the following main elements: body, auger, ceramic heating elements, actuator, as well as automation and control means, control panel. The inside of the extruder housing is a steel round cylinder. Above it there is an opening for feeding the material; with the end part there is provided a fastening of a spindle head. Extruder (granulator), if necessary, can be equipped with windows for the introduction of new components into the melt. The steel screw is in the housing inside the steel cylinder. The shape of the screw varies throughout the body, only the diameter of the turns remains unchanged. Ceramic heating elements cover the casing throughout its length.

Conditional housing is divided into 4 zones. In each of these zones, different technological operations occur due to a change in the screw configuration. In the feed zone, the raw material is stirred, heated and turned into a melt. In the dosing zone, the screw base is increased in order to pass a certain amount of material. In the vacuum degassing zone, the base of the shrine is reduced again, and air and other gases are removed through a special hole in the granulator body. In the compression zone, the melt is compressed before feeding into the spindle head.

The main item in the line is SHNEC. Why big letters? If all the details of the line (their hundreds of thousands) can be made in a few minutes-hours of shifts, then the making of a screw lasts about two months from special steel, with special high-precision equipment, high-class specialists (borers). The

worm is made from several types of high carbon alloy steel. Among the European manufacturers, the most commonly used for the production of screw is the alloy – SACM-645. The Russian and Chinese enterprises of chemical engineering use 38CrMoALA steel most often. A number of Chinese companies are popular with W6Mo5Cr4V2 high-speed steel. The so-called SKD-61 weaponry is the most resistant to wear, so it is fairly costly. To give the surface of the metal a due hardness (not less than 60 units on the HRC scale), it undergoes a stage of cementation by nitriding. As a result, steel acquires the required hardness to a depth of 0.5 to 1.0 mm, and the base remains "raw". The speed of the screw in different apparatus varies in the range from 50 to 500 rpm.

The granulator body is divided into heating zones. Each of these zones is served by a separate ceramic heating element. The heating temperature of each of the zones depends on the pressure of the screw, the type of polymeric material, the degree of its contamination, the dimensions of the plastic after the crusher, etc. For these reasons, in each particular case, the temperature should be set individually, during the adjustment of the equipment. For example, in the area of the outlet the raw material is recommended to be heated to 150-200 ° C. Particles of crushed secondary raw materials should not stick around the neck and stick to the screw. They should soften gradually and move further on the hull. In the next zone, the temperature rises to 50-80 ° C, bringing the starting material to the melting point.

In subsequent zones where homogenization, gas removal and compression occur, the temperature is set, which is lower by 10-15 ° C from the melting point of this type of polymer. It should be borne in mind that during spin rotation, the self-heating of the material occurs due to the resulting forces of friction and pressure. Based on our own experience, especially this phenomenon should be taken into account when operating a line based on a cone-screw extruder. The degree of heating is monitored using built-in temperature sensors. They are installed in different places along the length of the case and are connected with the controller and the control panel of the granulator. After adjusting the equipment, it will turn off the heaters in different zones by sensor signals so that the mixture does not overheat. The designs may include water cooling of the housing.

In the process of melting and compressing polymers in them various gases are formed. Unlike raw materials, gases tend to expand at the slightest opportunity. This, in turn, affects the shape and density of the final product. For this reason, before blowing through the spinner, air and other gases must be removed. For this purpose, at the end of the screw, a vacuum degassing zone is arranged. In this zone, the pressure is reduced by reducing the base of the shaft. The emitted gases leave the chamber through special openings. The body of the extruder (granulator) can provide structures for one or two screws (worms). In this case, the extruder is positioned in a horizontal position. CSE is placed vertically, which makes it possible to rationally use working areas with relatively small volumes of raw material processing.

Low cost extrusion lines are manufactured in China, Russia and Ukraine. In this case, the lines are completed with imported units. This concerns, above all, the auger. Metalworking equipment after the "restructuring" in Ukraine went into scrap metal. Making auger requires special grades of steel, high-class specialists do not qualify. The enterprises of chemical engineering either closed down, or their output decreased significantly. Their place in the domestic market was taken by a foreign manufacturer.

5. STRATEGIC WASTE MANAGEMENT

The world has accumulated a sufficient number of strategies, directives, resolutions, resolutions and other documents aimed at respecting man and society for respecting Mother Nature. With the adoption of the next strategic directive, the situation does not improve the planet, but, on the contrary, worsens. There are several key explanations. First, a person does not feel like a keeper of nature, but mostly a dependent. Secondly, the poorer part of the population (their majority) can not pay enough attention to saving the environment, and the rich part (the minority) does not want to divert its billions for these purposes. Thirdly, in the management system they have learned how to develop decisions, have mastered the procedures for their adoption, but not always the decisions made are implemented.

In Ukraine, the National Strategy for management of monies was adopted until 2030. It is supposed to apply a systematic approach to waste management at all levels of management, to increase the

volumes of their processing and re-use. The stages of the Strategy are defined. Among the intentions: improvement of legislation, introduction of innovations, attraction of investments, creation of necessary infrastructure, creation of 800 new capacities for processing of secondary raw materials, utilization and composting of biowaste, etc. During the planned period, it is planned to reduce the total volume of municipal waste disposal from 95% to 30%. Records of information on the nomenclature and quantity of waste at the stages of formation, processing, utilization and disposal will be adjusted. One of the important monitoring tools will be the creation of a National Register of Waste Generation Sources, capacities in the sphere of handling them and a system of reporting by all business entities involved in this process.

6. CONCLUSIONS AND RECOMMENDATIONS

The triad of sustainable development priorities (ecology, social progress, economy) is based on morality, on human education. Scientific and technological progress not only creates benefits for man, it creates problems associated with dishonest relations to these goods. The ecology deteriorates from the increase in the volumes of unprocessed wastes, including from the use of polymeric materials. The study actualizes the problem of secondary processing of plastic. Among the cardinal measures aimed at preserving the environment: reducing the population growth, reducing the inequality in the community, taking care of nature, ensuring the effective functioning of the human habitat, implementing an innovative model for handling waste and secondary resources, including polymers. Measures for the rational handling of secondary raw materials from plastic are proposed. The waste management system in the world and every country at the legislative level and in the executive bodies of power should function at all stages of the development, adoption and implementation of managerial, economic and engineering solutions. It is advisable to restore the practice of planning and managing waste management using targeted integrated programs. Effective should be a system of moral and material responsibility at all stages of production, consumption and disposal of waste to preserve the flora and fauna on our planet.

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USE OF ALTERNATIVE FUELS IN CEMENT PLANT LUKAVAC AS PIONEER PROJECT IN BOSNIA AND HERZEGOVINA

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ABSTRACT
The production of cement involves a combination of numerous raw materials, strictly monitored system processes, and temperatures on the order of 1500 °C. Immense quantities of fuel are required for the production of cement. Traditionally, energy from fossil fuels was solely relied upon for the production of cement. The overarching project objective is to evaluate the use of alternative fuels to lessen the dependence on non-renewable resources to produce portland cement. The key objective of using alternative fuels is to continue to produce high-quality cement while decreasing the use of non-renewable fuels and minimizing the impact on the environment. The use of alternative fuels to replace conventional fuels, in particular coal, is a widespread practice and can contribute to improving the global warming impact and total environmental footprint of the cement industry.

1. INTRODUCTION
In the production of cement, the cement industry uses millions of tones of waste as an alternative fuel and alternative raw material. This processing of waste while producing cement is commonly referred to as co-processing. Currently, there are considerable differences in co-processing rate across the EU, with the cement industry in some countries achieving a co-processing rate of only 7%, compared to 65% in others. The EU average is currently 41% [1].
Alternative fuels utilization in Bosnia and Herzegovina started in 2012 in Cement plant Lukavac. The usage of coal mud and used car tires in Cement plant Lukavac was the first attempt to reduce consumption of fossil fuels retaining the high level of product quality. With less then 10% total substitution rate in 2012 and up to 55% in 2018, Cement plant Lukavac have a constant growth. High substitution rate of energy achieved by alternative fuels ensure competitiveness on the cement market, decreasing of fossil fuel needs and provides opportunity for the higher level of waste management in local community and whole country.
The main part of fuel consumption, and consequently CO2 generation, takes place in the calciner and clinker forming kiln. The utilization of low-carbon content fuel with high hydrogen-to-carbon (H/C) ratio instead of conventional fossil fuels can remarkably diminish the rate of CO_2 emissions in the process [2].

2. MATERIALS AND METHODS

2.1 Types of alternative fuels in Cement plant Lukavac

Cement kilns use different sources of energy to produce the high temperatures necessary for the formation of clinker. The common sources of fuel for the clinker production in Cement plant Lukavac are: alternative fuels, coal, heavy oil, petroleum coke, and anthracite.

Alternative fuels are new source of energy used by cement producers around the world in recent history. These fuels are derived from the mixtures of industrial and municipal waste ant they are usually solid or liquid. In order to create efficient use of energy, alternative fuels are required to have an appropriate chemical and physical properties.
There are types of alternative fuels currently used in Cement plant Lukavac:

- Refuse-derived fuels (RDF): ≈17 MJ/kg (> 95% of total alternative fuels)
- Waste oil: ≈24 MJ/kg (< 2,5 % of total alternative fuels)
- Filter cake: ≈11 MJ/kg (< 2,5 % of total alternative fuels)

As shown, RDF is most common used alternative fuel in Cement plant Lukavac and around the world too.

2.2 Challenges of co-processing of RDF in cement kiln

Depending on the characteristics of the RDF and plant design, RDF can then be fed into the kiln or the preheater calciner in clinker production facility. It needs to be noted that certain constituents needs to be controlled continuously in order to avoid adverse impacts on the product quality, production processes and environment.

Most common issues regarding use of RDF are related to plant design, feeding systems, RDF particle size, calorific value, chlorine, moisture, mercury and trace elements content [3].

2.3 Lukavac cement kiln

In modern cement kiln systems there are two burning zones,one in the precalciner, where most of the carbonate in the raw meal is decomposed into calcium oxide and carbon dioxide, and another one in the rotary kiln outlet for clinker minerals formation. The precalciner, which operates at the lowest temperature (typically 850-900 °C), offers the greatest potential of using alternative fuels. Typical heat distribution rate in precalciner kiln systems, such as in Lukavac, is 60:40 precalciner:main burner.

Currently, Lukavac cement plan has possibility to utilize 54% of heat energy from RDF of total substitution rate thanks to the continuous investments in latest technologies. Inline calciner with material and fuels retention time more than 5,5 seconds secures complete combustion and proper heat exchange.

In order to get higher substitution rate new investments are required. New projects are utilization of RDF on main burner in the kiln and bypass dust extraction modification (high chlorine content dust).

2.4 RDF impact on alkali/sulphur ratio and process stability

Typical chemical problem that can occur in cement kilns when using RDF is high chlorine content. Correct process and chemical control can be provided by alkali/sulphur balance.

The alkali/sulphur ratio is used in two ways in kiln operation. The first is to measure if there is a molar balance between the total inputs of alkalis and sulphur contributed by all of the raw materials, fuels and AFR streams entering the kiln, the second is to measure the instantaneous molar alkali/sulphur balance in the kiln/preheater system (based on hot meal) [4].

Both use the same equation:

$$A/S = \frac{\left[(K2O/94) + (Na2O/62) - (Cl/71)\right]}{(SO3/80)} \qquad (1)$$

However, if there is little or no chloride in the raw material and fuel inputs to the kiln, the chloride component is often ignored when calculating the A/S ratio of the total inputs.

For hot meal though, chloride is always subtracted from the alkali molar total because alkali chlorides are far more volatile than alkali sulphates and recirculate within the kiln. (Over 98% of alkali chlorides (particularly KCl) are re-evaporated in the high temperature of the burning zone and return to the kiln inlet with the kiln gases where they condense on the incoming hot meal and continue to recycle.) Any K_2O or Na_2O tied up with the chlorides are therefore not considered in the A/S ratio calculation for hot meal.

The purpose of the hot meal A/S ratio is to predict the likelihood of alkali or sulphur related buildups in the kiln inlet. In particular, sudden decreases in this ratio can indicate lack of oxygen in the back end of the kiln and impending sulphur buildups. A high value indicates an excess of alkalis. The portion of the alkalis which do not combine with SO_3 to form sulphates will also recirculate in the kiln, increasing the potential for rings and preheater buildups.

When applied to the kiln material inputs, the alkali/sulphur ratio is used to manage raw material, fuel and AFR inputs. New raw materials, fuels and AFRs should be chosen taking their effect on the overall akali/sulphur ratio into consideration. Similarly, selective mining can "fine tune" the chemistry of existing raw materials to optimise the raw mix alkali/sulphur ratio, if it is not within the range 0.8-1.2

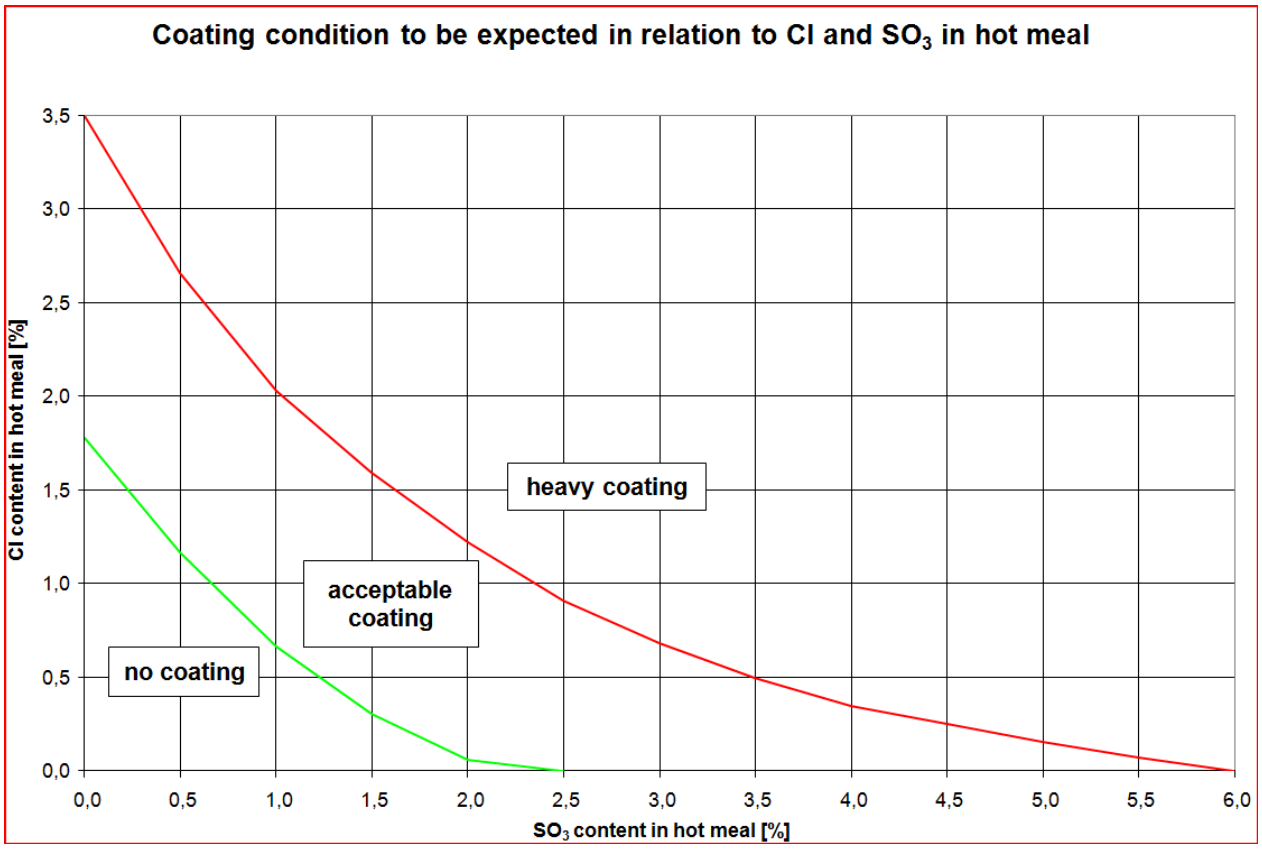
If alkalis are very high and are not balanced by sulphur, it will be very difficult for them to exit the kiln. They will therefore continue to recirculate within the kiln/preheater system and increase the probabliity of kiln rings and preheater buildups. Clinker quality may suffer because free alkalis can enter into solid solution within the clinker minerals affecting their reactivity.

If sulphur is very high and is not balanced by alkalis, it will also continue to recirculate within the kiln/preheater system and increase the probabliity of kiln rings and preheater buildups. Excess sulphur in the hot meal can also form sulphospurrite (2(CaO).SiO2.CaS04) in the middle cyclones, which forms exceedingly hard and dense buildups which can take a long time to remove. Clinker quality would also suffer because sulphur which is not combined with alkalis forms a solid solution with the silicate minerals, particularly C2S (up to 2%). Sulphur incorporated in this way stabilises C2S and inhibits its reaction with CaO to form C3S. As a result, C2S content is increased and C3S content is decreased in the clinker, causing a reduction in cement strengths.

If chloride is very high, it will first combine with all of the alkalis present forming alkali chlorides which will recirculate in the kiln and increase the probability of buildups in the preheater. Any remaining chloride will then combine with CaO to form CaCl2 which has a very low melting point (770-780oC). This will make the hot meal extremely "sticky" at this temperature and increase the chance of buildups higher up the preheater. Chlorides also form eutectic mixtures with sulphates of potassium, sodium, calcium and magnesium. These eutectic mixtures have melting points much lower than that of the pure compounds, further increasing the likelyhood of rings and buildups. Above

0.015%, in the raw meal, chloride recirculation is so bad that blockages in the preheater are eventually inevitable. If the chloride does manage to escape the kiln(ie during kiln trips, stoppages etc), too much chloride in the clinker can accelerate the corrosion of reinforcing steel in the concrete [5].

Figure 1. Coating condition to be expected in relation to Cl and SO_3 in hot meal



2.5 Chemical and physical properties of RDF

European standard BS EN 15359: 2011 which defines the quality criteria for SRF-RDF was developed using data from different industrial users such as cement kilns and coal fired power plants, therefore some of the classes are not appropriate for cement producers which have tighter fuel requirements to ensure they are economically viable and to ensure permitting regulations are not breached.

Chemical and physical properties of RDF are usually specified by cement producer especially because of their available type of technology for clinker production, raw materials composition and gas emission regulations. The main goal in each cement plant that uses RDF is high energy substitution rate, reliable, continuous and environmental friendly production and good and stable quality of final products.

In order to achieve efficient use of RDF in cement plant Lukavac , following requirements must be fulfilled:

Requirements :

LHV(NCV)…….....	min 17 GJ/ton
Chlorine content (Cl).....	max 0.8 %
Mercury content (Hg).....	max 0,03 mg/MJ
Moisture.....	max 20 %
Particle size:	
- in one dimension	max 2 mm
- in other two dimensions.....	max 50 mm

* The particle size is assessed by visual control of samples

Table 1. Trace elements in RDF

Trace elements	**Max.value [mg/kg] (dry basis)**
Antimony (Sb)	50
Arsenic (As)	5
Cadmium (Cd)	4
Chromium (Cr)	100
Cobalt(Co)	18
Manganese (Mn)	250
Nickel (Ni)	30
Lead (Pb)	240
Copper (Cu)	500
Thallium (Tl)	5
Vanadium (V)	10

2.6. Co-incineration of RDF and emission control

According to regulations on monitoring emissions of pollutants into the air (Official gazette FBH, no. 09 /14) evaluation of emission measurements results is done by comparison of measurement results with prescribed limit values.

Emission limit values for plants for the production of cement clinker, are defined by the Regulations on limit values for emission of polluting substances into air (Official gazette FBH no. 12/ 05) when using coal as the main energy source. According to the regulations in the following table are given the limit values for emissions into the air for production of the cement clinker when using coal as the main energy source and comparison of obtained values with the stated limit values, in normal operating mode.

Table 2. Polluting substances

Polluting substances	Limit value of emission reduced to reference content O2 of 10 %	Results reduced to dry gas, normal condition andO_{2Ref}
Dust	50 mg/Nm^3	4,5 mg/Nm^3
Sulfur oxyde as SO_2	400 mg/Nm^3	< 0,8 mg/Nm^3
Nitrogen oxydes as $N0_2$	500 mg/Nm^3	492,3 mg/Nm^3
Heavy metals	0,1 mg/Nm^3 Cd 0,1 mg/Nm^3 Th 0,1 mg/Nm^3 Be 0,2 mg/Nm^3 (Cd + Th + Be) 0,2 mg/Nm^3 (As, Co, Ni, Pb)	0,0003 mg/Nm^3 Cd 0,0015 mg/Nm^3 Th 0,0010 mg/Nm^3 Be 0,0028 mg/Nm^3 (Cd + Th + Be) 0,0073 mg/Nm^3 (As, Co, Ni ,Pb)
TOC	40 mg/Nm^3	8.76 mg/Nm^3

Limit values of emission for cement kilns in which co-incineration of waste takes place are defined by the Regulations on conditions for the operation of incineration plants (Official gazette FBH no. 12/05 and 102/12). According to the regulations in the following table are given limit values for the emissions into the air from the drive for the production of cement clinker when using coal and alternative fuels, and comparison of obtained values with the stated limit values, in the normal operating mode.

Table 3. Polluting substances

Polluting substance	Limit value of emission reduced to reference content O_2 of 10 %	Results reduced to dry gas, normal condition and O_{2Ref}
Total dust	30 mg/Nm^3	4,9 mg/Nm^3
HCI	10 mg/Nm^3	1.22 mg/Nm^3
HF	1 mg/Nm^3	< 0,08 mg/Nm^3
NOx	500 mg/Nm^3	486,5 mg/Nm^3
Trace elements	0,05 mg/Nm^3 (Cd+Tl) 0,05 mg/Nm^3 Hg 0,5 mg/Nm^3 (Sb+As+Pb+Cr+Co+Cu+Mn+Ni+ V)	0,0117 mg/Nm^3 (Cd+Tl) 0,0016 mg/Nm^3 Hg
		0,0046 mg/Nm^3 (Sb+As+Pb+Cr+Co+Cu+Mn+Ni+ V)
Dioxins and furans	0,1 ng/Nm^3	0,095 ng/Nm^3
SO_2	50 mg/Nm^3	< 0,8 mg/Nm^3

Based on the measured values, and made calculation it can be concluded that mass concentration of pollutants at the measuring site in Lukavac does not exceed limit values prescribed by the regulations on limit values of emissions of polluting substances into the air (Official gazette FBH no. 12/05), and Regulations on conditions for the operation of incineration of waste plants (Official gazette FBH no. 12/ 05 and 102/12).

3.0 SUMMARY

The clinker burning process is an excellent means of processing waste compared to a normal incineration plant. A modern kiln system works as a big scrubber, all acid gasses being neutralised by the lime in the system. The heat content of the waste is fully recuperated and consumption of fossil fuel is reduced The CO2 emission to the atmosphere is reduced, corresponding to the amount of fossil fuel replaced by the waste. There is no secondary waste product to deposit afterwards. The chemical composition of RDF must meet the regulatory standards by ensuring environmental protection. Calorific value of RDF must be stable in order to ensure continuous energy delivery since homogeneous and good clinker quality requires excellent control of the combustion process. The physical form of RDF as well as the technical conditions must be adequate to allow the material to be continuously dosed in the rotary kiln line.RDF should not contain chemical substances that may be harmful to the stability and continuity of the process, the environment and the quality of the clinker.

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UN SUSTAINABLE DEVELOPMENT GOALS 2030 AND SUSTAINABILITY COMMITMENTS 2030 AT KAKANJ CEMENT PLANT

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ABSTRACT

This paper is based on the Corporate Sustainability Strategy of HeidelbergCement and Sustainability Commitments 2030 for Kakanj Cement Plant as a part of HeidelbergCement Group.

Our Sustainability Commitments 2030 are based on the 6 following themes:

- Driving **Economic Strength and Innovation**
- Achieving excellence in **Occupational Health and Safety**
- Reducing our **Environmental Footprint**
- Enabling the **Circular Economy**
- Being a **Good Neighbor**
- Ensuring **Compliance** and creating **Transparency**

Keywords: strategy, commitments, UN sustainability goals

1. INTRODUCTION

The HeidelbergCement "Sustainability Commitments 2030" have been developed to replace the "Ambitions 2020" (HC Sustainability Rulebook[1]), which were implemented in 2011 to document the commitment of HeidelbergCement towards sustainability.

At the time the Ambitions 2020 were created the focus was mainly on Health & Safety as well as environmental aspects like emission reduction and biodiversity enhancement.

In accordance with the enactment of the UN Sustainable Development Goals[2] of 2015 HeidelbergCement has decided to review and update the ambitions with the target to widen the scope by including additional social but also economic aspects.

The **"Sustainability Commitments 2030"** are deemed to be Sustainability Constitution of HeidelbergCement describing the core principles of our sustainable behavior. Nevertheless the on hand version is not to be seen as immutable but should more be treated as a living document which needs to be reviewed regularly to adopt to changing societal and business requirements.

The creation process was supported by representatives from all business lines, all business areas and staff departments.

We have aligned our **Sustainability Commitments** with the **UN Sustainable Development Goals (SDG)** enacted 2015 by the UN General Assembly, which have been adopted by all 193 member states. Their aim is to end extreme poverty, fight injustice and to protect our planet with 17 goals set out for 2030.

Not only governments have a responsibility to achieve the SDGs, with progress being tracked regularly. Supporting the SDGs for us means: **doing our share in building a better world for 2030 and beyond.**

2. SUSTAINABILITY COMMITMENTS 2030

The Sustainability Commitments 2030 are policy designed to actively contribute to the global goals. Global footprint = Global impact and 13 of 17 SDGs are directly applicable to HeidelbergCement's core business.

▪ Driving **Economic Strength and Innovation**

"We will ensure sustainable profitability through the effective management of all processes and resources and the continuing innovation of products and services."

By 2030…

- We use all resources as efficiently as possible and target to earn a premium on top of our cost capital.

- We spend 80% of our product R&D budget on the development of more sustainable products.

- We are active in Green Building Councils and similar organizations in order to drive innovation of sustainable products together with our customers and partners.

▪ Achieving excellence in **Occupational Health and Safety**

"We are committed to continuously enhancing the occupational health and safety conditions of our employees, contractors, and third parties."

By 2030…

- We achieve zero fatalities.

- We achieve zero lost time injuries.

- We include health and safety management into our integrated sustainability management system.

▪ Reducing our **Environmental Footprint**

"We are committed to fulfilling our share of the global responsibility to keep temperature rise below 2°C, and we will continue to reduce our impact on air, land and water."

Emissions - By 2030…

- We reduce our carbon footprint by 30% compared to 1990.

- We source 30% of our total heat consumption from alternative fuels.

- We reduce cement production-related SOx and NOx emissions by 40% and dust by 80% compared to 2008.

- We permanently reduce all other air emissions below cement industry average.

Water - By 2030…

- We equip all production sites with water recording systems.

- We implement water management plans at all sites located in water scarce areas and aggregate them on country level to water reduction master plans.

- On Group level, all efforts are combined in a global strategic water consumption reduction plan.

- We implement the WASH pledge of the WBCSD[3].

Land use - By 2030…

- All our extraction sites are operated based on an after-use plan agreed with local authorities and in accordance with the needs of local communities.

- We include biodiversity enhancement recommendations in any new after use plan.

- We implement a biodiversity management plan at extraction sites within or in direct connection to nature conservation areas.

- In case of nature-oriented after use plans, we aim to achieve a positive impact on biodiversity value at our extraction sites.

▪ Enabling the **Circular Economy**

"We conserve our natural reserves by continuously increasing the use of alternative resources as substitutes for natural raw materials"

By 2030…

- We continuously increase the substitution rate of natural raw materials by using by-products of recycled materials.

- We implement an alternative raw materials strategic plan for the Group and relevant business units.

- We rely on internal specialist teams and external business partners to ensure reliable, economical access to alternative raw materials.

▪ Being a **Good Neighbor** 

"We are committed to supporting the social and economic development of our neighboring communities and ensure transparent communication to all our stakeholders."

By 2030…

- We hold an annual community dialogue at each site.

- We offer one hour of voluntary community work per full-time employee per year.

- We provide knowledge transfer and building materials to foster the capacities of local communities.

▪ Ensuring **Compliance** and creating **Transparency** 

"We adhere to international human rights, anti-corruption and labor standards and co-operate pro-actively in an open and transparent manner with all our stakeholders."

By 2030…

- We ensure that our employees comply with the international Human Rights Declaration of the United Nations[4], the OECD Anti-Corruption Declaration[5] and Fundamental Conventions of the International Labor Organization[6].
- We ensure compliance through internal control and risk management systems, such as internal audits and a whistleblower hotline.

- We ensure that our suppliers comply with our Supplier Code of Conduct[7].

- We ensure that each position is staffed with the most qualified person, independent from gender, origin, beliefs, and/or orientation.

3. CONCLUSION

With the Sustainability Commitments 2030, we will contribute to a sustainably built environment for the benefit of all.

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TYPES OF PRODUCTION LINES FOR WOODEN MASS PELLETS

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ABSTRACT

This paper presents the process of wood pelleting through main steps, factors that influence the production of pellets, as well as the types and variants of the production lines for wood pelleting. For different quantity of production suggested are parts of production lines and tips for production of pellets increasing. There is as well improving the 150 kg/h production plan with a goal for increased production capacity

Keywords: Pellet, Biomass, Renewable energy sources.

1. INTRODUCTION

Renewable energy uses sources of energy that are naturally continuously supplemented with the Sun, wind, water, Earth's heat and plants. Renewable energy technologies convert these fuels into useful forms of energy - most commonly electricity, but also thermal, chemical or mechanical energy [1].

Today, fossil fuels are mainly used for heating and supplying houses, as well as for car fuels. It is advantageous to use coal, oil and natural gas to meet energy needs, but the supply of these fuels is limited, because they are used faster than they are created. Due to security and waste disposal problems, the United States will "retire" most of the nuclear capacity by 2020. In the meantime, the country's energy needs are expected to grow by 33 percent in the next 20 years [2].

Even if there is an unlimited amount of fossil fuels, the use of renewable energy is better for the environment. Often, renewable energy technologies are called "clean" or "green" because they are small pollutants. Scientists claim that the average temperature of the earth has increased in the last century. If this trend continues, the sea level will increase, and scientists predict that floods, waves of heat, droughts and other extreme weather conditions will increasingly be reported [3, 4].

2. PELET

Pellet production began more than a century ago. Using heat and pressure, the pellet can be produced from various materials for different purposes.
Some companies that used fodder pellets began to work in the 1970s to produce wood pellets as a fuel source. However, due to low-cost fossil fuels that were available, the production of wood pellets continued to grow. In the 21st century, wooden pellets and pellets in general have an expansion, although there are problems with supply.
Figure 1 shows the appearance of a wooden pellet.

Figure 1. Appearance of wood pellets

Due to the high prices of oil and gas and climate change concerns, the pellet becomes a clean and cheap fuel for heating that can help reduce global warming. Over the past decade, there have been two major factors that have caused pellets to rise in the market. The first is a constant increase in fossil fuel costs and price volatility, while others have increased attention to the use of fossil fuels, such as oil and gas, and their impact on the environment. Other factors contributing to the development of pellets are that pellets can be produced locally, from local wood and biomass. Production and distribution of pellets can provide affordable fuel, as a type of heating and create such local jobs.
The primary purpose of material pelleting is to facilitate handling and reduce transport costs. Volume is often a limiting factor when it comes to transportation. By increasing the density of the material, the required volume for transporting a certain amount of material is reduced.
The advantages of pellets in relation to briquettes and wood as heating material are:

- Price - wood pellets and biomass, as an alternative to fossil fuels, have a more competitive and stable price in many countries, compared to natural gas and oil. As such, the wooden pellet has proven to be an effective countermeasure in the fight against global warming, energy security and oil price increases.
- Wide range of materials - As for wood-based pellets and biomass, the source of raw materials is diverse, such as wood waste (sawdust, etc.), yard waste (grass, leaves, twigs, bushes, etc.), farm waste (corn, corn trees, straw, etc.) and other waste from biomass. As traditional heating, fossil fuels are more expensive and easily polluting the environment. Trees (firewood) grow slowly and it is difficult to control moisture, so that both of these types of fuels are not good for furnaces and boilers.
- Environmental protection - the advantage of wood pellets and biomass is that it does not emit CO_2. When burning pellets, only CO_2 stored during the plant's life is released and harmless to the environment, while combustion of fossil fuels releases additional CO_2 into an atmosphere stored for millions of years and thus accelerates global warming.
- Convenience - Pellets are produced with a unique moisture content, shape, size and density that meets the needs of automated combustion systems for furnaces and boilers, and also takes up less storage space than other biomass.

Based on the above information, the primary characteristic is the following:

- Minimum of 640 kg / m^3
- A flow of liquids, ideal for automated systems
- Can be used in ovens and boilers
- Easy to handle, store and transport
- Improve the characteristic of combustion

Pellets on the market now have several industry standards in the US and Europe, which pellet manufacturers must adhere to. This depends on the size of the production and where and if the pellet is sold in the open market. Before purchasing equipment, it is recommended to investigate any industry standard that can be applied.

3. PELLETING MACHINEAND PELLETING PROCESS

The pellet production machine is a major part of the pelleting process. There are two types of pelleting machine, one of which is flat die, and the other with a round die. A flat pellet matrix appeared first, and the ring was later invented designed. Usually, they are used for small and medium pellet production, and ring for medium and large pellet production [2].

3.1. Pelleting machine with flat matrix

Figure 2 shows a flat matrix pellet machine that works on the principle of falling material from top to rolls rotating over the matrix. The material is then compressed between the rollers and the matrix surface through the openings. When the pellet exits through the opening of the die, the knife cuts the pellet to a certain length. The drive through the snail and worm wheel is used for some pallets with flat matrices, while in other drives it is done through the gears.

Below are some of the terms used in pellet production by the Pellet Fuels Institute Standard Specification for Residential / Commercial Densified Fuel, October 25, 2010:

- Bulk density - bulk density in the sampled pellet
- Diameter - average diameter of sampled pellets
- Pellet Durability Index (PDI) - a standardized parameter for specifying the ability of pellets to resist degradation while transporting and handling

Figure 2. The working principle of pellets machine with a flat matrix

3.2. Pellets with ring matrix

Figure 3 shows the working principle of pellet machine with ring matrix. Pellet machine with ring mat consists of a vertical ring matrix with rollers on the inside, which create pressure on the matrix.

The material is fed from the container through conditioner with variable speed above the pellet; the appropriate material is then inserted through the pellet door and goes into the center of the pellet chamber. In the interior of the chamber the rollers are stationary and the die is driven, similar to the washing machine. In the chamber, the material is driven by a rotating die and then compressed by rollers.

Figure 3. The working principle of pellet machine with ring matrix

3.3. Pelleting process

Wood pellets are often produced from waste products of other products, although several large pellet companies are preparing almost timber for pelleting only [3].
The raw material used for the pelleting process can be prepared in various ways, the examples of material are shown in Figure 4.

Figure 4. Materials for pelleting

Table 1 lists the properties of the material. The values of the specific energy content in Table 2 show that the wooden pellet has a specific energy content, which is five times higher than in wood waste and wood chips. High specific energy content of wood pellets reduces transport costs and requires storage capacity.

Table 1. Characteristic of wooden material

Property	Wood chips and sawmill wood waste	Dry sawdust	Wood pellets
Bulk density	300 [kg/m^3]	160 [kg/m^3]	650 [kg/m^3]
Moisture	55 %	12 %	8 %
Specific energy content	2.00 [MWh/ton]	4.40 [MWh/ton]	4.80 [MWh/ton]
	0.60 [MWh/ m^3]	0.70 [MWh/ m^3]	3.12 [MWh/ m^3]

The pelleting process passes through several basic steps, which are standard for all types of pellet production, whether mini-series or mass production, which are [5]:

1. Milling of the material to be pelleted
2. Transportation of materials
3. Drying
4. Mixing
5. Conditioning
6. Production of pellets (pellet)
7. Prosing
8. Cooling
9. Transport of pellets
10. Packaging and storage

3.4. Factors that affect the pelleting process

The pelletizing process is influenced by several properties related to the material being pelleted, as well as for the design of the matrix itself. The results of several studies have shown that some of these properties influence the process. These studies were primarily focused on the properties of pelleting materials. It is known that the following properties affect the pelleting process [6]:

- Wood type (type)
- Temperature
- Humidity
- Particle size and fiber orientation

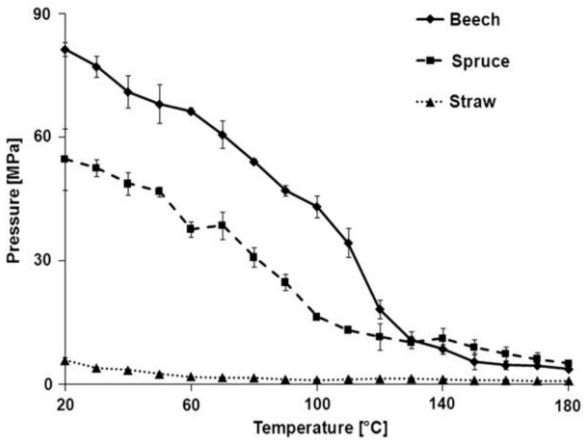

Figure 5. Pressure needed for pellet compression for temperature interval 20 - 180 ^{o} C [5]

Pelleting of hard wood leads to a higher load of pellets compared to softwood. Straw pelleting causes less stress compared to pelleting of wood. Friction studies between pelleting material and pellet wall have been confirmed by these experiences, Fig. 5.

4. TYPES OF PRODUCTION

4.1. Production of 250 kg/h pellets

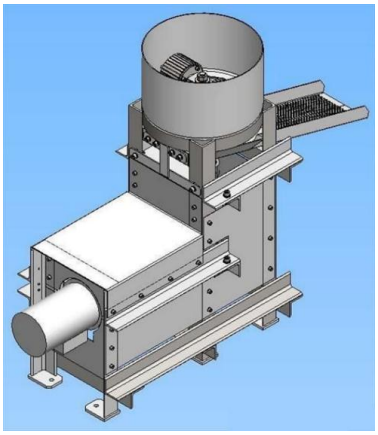

Figure 6. Pellets for the production of 250 kg / h pellets

Figure 6 shows a flat matte pellet and movable rollers. The average production of these pellets is 250 kg/h. The production capacity itself depends on many factors. The most important factor is the type of material that is pelleted, where softwood can be considered more productive than hardwood. However, with the exception of material types, production capacity can be affected by engine power and speed, as well as engine design itself. This type of pellet is intended for some smaller production, and even for home use only. Managing such a pellet is easy.

A worker is enough to hand out the material on the rollers manually. The material must be pre-molded so that it can pass through the matrix. The construction of this pellet enables easy and quick replacement of consumable parts at any time of production. How would made a complete line for the production of pellets, except pelleting machine, a saw mill crusher, a worm sawdust in a pellet machine, a pellet conveyor belt to a silo, a pellet screening screen and pellet packaging packs. If the material is pelleted, it has a higher humidity than it needs (for example, if sawdust is used), then the dryer must be installed in the production line with a capacity that will monitor the capacity of the pellet.

The main characteristics of production lines of this type are ease of management, they do not occupy much space and represent the cheapest option. Ideal is the solution for those who deal with wood processing, and have a problem with waste, i.e. sawdust.

4.2. Production of 500 kg/h pellets

Figure 7 shows the type of pellet production of 500 kg/h, where pellet machine with ring matrices are used. This type of pellet production line consists of 4 subsystems:

1. A system for shredding wood waste
2. Drying system
3. Pelleting system
4. Packaging system

The pelleting process starts from the insertion of wood waste into the mill hammer. This can be done with a conveyor belt in order to load the working material equally. The milled material from the mill is transferred by the worm conveyor to the dryer. After the material passes through the dryer, the conveyor belt is transported to the silo, the ratio of the pellet container, from where the pressurized material is compressed into the pellet. Finished pellets are sent to the refrigerator, where they will cool and prepare for packaging. At the exit of the refrigerator, a sieve is placed, in order to remove all dust and pellets that have turned into small parts. After that, the pellet is sent to the carton above the packer, where the bag is packed. Across the subsystem, cyclones that entrain dust are installed and thus provide a clean working environment.

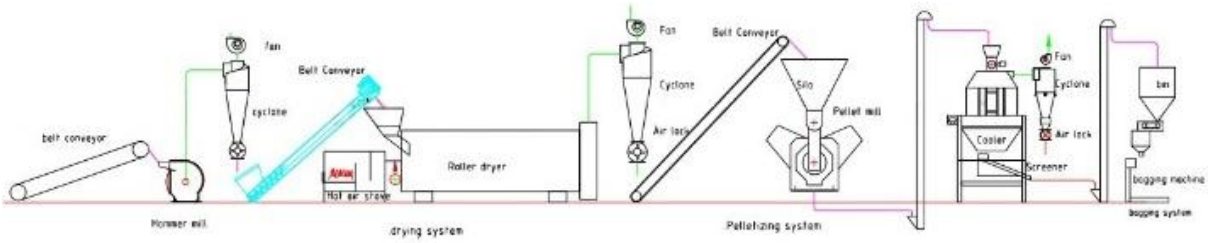

Figure 7. Production type of 500 kg/h pellet

4.3. Production of 2 t/h pellets

Figure 8. shows the type of pellet production line of 2 t/h. This type of production enables the pellet to be produced directly from the logs, as opposed to the previous types where the pellets were produced from wood waste, i.e. sawdust. Figure 8 shows how the sawdust that is stored in the silo is sent to the mill hammer. At the same time, wooden logs pass through a wood crusher, in order to make a cutter that also goes to the mill hammer. Crushed material derived from logs and material brought from the silo is sent in the dryer. After the drying process has been completed, the material is fed into the pellet by the worm conveyor. The pellet working principle is the same as for other pellets machine with ring matrices. The resulting pellet is sent to the refrigerator for cooling, and then on the packaging. The complete system is managed from the control center.

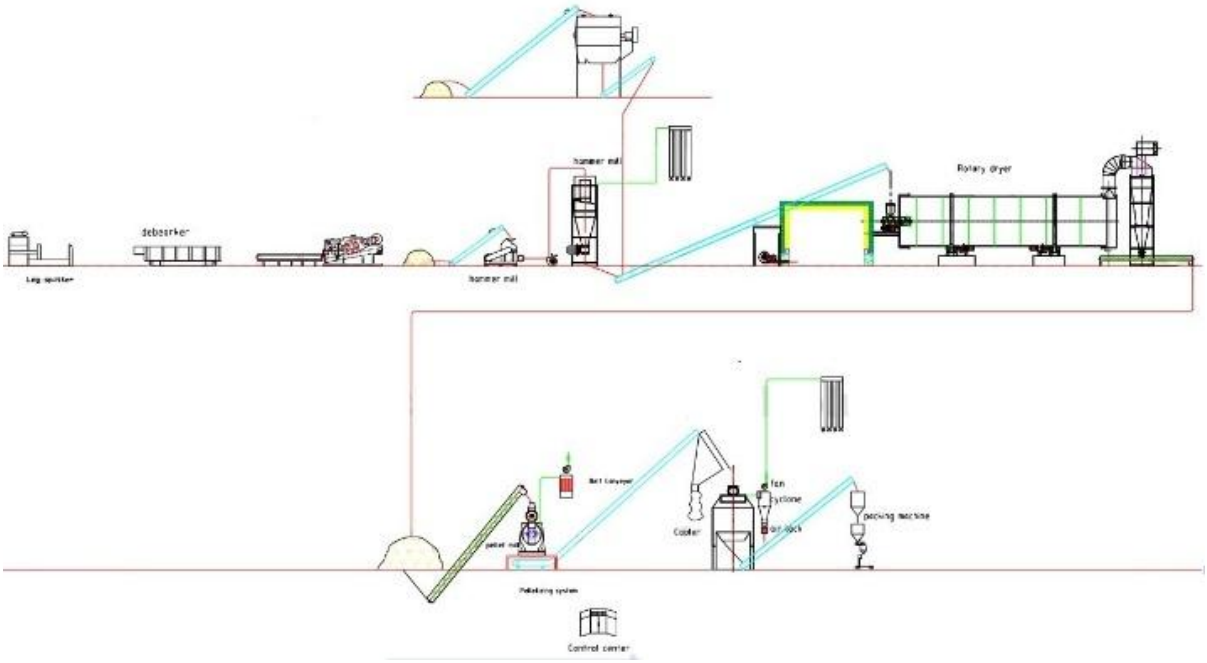

Figure 8. Production type of 2 t/h pellet

4.4. Production of 4 t/h pellets

Figure 9 shows the production type of pellets of 4 t/h. This type represents the mass production of pellets. In the production line there are two pellets with ring matrices, each of which produces 2 t/h. The working material can be with multiple sources, but it is brought together into a bunker above both pellets, where the worm gear is evenly distributed to the pellets. After that, the pellet goes to cooling and packaging. The whole process is automated.

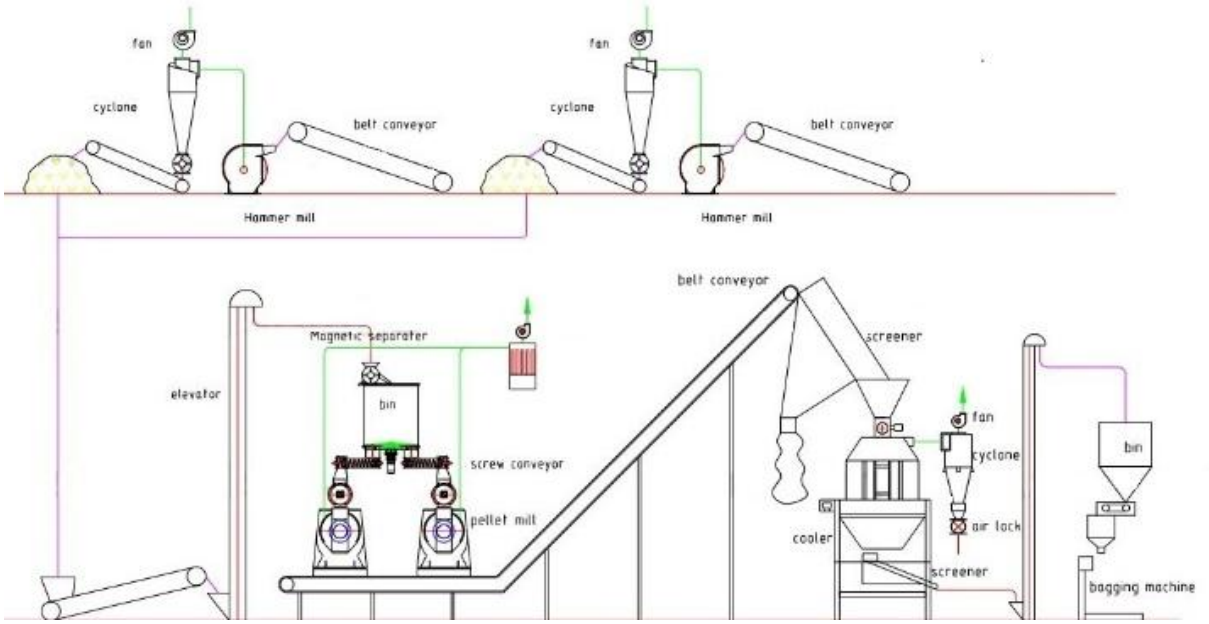

Figure 9. Production type of 4 t/h pellet

5. IMPROVING THE 150 KG/H PRODUCTION PLAN WITH A GOAL OF INCREASING PRODUCTION CAPACITY

In Figure 10, a pellet is shown in the production plant. This is a type of pellet with a flat matrix. The matrix turns, while the rollers stand still and rotate when the material is dispensed, or when a sufficient amount of material is created between the rollers and the matrix.

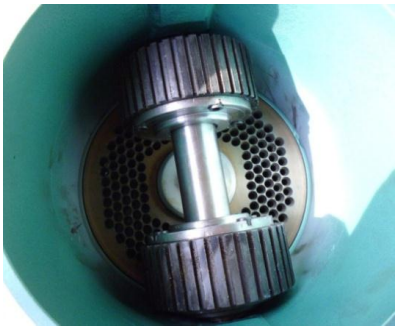

Figure 10. Equipment capacity is 150 kg/h

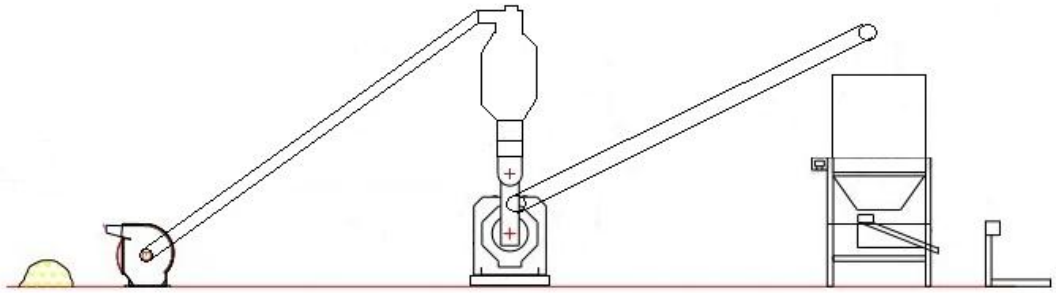

Figure 11. The pellet line has a capacity of 150 kg/h

The production plant consists of 4 machines: grinder, pellet, machine for the screening of pellets, while machined to the production line, the not connect in a line and worker serving every machine separately. The pelleting process in this production facility includes several steps:

- Preparation of the material 30 min
- Crushing material 500 kg / h 60 min
- Pelleting 500 kg 210 min
- Weighting 500 kg 60 min
- Packing 500 kg 60 min
- Lubrication 30 min

Working material is a mixture of beech, oak and fir, where the percentage of beech is 50 - 70%. On the basis of the overview of the time spent, it can be seen that the production capacity during a working shift of 8h with pauses, 500 kg of pellets. In order to increase the production capacity, a conveyor belt and a pellet silo, capacity 1t, was installed in the production line.

Figure 11 shows the production line after adding conveyor belt and silo. The mill is connected directly to the pellet from a pipe of 15 cm in diameter, and a dust extraction cyclone is placed above the pellet. Pellet pellets are transported by conveyor belt to the silo, where the pellets will be stored and cooled. Below the silo, a pellet screening machine was installed to remove dust and small parts of pellets before packaging in bags.

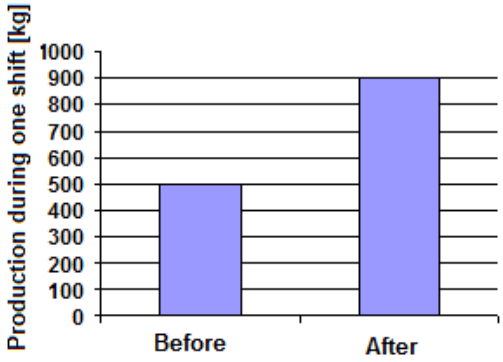

Figure 12. Display of the productivity of the product before and after the improvement of production

By using this method of distributing and connecting machines and other components in the pellet production line, a higher production capacity is obtained, because the time required for some production steps is now eliminated. That is, the worker, after preparing the material, inserts the material into the mill and inserts the material at the same time, both the pelleting process and the storage process of the pellets into the silo.
Since it is done in one shift, it is recommended that the pellet be lodged in a silo and thus cool down, and that at the beginning of the shift the pellet packaging from the previous day is carried out. If more shifts were to be made, then the pellet cooler should be inserted into the production line so that the pellet can be packed immediately.
The production capacity of the pellet production unit is about 900 kg of pellets in one single unit, which is 80% higher in the ratio before product development, as seen in Figure 12.
Figure 13. shows the increase in production in Euros in the past week for the current year.

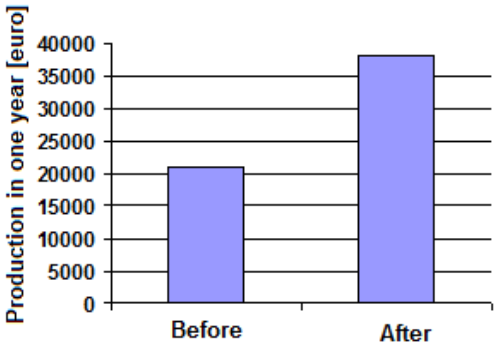

Figure 13. Production in the course of the year before and after the production improvement

6. CONCLUSION

Due to the variety of uses, the production processes of wood pellets can vary from plant to plant. For example, if a wooden pellet is for personal use, not all manufacturing steps are required, i.e. the packaging process is not necessary because the pellet can be used directly from the pellet container. However, if a pellet is made for commercial purposes, such a pellet requires an appropriate package, i.e. a pellet packing machine is required in bags.
Pelleting biomass has some important advantages:

- The use of pellets as alternative sustainable energy is an effective tool in combating climate change;
- Lower transport costs, smaller quantities of dust, higher heating values and less pollution [7]
- reduced wood cutting, providing replacement for wood used as heating

The main disadvantages of biomass pellet are:

- Emissions of low-quality pellets lead to corrosion
- Small pellet particles may disrupt automatic control of the system or cause a breakdown of automatic pellet delivery

- Small particles faster upwards and cause melting of dust
- Dust resulting from the breakdown of low-quality pellets is a health risk, and can also lead to ignition and explosion during handling, storage and transport.

Pellet production has shown continued expansion over the past few years and is expected to have faster growth in the near future.

In the coming years, in addition to the growth of pellet consumption, the growth and trend of the development of new types of energy crops (eg Paulownia, which grows much faster than beech, oak, meal, etc.) will be expected to serve as an alternative raw material. These types can be used in combination with existing raw materials from wood. By combining this biomass, the content of pellet ash will decrease, while the effective pellet power will increase, and both factors will positively influence the increase in pellet quality.

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DISTRICT HEATING SYSTEMS IN BOSNIA AND HERZEGOVINA. AN OVERVIEW FROM EU PERSPECTIVE

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ABSTRACT

District heating means the distribution of thermal energy in the form of steam or hot water, from a central source of production through a network to multiple buildings or sites, for the use of space or process heating. Promotion of efficiency in heating has been discussed within the Directive 2012/27/EU as one of the most important things and it is considered within articles 14, 15 and 24 as well Annexes VIII and IX of this document. Heating and cooling consume half of the EU's energy and much of it is wasted. Although the heating and cooling sector is moving to clean low carbon energy, 75% of the fuel it uses still comes from fossil fuels (nearly a half from gas). The legislation and regulation on district heating systems in Bosnia and Herzegovina is prepared and adopted at the local community level, because the most of them are in the ownership of local communities. Apart from that, heating and cooling (including district heating systems) are treated in some documents at state's and/or entity's level as for example Energy strategies and National Renewable Energy Action Plans. From one side, there is no monitoring on the implementation of the action plans and strategies (or at least it is not efficient) and, on the other side, action plans and strategies are far from reality. There are 142 municipalities in BiH (79 municipalities in the FBiH and 62 municipalities in RS and the Brčko District of BiH as a special unit of BiH), and 31 of them have one or more DHS. The future of DHS in BiH is not so bright, but the existing DHS will probably be in operation and some of them will be extended. On the other hand, the development of new DHS is not expected in the near future.

Keywords: district heating, EU, perspective

1. INTRODUCTION

The definition of a district heating or district cooling is given in EU Directive 2010/31/EC (Energy Performance of Buildings Directive - EPBD) as following: *"district heating or district cooling means the distribution of thermal energy in the form of steam, hot water or chilled liquids, from a central source of production through a network to multiple buildings or sites, for the use of space or process heating or cooling"*[1]. Regarding heating generally but also district heating, some other important things have also been mentioned in this document, as for example:

- energy needs for heating and cooling are reduced to cost-optimal levels,
- there should be a focus on measures to prevent overheating,
- regular maintenance and inspection of heating systems by qualified personnel,
- an independent assessment of the entire heating system should occur at regular intervals during its lifecycle in particular before its replacement or upgrading.
- Member States should enable and encourage architects and planners to properly consider the optimal combination of improvements in energy efficiency, use of energy from renewable sources and use of district heating and cooling when planning, designing, building and renovating industrial or residential areas.

Two years later, the EU adopted the Directive 2012/27/EU on energy efficiency [2] that is also quite important for heating systems. This Directive establishes a common framework of measures for the promotion of energy efficiency within the EU in order to ensure the achievement of the Union's 2020 20% headline target on energy efficiency and to pave the way for further energy efficiency improvements beyond that date. It lays down rules designed to remove barriers in the energy market and overcome market failures that impede efficiency in the supply and use of energy, and provides for the establishment of indicative national energy efficiency targets for 2020. Promotion of efficiency in heating and cooling has been discussed within this Directive as one of the most important things and it is considered within articles 14, 15 and 24 as well Annexes VIII and IX of this document.
After adoption of this document, EU has prepared and adopted a couple of documents (strategies and action plans) for implementation of this document and to be able to achieve its goals. Amongst others, the following documents should be mentioned: An EU Strategy on Heating and Cooling, Heat Roadmap Europe 2050, Low-Carbon Heating and Cooling Strategies for Europe, Energy Roadmap 2050, etc.
The main reasons for EU to adopt strategies, roadmaps and legislation were:
- 1% increase in energy savings would reduce gas imports by 2,6%,
- the buildings sector emits around 13% of all CO_2 emissions in the EU,
- 72% of the heating and cooling demand of single-family houses is consumed in rural and intermediate areas,
- 85% of the energy consumed in buildings is used for space heating and hot water production, and 45% of the heating and cooling in the EU is used in the residential sector,
- on average, Europeans spend 6% of their consumption expenditure on heating and cooling, and 11% cannot afford to keep their homes warm enough in winter;
- there are currently major differences in annual expenditure on energy for heating purposes between the various climate zones in Europe, with an average of 60 to 90 kWh/m^2 in southern European countries and 175 to 235 kWh/m^2 in central and northern Europe;
- the low level of awareness among consumers concerning the lack of efficiency of heating systems is one of the factors having the greatest impact on energy bills;

The vision and goals of EU regarding the heating and cooling were set up in [3]. To achieve EU's decarbonisation objectives, buildings must be decarbonised. This entails renovating the existing building stock, along with intensified efforts in energy efficiency and renewable energy, supported by decarbonised electricity and district heating. Buildings can use automation and controls to serve their occupants better, and to provide flexibility for the electricity system through reducing and shifting demand, and thermal storage. Industry can move in the same direction, taking advantage of the economic case for efficiency and new technical solutions to use more renewable energy. In this sector, however, some fossil fuel demand can be expected for very high temperature processes. Industrial processes will continue to produce waste heat and cold, as will infrastructure. Much of it could be reused in buildings nearby. This is a vision for the longer term, but big gains can be reaped immediately.

2. DISTRICT HEATING SYSTEMS IN EUROPEAN UNION

Heating and cooling consume half of the EU's energy and much of it is wasted. Although the heating and cooling sector is moving to clean low carbon energy, 75% of the fuel it uses still comes from fossil fuels (nearly a half from gas). Heating and cooling and the electricity system can support each other in the effort to decarbonise. It is essential to recognise the links between them and exploit synergies. With 50% (546 Mtoe) of final energy consumption in 2012, heating and cooling is the EU's biggest energy sector. It is expected to remain so. Renewables accounted for 18% of the primary energy supply for heating and cooling in 2012, while fossil fuels accounted for 75% (*Figure 1*).
With the EU targets for 2020, renewable energy is growing. In their National Renewable Energy Action Plans, each Member State adopted a renewable energy target for heating and cooling. Most are on track to achieve them; some are switching faster than planned. Renewable energy sources (RES) share of energy used in heating is highest in Baltic and Nordic Member States (ranging from 43% in Estonia to 67% in Sweden). Biomass is the most widely used renewable energy for heating today, representing some 90 % of all renewable heating. The Commission will propose at the end of 2016 a

bioenergy sustainability policy, which will take into account the impact of bioenergy on the environment, land-use and food production. 45% of energy for heating and cooling in the EU is used in the residential sector, 37% in industry and 18% in services. Each sector has potential to reduce demand, increase efficiency and shift to renewable sources. [3]

Almost half of the EU's buildings have individual boilers installed before 1992, with efficiency of 60% or less. 22% of individual gas boilers, 34% of direct electric heaters, 47% of oil boilers and 58% of coal boilers are older than their technical lifetime. Decisions on replacing old appliances are typically made under pressure, when the heating system breaks down. Comparison of prices between solutions, as well as information on how their existing system performs, is not easily available for most consumers. This leads them to continue using older, less efficient technologies.

In some parts of Europe, up to three quarters of outdoor fine particulate matter pollution is attributable to household heating with solid fuels (including coal and biomass). The Commission has initiated infringement procedures on ambient air quality against several Member States, referring two cases regarding persistently high levels of fine particulate matter to the European Court of Justice in 2015. The Commission warns about the negative impact on air quality from the use of coal (lignite) and boilers and stoves with poor emission standards for heating as healthier solutions are available, easily accessible and more efficient and cheaper in the long run.

Ecodesign and energy labelling requirements for space and water heaters came into application in 2015. The sale of inefficient boilers is now banned. Consumers see efficiency ratings – both for single technologies and for packages that include the use of renewables. The transition that these measures are expected to foster, should bring annual energy savings of 600 TWh and CO_2 emission reductions of 135 million tonnes by 2030. At the same time, emissions of air pollutants will also be reduced.

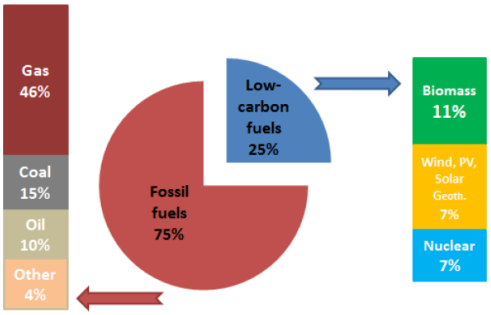

Figure 1: Primary energy for heating and cooling, 2012

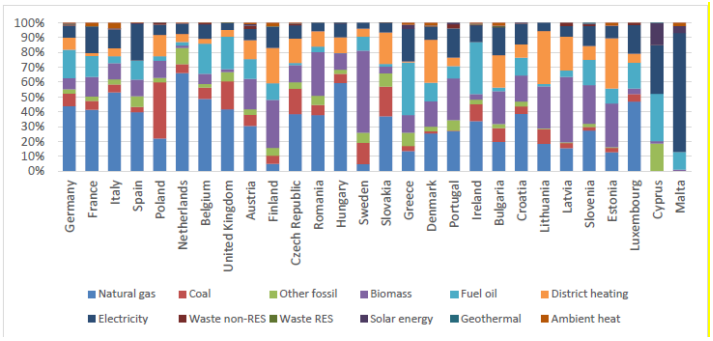

Figure 2: Final energy consumption for heating and cooling, 2012

District heating systems (DHS) provides 9% of the EU's heating. In 2012 the main fuel was gas (40%), followed by coal (29%) and biomass (16%). District heating can integrate renewable electricity (through heat pumps), geothermal and solar thermal energy, waste heat and municipal waste. It can offer flexibility to the energy system by cheaply storing thermal energy, for instance in hot water tanks or underground.

Industry accounted for a quarter of the EU's final energy consumption in 2012. 73% of this is used for heating and cooling. European industry has cut its energy intensity twice as fast as the US since 2000. The improvement rate is steeper in energy intensive sectors. The reason is clear: energy is an important cost. By putting a price on CO_2 emissions, the EU Emissions Trading Scheme has provided an incentive to use low carbon fuels and to invest in energy efficiency. Significant potential remains. Using existing technologies, it is possible to reduce energy costs in industry by 4-10% with investments that pay-off in less than 5 years. However, the visibility of energy savings is low.

Collectively, energy demand of small and medium enterprises is considerable. They often have fewer resources and less access to finance to make improvements. They may lack the capacity to run such projects and, not having a direct carbon-price incentive, they rarely view energy efficiency as a priority, especially in their early years. Financial institutions often remain reluctant to provide financial products due to perceived risks. The use of renewable energy in industry is limited. Nearly all is biomass, despite the market maturity – at least for low-temperature heat – of heat pumps, solar

and geothermal. With technological development, more applications for medium-temperature heat (up to 250°C) will become market feasible.

3. DISTRICT HEATING SYSTEMS IN BOSNIA AND HERZEGOVINA

The legislation and regulation on district heating systems in Bosnia and Herzegovina (BiH) is prepared and adopted at the local community level, because the most of them are in the ownership of local communities. Apart from that, heating and cooling (including district heating systems) are treated in some documents at state's and/or entity's level (Federation of Bosnia and Herzegovina – FBIH and Republika Srpska – RS) as for example: Energy strategies and NREAPs – National Renewable Energy Action Plans (BiH, FBiH and RS). From one side, there is no monitoring on the implementation of the action plans and strategies (or at least it is not efficient) and, on the other side, action plans and strategies are far from reality. An overview of the population, total number of households and % of households connected to DHS in Bosnia and Herzegovina is shown in *Table 1*. It can be seen that official statistics data are different for different years, but also the are not correct according to our assumption based on the bottom-up model. In any case, even with the official statistical data from Agency for Statistics of Bosnia and Herzegovina, percentage of households connected to DHS (8-10%) against the total number of households is similar to percentages in EU (9%). Taking into account our assumption, this percentage (14%) is quite good in comparison with DHS in EU.

Table 1. Overview of the number of citizens, total number of households and % of households connected to DHS in BiH

	HBS* 2004 [4]	HBS* 2007 [5]	HBS* 2011 [6]	HBS* 2015 [7]	BHAS** 2015 [8]	FAO*** 2017	IGT assumpt.
Citizens	3.507.868	3.447.156	3.169.985	2.995.603	3.531.159	3.531.159	2.995.603*
Households	1.067.120	1.054.613	1.033.452	1.033.452	1.163.387	1.163.387	1.033.452*
Households connected to DHS	95.530	100.450	94.033	100.245	91.907	126.189	145.000
% of DHS in total number of households	(8,95%)	(9,50%)	(8,90%)	(9,7%)	(7,90%)	(10,95%)	(14,03%)

**) Household Budget Survey, Agency for statistics of BiH (2004, 2007, 2011 and 2015)*
***) Survey on household energy consumption in BiH (2015)*
****) Survey by FAO (Food Agriculture Organisation), 2017*

There are 142 municipalities in BiH (79 municipalities in the FBiH and 62 municipalities in RS and the Brčko District of BiH as a special unit of BiH), and 31 of them have one or more DHS. Generally, the basic characteristics of DHS in BiH

- there are 3 periods of developments of DHS: until 1992; from 1992-1996; after 1996 until today and each of these periods is specific for their developments,
- heat from DHS is used for heating only (there are neither sanitary hot water supply nor district cooling),
- heat production plants are quite old (especially coal and heavy fuel-oil fired plants which are elder than 30 years),
- heat for DHS is produced in own boiler houses, in TPP (CHP) and in industry,
- DHS are mostly public utilities (or part of public utilities) with ownership from 51 to 100% of local community, but there are a couple of private DHS,
- heat distribution network are quite old and with heat losses (sometimes with water loses too),

- there are no individual heat measurements, but generally heat measurement is not often used,
- automation and control of DHS are mostly not at sufficient level,
- there is no possibility to manage heat demand at consumer side

3.1 District heating systems in Republika Srpska

According to [9], currently there are 13 DHS companies in Republika Srpska that provide service of DHS with installed capacity of 406,7 MW. They are located in the following cities: Banja Luka, Bijeljina, Brod, Čelinac, Doboj, Gradiška, I.Sarajevo, Pale, Prijedor, Sokolac, Ugljevik and Zvornik. All of these 13 DHS companies deal with heat production, distribution and supply and have their own heat production plants. Apart from these 13 companies (in 11 municipalities), there is one company dealing with heat distribution and supply (without heat production) in Ugljevik. In Republika Srpska, 40.000 units (households/departments) in the residential sector with ca. 2,3 mil. m^2, and ca. 460.000 m^2 in the service sector are heated. Heat is used for heating only, and there are no supply of sanitary hot water. Heavy fuel-oil, coal, natural gas and wood (including wooden residues) are used as energy carriers in Republika Srpska, and heavy fuel-oil is the most used. In 2017, 40,03% of heavy fuel-oil, 28,45% of coal, 28,60% of wood (including wooden residues) and 2,92% of natural gas were planned to be used for heat production. [9]. The planned gross heat production in RS in 2017 is 1.761 TJ, that's 1.731 TJ in boiler houses and 30 TJ from TPP Ugljevik. Heat losses in the heat distribution systems are estimated to 297 TJ (17%), own consumption of boiler houses to 84 TJ (5%), final energy consumption to 1.380 TJ (78%) - 1.032 TJ – households (75%), 30 TJ – industry (3%) and 318 TJ – other consumers (22%).

3.2 District heating systems in Federation of BiH:

There are no official statistic data on district heating systems in FBiH as it was dicussed for RS in the previous chapter. Based on our experience and contacts we identified the following municipalities in FBiH with one or more DHS: Banovići, Breza, Bugojno, Gračanica, Kakanj, Konjic, Livno, Lukavac, Novi Travnik, Sanski Most, Sarajevo, Srebrenik, Tešanj, Travnik, Tuzla, Vogošća, Zavidovići, Zenica and Žepče. According to [10], heat production by energy carriers in FBiH in 2015 was as following: ca. 48% - produced heat in own boiler houses, ca. 34% - produced heat in TPP, and ca 18% - produced heat in industry.

3.3 The future trends of DHS in BiH

The future of DHS in BiH is not so bright. The existing DHS will probably be in operation and some of them will be extended. On the other hand, the development of new DHS is not expected in the near future. What kind of DHS (centralized or decentralized, or renewable DHS) in BiH would be preferable, depend on many factors:

- possibility to extend the existing DHS (including DHS capacity as well heat transport/distribution network)
- availability of energy sources for existing and/or new DHS
- available or possible waste heat from industry sector,
- organisation of companies,
- legislation etc.

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SOLAR HEATING SYSTEMS FOR HOUSEHOLDS

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1. ABOUT ENERGY ...

In response to the question of how to meet the needs of mankind and allow for further development without additional pollution and exhaustion of natural resources, renewable energy sources are imposed.
The characteristic of renewable energy sources is that they do not diminish in fossil fuels while using their stocks, they have huge volumes and, most importantly, they do not pollute the environment.
As for energy sources, the solar power has the most advantages for several reasons. The term solar energy usually refers to the direct exploitation of solar energy for generation of heat and electricity.
The amount of solar energy that falls on Earth is enormous. All the reserves of coal, oil and natural gas together are equal to the solar energy that comes to Earth in 20 sunny days. On average on the entire surface of the planet, for 24 hours a year, every square meter collects energy corresponding to barrels of oil or 4.2 kWh of energy every day. The sun's energy varies during seasons, some areas receive very little sunlight during the winter.

2. SOLAR SYSTEM - SPECIFICATIONS

The active thermal exploitation of the Sun's energy is obtained by converting solar energy directly into the heat energy by means of an air or fluid medium (collectors). In this case, the flow of media requires special energy. Heated medium is most often used for domestic hot water heating, but sometimes also for heating the pool, greenhouse, drying of fruit.
The solar system consists of several components: solar collectors, solar and / or accumulation water heaters, regulation, solar pumping groups, expansion vessels and reinforcement elements and insulated pipes.
In our region for the year-round needs of consumable heating water, solar energy as an independent source of heat is insufficient, so in the systems with the solar system there is a need for a conventional heat source (boiler for oil, gas, electricity or biomass (wood, pellets, cuticle ...)). It is important to know that solar systems collect and save the Sun's energy only when there is a Sun, i.e. if it is cloudy outdoors for several days, the solar system will not have hot water. For this reason, it is necessary to have a large amount of water (large water heater) in the system that can accumulate the solar energy when the Sun is out so that it can consume warm water at a time when the Sun is not there (most often

in the evening and in the morning). The components of the solar system need to be carefully dimensioned so that the heating system can be work well. The optimal dimensional solar system can satisfy from 45% to 75% seasonal needs for the preparation of consumable hot water and about 30% of the thermal energy for space heating.The water heating system functions in such a way as to heat the heat medium which the circulation pump transfers to the consumable hot water tank, while the heat exchanger warms the water. The solar control automatically switches on the circulation pump when the temperature of the medium in the solar collectors is greater than the water temperature in the tank, or it turns off when it is the same or smaller.

3. MORPHOLOGICAL MATRIX

The optimal heating system of consumable hot water can be determined using a morphological matrix. The morphological matrix is one of the key parts within one problem solving task assigned to engineers. Before the morphological matrix, experts involved in the development of solutions need to go through a series of preparation stages in order to form a morphological matrix or the principle of solution for a particular problem.
In this case, the system of heating consumable hot water, as one of the engineering tasks, has passed through the construction process, in order to determine the best or optimal solution.

Table 1.Morphological matrix

<table>
<tr><td colspan="4">Home heating system using solar panels</td></tr>
<tr><td rowspan="2">1. Type of solar collector</td><td colspan="2">Vacuum tube collector
  </td><td>Plate collector
  </td></tr>
<tr><td colspan="2">1.; 2.</td><td>3.</td></tr>
<tr><td rowspan="2">2. The type of solar fluid</td><td colspan="2">GlycosamTermofluid MPG
(based on propylene glycol)</td><td>GlycosamTermofluid HVAC
(based on ethylene glycol)</td></tr>
<tr><td colspan="2">1.; 2. ; 3.</td><td></td></tr>
<tr><td rowspan="2">3. Place of installation solar panels</td><td>Slantted roof
  </td><td>Flat roof
  </td><td>On ground
  </td></tr>
<tr><td>1.; 2.</td><td></td><td>3.</td></tr>
</table>

<table>
<tr><td rowspan="2">4. Solar differential automation</td><td colspan="3">Heat regulators
  </td></tr>
<tr><td colspan="3">1.; 2. ; 3.</td></tr>
<tr><td rowspan="2">5. The pump</td><td colspan="3">Solar pump group
  </td></tr>
<tr><td colspan="3">1.; 2. ; 3.</td></tr>
<tr><td rowspan="2">6. Storage for water heating</td><td>Solar water heater
  </td><td>Accumualtional water heater
  </td><td>Solar water heater installed above the solar collector
  </td></tr>
<tr><td>1.</td><td>3.</td><td>2.</td></tr>
<tr><td rowspan="2">7. Expansion vessel</td><td colspan="3">Expansion vessel
  </td></tr>
<tr><td colspan="2">1.; 2. ;</td><td>3.</td></tr>
<tr><td rowspan="2">8. Devices for additional water heating</td><td colspan="2">Condensation boiler
  </td><td>Accumulational tank
  </td></tr>
<tr><td colspan="2">3.</td><td>1. ; 2.</td></tr>
</table>

3.1. A variant solution

A variant solution presented as optimal through the valuation method based on technological and economic criteria is a variant solution 1, that is:

1. Vacuum tube collector
2. GlycosamThermofluid MPG (based on propylene glycol)
3. Slab roof
4. Heat regulators
5. Solar pump group
6. Solar water heater
7. Expansion vessel
8. Accumulation tank.

Figure 1. The optimal solution given from the matrix

One of the biggest differences in choosing the optimal solution was the choice of the type of collectors to be used. The type and number of collectors depend on several parameters: climate zone (continental and coastal part), turning collectors to the south, collector usage in seasons, the volume of water heater and accumulation tank, water temperature in the water heater and accumulation tank ... In summer months, vacuum and plate collectors can heat an equal amount of water, while in the transition period, spring and autumn, and in winter, more energy can be provided by the tubular vacuum collector due to its construction. This is one of the most important differences between these two types of collectors.

3.2.Vacuum tube collector

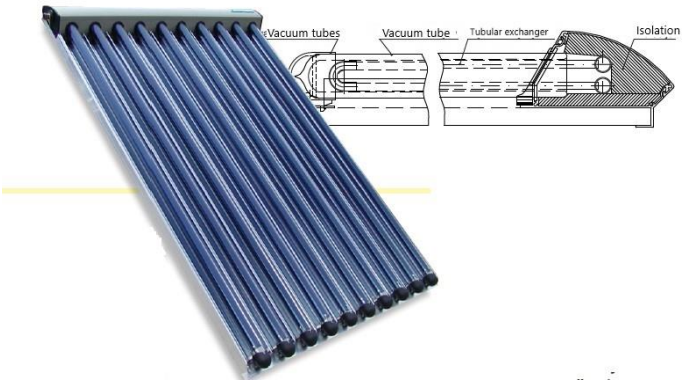

Figure 2. Vaccum tube collector

Benefits of the tubular vacuum collector:

- High-efficiency tubular vacuum collector with 10 tubes.
- Max. temperature of the collector is 286 ° C.
- Beneath each vacuum tube there is a reflecting mirror mirror which allows the use of the tubular tubes and tubes. Absorbent surfaces are extensively expressed in transient distances at small angles of decay of the sun.
- Installation is facilitated by the already installed frame with the individual collector.
- The collector is mounted on a slanted roof or on a standstill.
- By incorporating a collector into heating systems for hot water, water for pools and central heating systems, fuel is saved by legitimate energy sources, and thus the environment pollutes the environment.

3.3. Plate collector

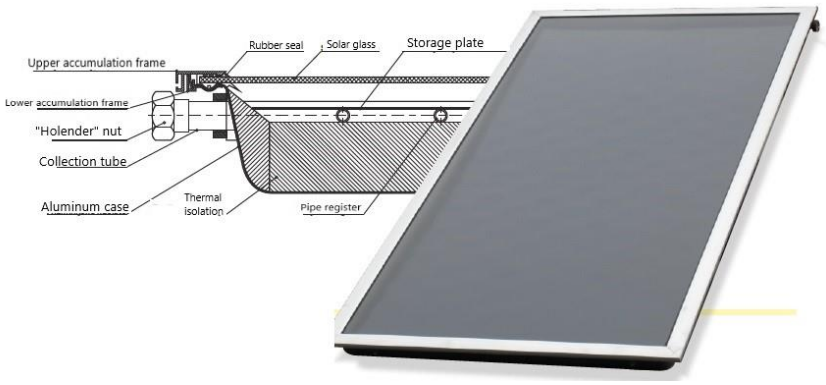

Figure 3. Plate collector

Advantages of a plate collector:

- Register of copper pipes (harp shape) is attached to the aluminum plate by welding with laser.
- The aluminum plate is coated with a high-efficiency selective pre-position and is positioned across the entire surface of the collector, which prevents the occurrence of air turbulences and unnecessary energy losses.
- The upper distribution pipe is blocked at half its length, thus ensuring two passages of the working medium through the collector.
- The collector is intended for installation only in the vertical position.
- The collector can be installed on the roof or as a free standing stand.
- The collector system is filled with a mixture of glycol and water, which ensures the whole year operation of the collector, without the need for discharging in winter.

4. CONCLUSION

The heating system of hot water through solar panels was presented as a very good solution for energy saving in the 21st century. But how much is this system actually paid off in the Balkans or, more specifically, in the territory of Bosnia and Herzegovina? The system is taken in an ideal environment without any problems that could affect the operation of this system. As far as realistic conditions are

concerned, in this area, the solution could be adapted to geographical conditions and it is not at all strange to see already established systems that function for a longer period. From the financial side, this system represents one of those investments that are paid for 7-9 years. Of course, after this period, the profitability increases as the money is returned, the water heating continues in a modernized way, the energy of the Sun is exploited, the environment is preserved, which is one of the best advantages of this system.

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CORPORATE GOVERNANCE AND SOCIAL RESPONSIBILITY IN "FIGHT" AGAINST ECOLOGICAL CRIMINALITY

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ABSTRACT

The technical-technological revolution has changed its core business activities and has created a new socio-economic and economic structure called: knowledge society, information society, digital society, digital economy and electronic economy. Enterprises are part of society they function in; therefore, they must, besides the implementation of economic objectives, pay attention to the impact they have on society and environment i.e., they should act responsibly. The growing conflict between economy, ecology and ethics (model "3E") must solve the corporate-social responsibility and global consensus around vital issues for the survival of mankind. Because of this, we are further improving our internal regulations by strengthening corporate governance, compliance, and risk management, in order to further increase corporate vitality and transparency. Therefore, we further improve our internal regulations by strengthening corporate governance, respect and risk management in order to further increase corporate vitality and transparency. This integration of logistics functions is part of the feedback logistics, which significantly contributes to the efforts to save the natural environment. In creating an organic product, Corporate Social Responsibility represents the commitment of the company / company to contribute to sustainability of economic development, working with employees, organizations, institutions and the local community in order to preserve products, health, quality of life and living environment. There is a significant interaction between eco-security and globalization. Namely, nowadays globalization does not show its influence and has more concrete effect and exposure than it is in the field of eco-security. In the field of eco-security, local threats can have global conditions. Likewise, the resolution of global eco-problems requires the engagement of all - global engagement. Globally, effective environmental protection can only be achieved through effective global cooperation. In this regard, it is necessary to establish a legal and political organization of the umbrella organization, which will deal with the issues of eco-security at the global level in the most direct, explicit and unique way. Feedback marketing logistics play a key role in the success of sports and environmental activities, which significantly contributes to the health and quality of life and respect for eco-values in ambient conditions.Corporate governance is based on a way of sharing rights and responsibilities in a group of corporate actors, especially shareholders and managers in all areas of human activity. Environmental quality management in this co-authoring work is defined as the management of all activities in society that have or may have an impact on health and quality of life. University management aims at business activities in a way that contributes to the success of learning and development of younger generations in order to reduce environmental degradation and ensure a brighter future for present and future generations in the Western Balkans and beyond. To be socially responsible does not just mean fulfilling legal obligations, but rather go beyond full compliance with legal regulations and invest even more in capital, environment and

relationships with stakeholders. The stakeholder is in inextricable relationship with management. What are stakeholders? What are the interests and needs of the stakeholders? These are some essential questions for eco-product safety, and have explanations in this co-authoring work.

Keywords: corporate governance, social responsibility, stakeholders, eco-crime, eco-security, sustainable development

1.INTRODUCTION

The man is surrounded by nature and part of it, it contains all that is needed, and the destructive forces lead to more and more eco-hazard and (un) sustainable development. In a constant "struggle", man has reached yet another powerful natural force, to nuclear energy and numerous chemical compounds-mixtures and biological agents. This is another series of scientific and technological inventions that can help a person, but also to endanger and destroy him. Nuclear danger - the phenomenon of the modern era, certainly with its action unpredictability, represents, and it will be in the future, a great threat to humanity, especially in the conditions of ever more present eco-terrorism.

Always, and especially in modern conditions of existence, between eco-security and globalization there is a significant interaction. Any state in question, the region as well as the continent, can be affected by significant eco-problems. The green garden effect does not leave immune to Europe, Asia or America, or any other part of the globe. Also, nuclear radiation, the euthanic use of NHB weapons, NHB terrorism, or any other type of weapons of mass destruction

Data security risks can be divided into legal risks, ICT risks and risks of physical damage or destruction. When talking about legal risks, they are reflected above all on non-conformity, poor external regulation and the lack of internal protection in companies, while ICT risks include high-tech crime and failures, and the dangers of technical and technological processes. Risks of physical damage or destruction can be divided into fires and explosions, natural disasters and property and commercial crime, terrorism and other types of eco-crime, above all.

Business protection measures, etc. Secrets are determined in accordance with the risk assessment of the illegal acquisition, use and disclosure of information representing business secrets. This kind of business deals primarily with specialized institutions, executive management, managers and executives in the corporate security and legal sector, or all who are In any way related to security issues in companies, institutions, large enterprises and other organizations.

In the coming period, in the Western Balkans and the environment, the participation of leading domestic and foreign experts in the field of public, private, corporate and urban security is expected in order to exchange and consolidate their experiences. The main topic of this year's and next security / security days is security and economy , An actual challenge for the administration of companies and the security sector.

Cooperation in the field of eco-safety in the promotion of environmental protection, in general, must have a significant place in the general integration flows and globally. The very nature of environmental security points to the need for cooperation, and this is the only way to avoid the prevention of possible accidents in the field of eco-security.

Therefore, in the field of eco-security, local threats can have global conditions. Likewise, the resolution of global environmental problems requires the engagement of all, or global engagement. However, in such situations, it is necessary to note that investment in environmental protection is drastically different from country to country, according to their economic power and access to a block, first and foremost. In this sense, it is difficult to build any global standard, which all countries could fulfill, and again, on the other hand, this standard is inevitable and is no longer a matter of protecting the environment but the survival of the human species on the earth in general. Therefore, the necessity of treatment is necessary and urgent. Part of the problem is to solve the problem through international conventions and organizations.

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2. EMERGENCY SITUATIONS AND ECO-CRISIS

In ecology, the word "extraordinary situation" is today one of the most commonly used words by mass media, and in everyday life it is often heard or read. Environmental emergencies have become more frequent, more diverse, regardless of whether they have been created by the action of nature or man, each day they cause more and more consequences for people, material goods and the environment. Bearing in mind all the features of the 21st century, terrorist emergencies pose a serious threat to national and regional security.

Extraordinary situations are one of the constants of human history and its conceptual definition is determined primarily by the various types of dangers that endanger the safety and which, caused by the nature of the action or the activity of a human factor, can lead to its creation in a certain territory, which is difficult to suppress within the framework Eco-safety and sustainable development.

In this co-authoring work we will pay special attention to applying clear rules of work and establishing the principles of corporate governance within and social responsibility, from the aspect of eco-security and sustainable development, which should include:

1) transparent management and administrative control systems,
2) consistent and rational management of corporate finances,
3) social responsibility of the corporation.

The effective organization and work of the Board of Directors, the Internal Audit Committee, the Remuneration Committee, the Success Committee, the Corporate Governance and the Board of Executive Directors of the company play a major role in achieving these objectives in an atmosphere of responsibility, mutual trust and consent. To meet the expectations of our stakeholders, including employees, partners, customers, shareholders, suppliers and all the other communities in our ecosystem, World businessman Safran has made corporate social responsibility (CSR) an integral part of its growth strategy. Our CSR policy is grounded in six strategic priorities that are fully aligned with the Group's global strategy, actions and commitments.

At Safran, we see corporate social responsibility as a source of growth and performance improvement. Our core commitments of innovating to protect the environment, striving for excellence in the protection of people and goods, valuing our employees, suppliers and partners, and affirming our values of integrity, are pursued with all internal and external stakeholders.

Safran's corporate social responsibility policy encompasses all of the Group's stakeholders: customers, shareholders, suppliers, employees, unions, community associations, government authorities and institutions, financial analysts and ratings agencies, consumers and the media. This policy is anchored in the ethical values that form the basis of our corporate culture and are shared across the Group: responsible corporate citizenship, people development and recognition, meeting commitments, and the power of teamwork.

Figure 1. Safran policy is based on six strategic priorities which were defined

A structured approach-To ensure that behavior is consistent with our ethics and values, Safran's corporate social responsibility policy is organized and shared across our global organization:

CSR sponsor at Safran Corporate Management and on the Executive Committee,

CSR authority (Diversity and CSR Manager),

CSR steering committee (representing all departments concerned),

CSR correspondents at each Group company worldwide.

Underscoring our integrity-based approach, in 2013 Safran signed the United Nations Global Compact, proof of our commitment to uphold the universal principles of human rights, labor standards, environmental protection and the fight against corruption.

Safran completed the mapping of its CSR issues, also referred to as a "materiality analysis[(1)]". This was done by surveying its stakeholders in late 2014. An analysis of this kind participates in the Group's reflection on its strategy of Corporate Social Responsibility and ensures that the most relevant issues are taken into account.

Thirty relevant issues were listed and validated by the Group's CSR steering committee. These issues have been grouped according to five major themes: governance , products and services, sSocial and management, society and environment.

Secondly, interviews with both internal and external stakeholders were conducted from a grid defining these issues. The procedure required the respondent to assess, on a scale from 1 to 4, the importance of each of these issues by answering the question:

- As an internal stakeholder: *Is this issue likely to affect Safran's business?"*
- As an external stakeholder:*What are your expectations with regard to Safran in relation to this issue?*

This evaluation was supplemented by qualitative feedback, derived from interviews with all respondents. Internal stakeholders (eleven interviews) are representative of the company's various businesses. External stakeholders (ten interviews) were selected among customers, suppliers, authorities or experts.

Figure 2. Safran's corporate-social responsibility policy

The analysis of this map highlights a convergence of perceptions among all respondents. Indeed, in most cases, internal stakeholders rated the importance of each issue in the same way as external stakeholders. This illustrates that the importance of these issues is taken into account upstream by the company.

It emerges from this analysis that the priority issues are:

- anti-corruption and business ethics;
- responsible relationships with suppliers;
- quality of products and services;
- continuity of business and procurement ;
- customer relations;
- intellectual property and access to technology;
- safety of products and services;
- These results will be used by Safran to continuously improve its performance while taking into account the ongoing dialogue with its stakeholders;
- The concept of materiality refers to the importance of issues such as sustainable development, i.e., their positive or negative influence on a company's business (its ability to create, preserve and redistribute value) and on that of its stakeholders. The end result of the analysis is often presented in the form of a matrix, a materiality matrix, which cross-references the expectations of internal and external stakeholders in graphic form;
- Safran is driven by the values and ethics shared by all of our employees. We conduct our business in compliance with the highest standards of honesty, integrity and professional behavior. Through this approach, we strive to be worthy of the trust placed in us by our customers, employees, shareholders, suppliers and all other stakeholders.

In 2005, Safran introduced Ethical Guidelines defining the principles and standards common to the Group, to provide a shared reference for employees under all circumstances. These guidelines are not intended to replace or override current laws and regulations, but rather to provide reference points for everyone in their professional conduct. Safran naturally complies with all laws concerning the fight against corruption and export controls.

Safran employees must uphold the laws in all countries where we operate. We are especially attentive to this point because understanding the applicable laws may be more difficult in cultural and legal environments very different from those where employees have worked in the past. If there is any doubt, employees should immediately ask their manager or the company's legal department. Employees who work for a company jointly owned by Safran and another company must respect the laws of the host country, as well as the laws of countries where the company does business and where its shareholders are based. All of Safran's employees should be guided by integrity, honesty and transparency in their professional conduct.

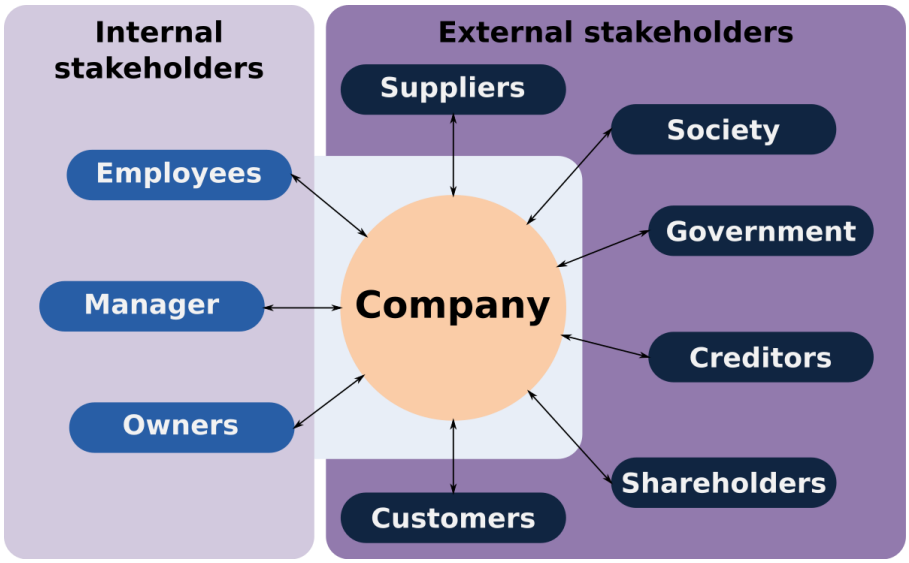

Figure 3. Security challenges and stakeholder interest in corporations

Employees are expected to deal with customers, suppliers and business partners in the Group's interest and in compliance with laws and regulations. All personnel must take particular care to uphold laws on competition, export and re-export controls, labor and employment, safety, health and environmental protection.

Safran, its companies and employees will tolerate absolutely no form of corruption, whether active or passive, direct or indirect, for the benefit of players in the public or private sector. Group companies comply with all international agreements concerning the fight against corruption, as well as the anti-corruption laws applied in countries where we do business. The Group, its companies and employees, may never use a third party to perform any task that they are ethically or legally forbidden to do themselves. Engaging a third party for the purpose of bribing an individual or legal entity violates anti-corruption laws. Prior to entering into a contractual relationship with a business partner, the Group's companies must undertake a methodical and fully traceable selection process.

Business courtesies, such as gifts and hospitality, given to or received from customers, suppliers and other partners are solely used to build brand image and maintain good business relationships. However, these courtesies must not exceed a nominal value and may not influence, or give the appearance of influencing, any business decision. Safran should always be guided by common sense, discretion and prudence in these situations. Business courtesies are prohibited by law under certain circumstances and in certain countries. Safran's employees must comply with the applicable laws and regulations in each country where we do business.

As a global enterprise, Safran purchases goods and services from a diverse range of suppliers. The Group also provides goods and services to customers all over the world. It is therefore critical that Safran strictly comply with all applicable regulations that govern its export activities. Before engaging in any export activity, Safran employees must verify the eligibility of both the delivery location and the recipient. They must also obtain, when applicable, all required licenses and permits, including government authorizations and approvals for regulated products or technologies. These authorizations can be obtained from the relevant authority in conjunction with Safran's export controls organization. Import activities are also subject to various laws and regulations, and it is the responsibility of Safran employees to comply with applicable standards. Any breach of these import and export regulations may have serious consequences for the Group. It is Safran's responsibility to know and comply with the laws and regulations that apply to the Group's activities.

It is necessary for Safran to collect certain information about its providers, customers and prospective customers including personal data in order to comply with applicable export control laws and regulations.

Reflecting our full commitment to fair competition, Safran strictly complies with all competition laws in the countries where we do business. These laws generally prohibit agreements or practices that could restrain or undermine trade or competition. In particular, they ban price fixing, bid rigging, splitting markets, territories or clients between competitors, or boycotting or discriminating against certain customers or suppliers without legal justification. The discussion or disclosure of commercially sensitive information relating to competitors, customers or suppliers may also violate applicable laws.

Each employee must uphold the principles of fairness and integrity in dealings with customers. Since Safran's business largely concerns air transport safety, there can be absolutely no compromise. Any situation that seems questionable to an employee must be immediately reported to management or a Quality manager.

Safran ensures that all shareholders simultaneously and effectively receive, on a timely basis, complete, relevant and accurate information that is consistent with previously published information. We takes particular care to apply international corporate governance standards and recommendations.

Safran selects suppliers on the basis of objective criteria and demands high performance to ensure that we can fully meet our expectations and those of our customers. Under no circumstances will Safran use suppliers that employ children or use forced labor. In 2010, Safran signed a charter governing relations between major contractors and small and medium-size enterprises (SME), under the auspices of the French Ministry of the Economy, Industry and Employment.

Under no circumstances may employees damage Safran's reputation or compromise the integrity of its assets or information systems. Paid work of any kind that employees may perform outside the scope of their employment with Safran must not cause conflicts of interest with their duties within the Group. From the same standpoint, considerable caution is required when purchasing shares, directly or via an intermediary, in companies doing business with Safran. These restrictions do not apply to listed companies, except if confidential information is used, which may be construed as insider trading.

Protecting the environment is more than ever a vital concern of all Safran employees, starting with product design and development, and concerning the entire production process, as well as disposal at end of life.

Safran does not finance any political parties and any political activities must be performed outside the workplace and working hours. Any employee religious practices must be practiced exclusively outside the workplace and working hours, except in the case of a legal exemption.

Employees must protect all information acquired in the course of or in connection with the performance of their duties. In particular, they must pay particular attention to complying with internal rules and requirements concerning both written and oral communications.

In the course of their duties, all employees have access to confidential information, which represents a key asset for Safran. Confidential or classified information is considered sensitive, and must not be disclosed or communicated outside of the Group. Similarly, Safran employees may hold information concerning the national security of the country in which their company is located. They must therefore take special care to ensure that this information is not divulged to third parties. Any information that could influence the Safran share price must remain confidential, unless it has been published by Safran. Any use of this information for personal benefit would constitute insider trading and could expose the employee to both civil and criminal liability.

Ensuring our people's health and safety is a primary goal at Safran. We are an equal opportunity employer; hiring and promotion are solely based on professional qualities and results. We fully respect the dignity and private life of each employee. Furthermore, one of our core values is to create the conditions needed for all employees to be fulfilled in their chosen profession. All Safran companies comply with the personal data protection rules known as the "Binding Corporate Rules" (BCR), applicable to the processing and transfer of data outside of the European Union.

Each employee is asked to read, understand and comply with Safran's Ethical Guidelines. In the event of a question or any doubt regarding appropriate conduct, it is the responsibility of the employee to immediately contact a manager or the Legal Department. Each employee has a binding obligation to comply with these Ethical Guidelines.

Safran was the first company in the French stock market index CAC 40 to receive anti-corruption certification from the information technology agency ADIT.

Following an audit carried out from September 1 to December 15, 2012, on December 23, 2012 Safran was awarded anti-corruption certification by ADIT (*Agence pour la Diffusion de l'Information Technologique*). This certification was conducted on the basis of standards approved by the SCPC (*Service Centrale de Prévention de la Corruption*), an interministerial corruption prevention department reporting to the Minister of Justice.

The certification is valid until December 2015, and recognizes the effectiveness of the processes deployed by Safran and our efforts over the last few years to upgrade our rules and procedures to establish them on a par with best-in-class international standards.

The certification audit, carried out in compliance with current international standards (ISAE 3000, International Standards on Assurance Engagements), entailed an evaluation of Safran's corporate culture and commitment to implementing the anti-corruption program (based on a clear policy and broadly circulated ethical guidelines, the deployment of Compliance Officers, an effective risk management policy, control and measurement activities to apply the program and wide circulation of relevant information both within the company and externally).

This certification will be applied to all Safran Tier-1 companies from now until 2017: Sagem and Morpho were certified in early 2014; Snecma and Turbomeca will be certified by the end of 2014; Messier-Bugatti-Dowty and Herakles in 2015; Labinal Power Systems and Techspace Aero in 2016; and Aircelle and Hispano-Suiza in 2017.

Known for our excellent products and services, Safran drives economic, social and cultural progress, and shares the fruits of these improvements. For example, we are committed to developing a culture based on prevention, to more efficiently manage all health, safety and environmental risks. We actively contribute to social inclusion and equal opportunity through a corporate policy that promotes the integration of underserved communities, and by promoting diversity throughout our organization.

Safran has defined Group-wide requirements in terms of trade compliance. We deploy a network of Trade Compliance Officers, backed by comprehensive training, to ensure the strict application of these requirements. We are involved in a number of international initiatives, placing us in the front lines of the fight against corruption.

Safran has defined strict trade compliance requirements, applicable to all of our companies. Each company applies these requirements in terms of operating procedures tailored to its organization, products and markets.

Lobbying can be defined as "*Any communication, written or oral, between a representative or an interest group and a public decision-maker in order to influence decision-making*."

The World Economic Forum asks business leaders to work for a corruption-free world. Safran is an active member of the "Aviation and Travel Partnership Against Corruption Initiative: Safeguarding Aviation and Travel Value Chains."

Safran strictly complies with all regulations concerning its import and export activities for military and dual (civil/military) technologies.

Facing today's ecological challenges, Safran applies a strategy of reducing our environmental footprint, by designing more environmentally-friendly products and sustainably managing our production facilities. But also by its implication in the European program Clean Sky in which it participates since its launch, in 2008. The Group plays it a major role, in particular in the field of engines and aeronautical equipment.

Decreasing atmospheric pollution has been one of the main design criteria for Safran engines for a number of decades.

Limiting aircraft noise during the takeoff and landing phases facilitates the responsible development of air transport. Safran designs systems and equipment that help reduce the noise generated by aircraft.

3. EXAMPLES OF GOOD PRACTICE IN ACCIDENTS

At present, all over the world the problems of radiation emergency response are addressed through establishment of the specialized crisis centers. In Russia, this concept was adopted about twenty years ago, and the first operating organizations were established in 1987. shortly after the Chernobyl accident.

The top priority task of TCC IBRAE RAN is assessment of release consequences and development of recommendations on population and environment protection in emergencies at nuclear and radiation hazardous facilities. This task is performed in one of three modes: daily activities (with around the clock duty of experts and OPAS group- the group to assist the nuclear power plants), elevated preparedness mode or emergency mode.

ATG, IAG and TG are the permanent groups of TCC organizational, informational and technical support, EG functions during exercises, drills or in emergency situations.

a)TCC ATG functions:

- coordination of all TCC activities,
- organizational support of TCC in the modes of daily activity and emergency situations,
- warning and assembly of TCC personnel,
- guidelines on assembly of the full TCC staff (by a decision of the TCC head or IBRAE management) in accordance with operation mode and procedures of notification, assembly and involvement of pre-defined additional forces and resources from IBRAE reserves;,
- information interaction with other organizations participating in emergency response,
- participation in preparation of materials for the main TCC activities,
- long-term planning of the measures to protect the population and territories in emergencies.

b)TCC IAG functions:

- daily maintaining of operability of TCC software,
- improvement of methodical, information, hardware and software tools and maintenance of TCC software and hardware,
- information and analytical support of TCC EG in exercises and emergencies,
- preparation of information and analytical materials.

c)TCC EG functions:

- analysis and correction of the characteristics of contamination source,
- analysis and correction of the levels of radioactive contamination of environment and exposure doses for population,
- analysis of radiological situation and making the recommendations for population protection and other measures aimed at mitigation of accident consequences,
- interaction with the experts of crisis and support centers of the agencies and organizations,
- participation in preparation of information and guidance materials for the population within the area of emergency.

d)TCC TG functions:

- maintaining of operability of TCC equipment,
- implementation of measures for development of TCC technical capabilities, including innovations,
- technical support during the exercises or emergencies.

TCC equipment includes hardware needed to successfully meet the challenges of scientific and technical support to emergency response participants:

- up-to-date automated workstations for personnel,
- video conferencing system and satellite communications,
- equipment for audio and video presentations,
- servers and communication equipment,
- cluster computing installation of IBRAE RAN for resource-intensive computations,
- uninterrupted power supply system and diesel generator,
- dosimetric equipment.

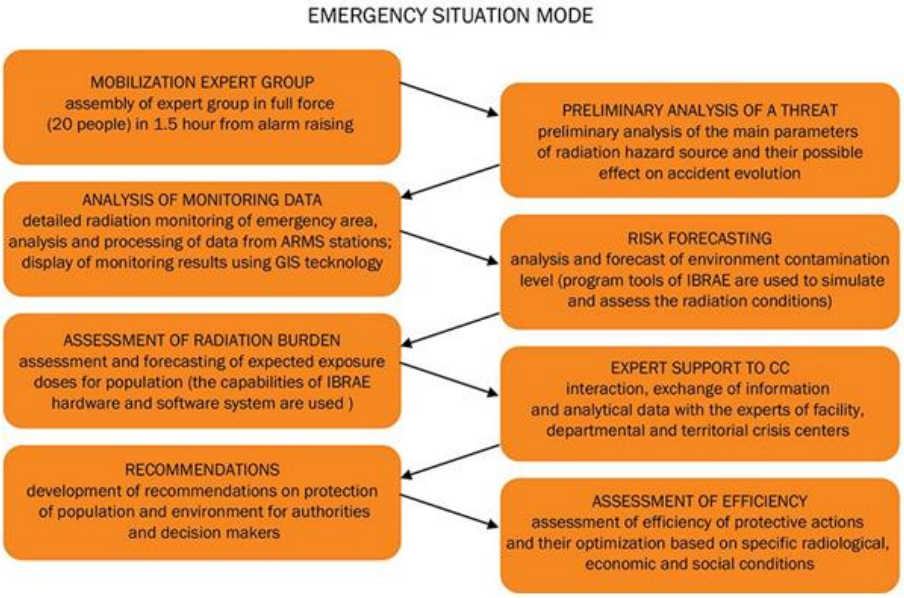

Figure 4. Technical crisis center of nuclear safety institute

The experts and specialists of TCC IBRAE RAN have wide experience in mitigation of the consequences of radiation accidents and incidents. Even before establishment of IBRAE, many of them were included in the Chernobyl expert group under the leadership of L.A. Bolshov. This activity was followed by work on assessment and prediction of radiation conditions at the site and in the observation area of Armenian NPP after the Spitak devastating earthquake in 1988.

In October 1999, express analysis of possible evolution of beyond design basis accident at the nuclear fuel plant in Tokaimura was conducted at TCC IBRAE RAN upon request of the Japanese Embassy in Russia; and at the request of Minatom of Russia, analysis of the impact of the radiation incident at the South Korean Volsung-3 NPP was carried out and recommendations were made to minimize the consequences of these accidents. In their subsequent work, the TCC experts provide scientific and technical support to the actions on localization of all more or less serious radiation incidents both in Russia and abroad.

4. FUNDAMENTALS OF GLOBALIZATION SECURITY

The concept of security is one of the fundamental preconditions for the existence of a social community. It is the basic function of each state, since without a proper level of security we can not talk about democratic governance, or the stability of the society as a whole**.**

If we look at the etymological significance, in our field of speech, two terms are used: security and safety. Security itself comes from the Latin word securitas-atis, which means security, absence of danger and certainty, self-confidence, fearlessness, protection (securus-safe, carefree, reliable, fearless, confident, steady, firm, loyal, true). Thus, in English, two expressions are used: security and safety.

The term security is used in the sense of "national security" (secure-secure, secure) -national security, which means the achievement and preservation of state-national interest, while the term safety signifies the ability to function so as not to cause a security situation or such opportunities that can Also cause security implications. In the French language there are and are used the expressions of the Securites and Beliefs, while in Russian the term security is used, which means the absence of material misery. In Italian, this is a sicurezza (sciuramente- sigurno), in Albanian siguri, while in Germany this term is sicherheit.

Safety and security terms have almost identical meanings, although they are not synonymous. Safety is derived from the word safely, which in essence represents security, security with the greatest

confidence, firm, decisive, without hesitation, constantly, without interruption. On the other hand, the notion of security implies the condition, that is, the characteristic of the one who is safe, that is to say, that it does not threaten somebody or something from danger, in more specific terms, it means the absence of danger, security, determination, firmness, certainty, clarity, Determination, consistency, etc. For Tomas Hobs' security is the most basic value on which humanity has built its individual and collective lives.

In the Political Encyclopedia, security is defined in the most necessary legal sense. It "includes measures and activities, safeguards and protection from endangering the independence and integrity of one country and the internal constitutional and legal order". In the first case, it refers to the outside, and to the other on internal security.

According to the 1985 UN definition, security is a state in which states consider that there is no danger of a military attack, political coercion or economic coercion, so that they can freely develop

The most complete definition, from the legal point of view, was given by Slobodan Miletic. It defines security as "well-regulated and secured social relations, established, maintained and improved state of affairs in a country that enables the effective protection of the state and citizens living in it from all (external and internal) unlawful acts (activities) that endanger the constitutional order, sovereignty , The independence and territorial integrity of the state, the work of state organs, the performance of economic and social activities, and the exercise of the freedom, rights and duties of man and citizen "

Defining the term "security", prof. Javorović emphasizes the following: Safety is a state in which there is no disturbance of the normal "state of things due to various threats and danger; security as a state of full balance between man and nature and their interaction, which does not lead to degradation of nature and Quality of the human community", that is," security as a state of balance between constructive and destructive forces, in which there is no disturbance and degradation of the ecological system, the civilization of the human community, man and his values and values, or they do not exceed the scope of development "**.**

It is evident that the definition of prof. Javorović includes terms such as "the state of full balance between man and nature", "degradation of the nature and quality of the human community", "degradation of the ecological system" and the like, which places him in rare authors, at least in our region, Which in particular in the general definition of security incorporates both ecology and eco-security.

In general, there is no single understanding of the concept of security. From different definitions and visions, it is possible to differentiate internal and external security. When it comes to the difference between the concepts of national and state security, most authors do not distinguish between these two terms. Whether the determinant is national or state security depends on the very object of security, or the subject to be protected. As a security object, a state can appear, and hence the state security or nation, in which case the security assumes nationality. When it comes to state security as a security object, it can be a state as an institution, a majority nation, or all members of society, regardless of religion, nation, ideology or any other affiliation.

In this regard, the issue of some other types of security that would be determined by the security object is posed logically. Thus, international and global security, as well as the security of some other collectivities, arise. The paradigm that monitors security is reflected in who is the subject behind certain types of security.

If an individual stands behind individual security, behind the national, state, or nation, the question arises which entity is behind global security. In the era of total change of the global image of the world, the integration processes and the contemporary security challenges of the risks and threats of the national strategy, they are increasingly giving way to international, bloc and global tactics, while states largely limit their sovereignty and transfer it to some other non state entities. In this respect, the modern concept of security has been greatly redefined and changed in relation to the traditional one both formally and substantially.

Ecological safety is one of the most important security factors in the world of savvy. This syntagm is most often viewed and defined as "the absence of threats and damage", in fact, the exclusion of any activity of a person that is harmful to nature, health, quality of life and environmental safety in general. The perception of issues and problems of ecological security points out direct connection with

environmental protection, as essentially inseparable phenomena. It is a process of protecting vital interests of individuals, society, nature, the state, the region and the world from real and potential threats caused by anthropogenic or natural impacts on the environment.

Literature sources show that the most common risks in the work and environment that can affect ecological safety are as follows:

- high-risk industrial processes and handling of toxic and radioactive materials,
- radioactive contamination and toxic pollution,
- uncontrolled disposal of radioactive and military waste,
- unsatisfactory collection and disposal of solid waste,
- inadequate management and pollution of water resources,
- inadequate management and degradation of soil and soil,
- natural disasters and accidents (floods, earthquakes, droughts, fires). ..

In addition to the impact of these anthropogenic factors and natural disasters, there is a real potential risk of new security risks that can turn into crises and threats to environmental security (various military and non-war risks and threats such as wars, terrorism, proliferation, political risks, refugees, etc.).

In academic speech, the crisis signifies a phase of disorder in the seemingly normal development of a system, and this complex phenomenon is often used as a concept that includes all types of negative events and, more broadly, applies to situations that are unwanted, unexpected, unpredictable, and almost Inconceivable, and cause unbelief and uncertainty

Although the term is often used up, globalization has no clear and precise definition. True, there are definitions that are more or less general, abstract or concrete, influential or less influential, but some unique answer to the question of what globalization does not have. According to the definition of the International Globalization Forum, globalization is the process of denationalization of the market, policy and legal system at the highest political and economic level.

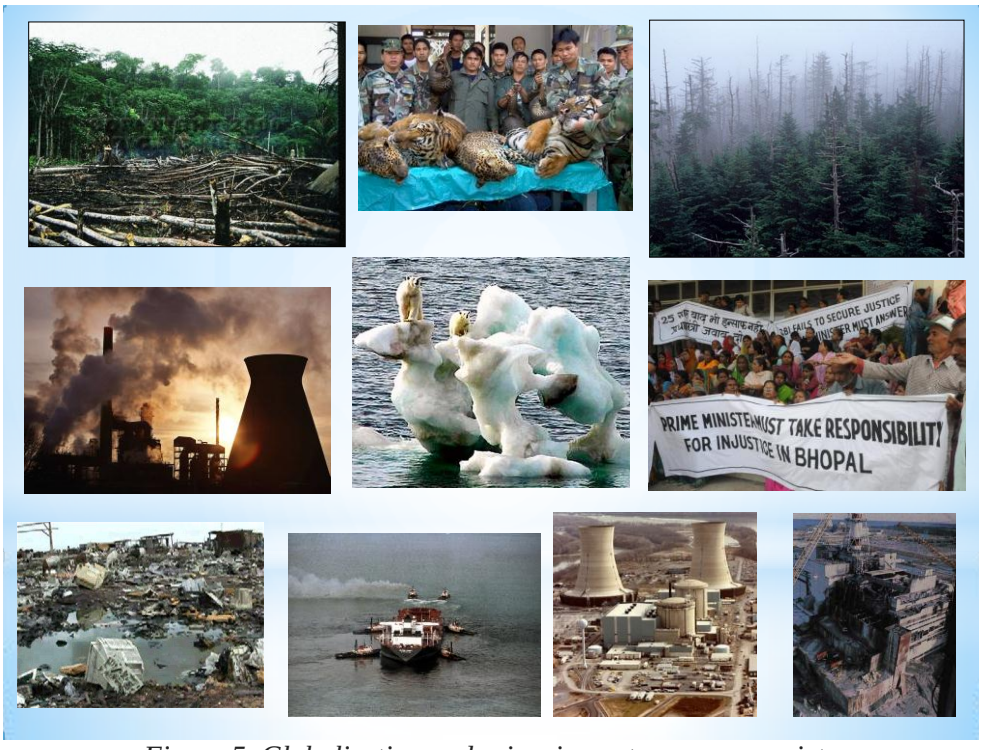

Figure 5. Globalisation and crime in contemporary society

Globalization is generally understood as the " consequence of modernity ", "western modernization project " as a " global human condition ". The strong effects of governance and the spread of globalization

processes to everyday life, and especially in developed countries. Globalization is at the same time the creation of new transnational systems of power and the transformation of the institutions of the society in which we live. Those nations who believe that they have achieved their national dreams in the past decade (now have their own state), now operate in a globalized space and time, as much as they accept the values of a globalized society and its criteria for the success of transitional movement.

In his book History of History, English scientist Arnold Toynby argued that in the history of society there existed and there exists a pluralism of civilizations. In the world society, the conflict of civilizations is dominant, because "today's civilization" is the result of the merging and overlapping of several individual global civilizations: Western, Chinese, Japanese, Islamic, Hindu, Slovenian-Orthodox, Latin American and African civilizations.

Globalization denotes all those processes by which people around the world are incorporated into a world society, or a global society (Albrow). Globalization is the unstoppable integration of markets, national states and technologies in an unprecedented degree, enabling individuals, corporations and national states to expand their activities through the world faster, deeper and cheaper than ever before (Friedman Thomas). Globalization is connected with the crisis of a territorial national state, because the national state is too small to solve a major life problem, and too great to solve small life problems (Bell). Globalization means that the world has become a global supermarket, in which ideas and products have become available everywhere and at the same time gathered to promote the idea of globalization.

At the same time, international relations for the first time really became global. Communications are current, and the world economy functions simultaneously on all continents. The whole range of problems that have arisen (uncontrolled expansion of nuclear weapons, NHB terrorism, environmental threats, demographic explosions and economic interdependence can be solved only at the world and regional level.

5. GLOBAL ORGANIZATION AND "FIGHT" AGAINST ECO-CRIME

Environmental crime typically refers to any breach of a national or international environmental law or convention that exists to ensure the conservation and sustainability of the world's environment. Five areas are considered to be of major importance: illegal trade in wildlife, illegal logging and its associated timber trade; illegal, unreported and unregulated (IUU) fishing, illegal trade in controlled chemicals (including ozone-depleting substances) and illegal disposal of hazardous waste. New types of environmental crime are also emerging, for example in carbon trade and water management.

Environmental crime is one of the most damaging, high profile and economically significant fields of global criminal activity – second only to drug trafficking, and is pushing our planet to the point of eco-system collapse.

As the biggest threats to eco-security globally, the following can be distinguished:

- demographic expansion;
- nuclear energy and any other form of energy, which is transmitted by modern technological achievements;
- massive cutting and devastation of forests, which reduces the amount of oxygen on the planet;
- the bird, small animal and fish mortality;
- global warming due to the wear of the ozone layer, which results in the creation of greenhouses;
- problems of hazardous waste management (industrial, medical, military, pharmaceutical);
- abuse of the achievements of biological and medical sciences based on whose research it has come to life production of genetically modified organisms;
- harmonized (sustainable) development.

From the global aspect of eco-security, the so-called "Hazards". These are special hazardous industrial areas, the existence of which is a potential risk of an ecological accident occurring. The geographical and geo-strategic position of the country is of great importance for eco-security, especially in terms of global security. Thus, for example, when the famous accident of the nuclear power

plant in Chernobyl occurred in 1986, the countries of the former SFRY were found to be hit by precisely because of its geographical location and sensitivity to radiological contamination

So today, there is a new form of crime that has a particular danger, which is eco-crime. Its danger is much higher than in other forms of crime, in that it takes on global and regional circumstances both in terms of rapid expansion and mass, as well as in the breadth and severity of the consequences it can cause. Namely, the consequences caused by eco-crime are irreversible in most cases.

Today, the two most important international organizations dealing with environmental protection and eco-security, which operate globally and have legal and political capacity under the auspices of the UN, are UNEP and UNDP.

The United Nations Environment Program (UNEP) is the UN Environment Program on a global scale. Its headquarters are in Nairobi, Kenya, with offices all over the world. The program is based on UN Resolution No. 2997 (XXVII) of December 15, 1972. The Program is managed by the Steering Council, which reports to the UN General Assembly about its work. The council has 58 members from different regions of the world. The aim of the program is to create and strengthen partnership in the protection and development of the quality of the environment.

The United Nations Development Program (UNDP) is a UN development program that advocates linking countries to develop and share experiences in order to achieve better living conditions. The organization covers 166 countries around the world and is of a global character. The program covers the following areas: democratic governance, poverty reduction, crisis prevention and recovery, environment and energy, and the fight against HIV / AIDS. Therefore, it is evident that UNDP is developing an entire area called the environment and energy efficiency. In this respect, the organization deals with the following areas of the environment: sustainable development strategy, water management, sustainable energy, sustainable land development, biodiversity, chemical management, national policies and programs for the control of hazardous radiation from radiation and waste.

In addition to numerous non-governmental organizations operating around the world that do not have a specific coordination or a joint global strategic action plan whose role, the truth is not negligible, except for UNEP and UNDP, there are no significant environmental organizations in terms of quality and comprehensive NHB Protection and eco-security. UNDP and UNEP, undoubtedly by their structure, network, number of members and the financial fund, represent a significant subject of global eco-security.

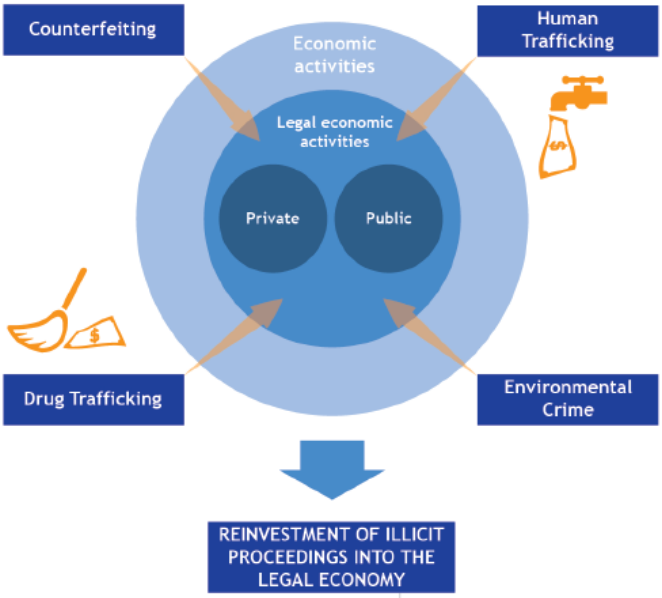

Figure 6. Theoretical Model of the Modus Operandi

General co-operation between states in the field of eco-security is more developed than economic or political co-operation. In this sense, more help is provided by more developed countries to the underdeveloped ones. In this regard, the mass media and non-governmental propaganda promotes environmental protection and eco-security, with the aim of raising awareness among all countries around the world about the importance of eco-issues and "fighting" against eco-crime. In order to make it more efficient Cooperation in the field of eco-security, it is necessary to take the following measures and activities:

- to legally regulate potentially hazardous industrial systems through hazard maps, and in this respect to establish a data exchange and notification system;
- Legally prescribe the standards and measures taken in certain situations of threats to eco-security, which would be unified for all countries according to the possibilities;
- legally regulate the protection of watercourses, cross-border pollution / air, soil and water contamination, ecological aspects of international traffic;
- legally and politically determine an umbrella organization that will deal globally on the most direct, explicit and unique way to issues of eco-security.

6. ECOLOGICAL SAFETY IN THE POST-MODERN ENVIRONMENT

Ecotoxicology and Environmental Safety focuses on integrated mechanistic research related to shortand long-term pathways and interactions of substances and chemical mixtures in environmental systems and subsystems on their bioavailability, and assimilation in organisms, as well as biological responses of these organisms, and damage mechanisms (endocrine disruption, genotoxicity); and on their subsequent fate in the environment, food chain, including humans.

Novel technologies, techniques, and methods such as biomarkers, biosensors and bioanalytical systems, bioremediation methods, QSARs and QSPRs, advanced high performance computational methods, models, and their applications in obtaining and processing interdisciplinary ecotoxicological information are also addressed in this co-author's work.

We welcome the applied outcome of complex ecotoxicological research such as developing the science-based Environmental Quality Criteria, standard toxicity tests, techniques, and methods for ecotoxicological evaluation of the environment, as well as developing ecotoxicologically proven methods and technologies for prevention, interception, and remediation of human-induced damage to ecosystems.

Emphasis is placed on ecological animal models rather than laboratory based rodent studies; The above scope of the journal is aimed at providing science-based tools for sustainably managing the environment through risk assessment, risk characterization, risk prediction, and risk management.

In the current post-modern environment, if people can so adversely affect the planet Earth, then we are able to correct something. This will require new forces, new ways of thinking, smarter methods of production, wise consumption, and new systems of financing and risk management. In this section the issues of NHB accidents / events are being actualized, the possible solutions of NHB protection are proposed, including the fundamental changes in global, food, energy and financial systems that are necessary to meet the needs of current and future generations-sustainable development.

Backpropagation neural network for sufficiently large training, a sample as it was for a larger medium of people gave satisfactory results. Re-equilibrium and ecological stability of the eco-system can be established only by radically removing disturbances that have caused changes, applying ecological criteria at all stages of production, exchange and consumption, as a general elimination of the causes of disorders in modern industrial, military and other institutions

Process and system approach involves the prescribed organizational behavior of employees to institutions, corporations and enterprises, with active participation of staff. In addition to the behavior of employees, the behavior of managers in the business system is also significant. It suggests that there are three different ways in which employees are employed in organizations: cognitive, behavioral, and adapted (comunity) behavior of staff.

Behavioral leaders of institutions in the region based on management styles, which mainly depend on: characteristics, profiles and activities of managers. Organizational culture is a set of organizational

behaviors that can be seen in the organization's environment while the organizational climate is shaped by the management through a personal policy within an organization.

The German company Messe Frankfurt, one of the world's largest business event organizers, has made an agreement with the organizer of Adria Security Summit to provide support for an extraordinary event, which will now use the Powered by Intersec license. This will be the first time that the company will provide support to the Adria Security Summit. The event will be held in the future under the name "Adria Security Summit powered by Intersec", a regional high-level conference dedicated to protection and security technology, which includes the accompanying fair, which is being held since 2015, each time on the other Location within the Balkan region.

In some Western Balkan countries, the Association of Corporate Security Managers was formed, mainly within the chambers of commerce, the initiative of professionals, experts from all areas of corporate security, with the aim of promoting, developing and popularizing the profession as well as strengthening professional and corporate standards. These specialized Associations bring together a large number of corporate security managers from private companies and public companies from home and abroad. So far, a significant number of scientific-professional meetings, education, presentations and meetings of security managers have been held. Traditionally, each year they organize and are very busy with the International Conference of Corporate Security Managers, and awarded annual awards for top managers, companies, institutions and larger companies, with the best results in the field of corporate governance and social responsibility in the security system.

In the case of critical infrastructure, it is best to see how public and private interest intertwine. The EU has the largest number of critical infrastructure in private ownership, but its protection is of public importance, because the consequences for protection will not be tolerated only by the private owner, but by a large number of citizens.

The common problems of the private security sector in Southeast Europe are: (unrealistic) low labor costs, poor quality of training of security workers, unfair competition, lack of security managers in the clients, and very weak control of state institutions over companies

It is necessary to regularly review the main elements of the responsibility of security companies, with the underlying assumption that responsibility should not be solely confined to their responsibility towards their (diverse) clients, but also towards the public and citizens. With this, the consequences of poor performance of private security companies will not only suffer from their client, but also citizens as a whole.

Increasing the responsibility of the private security sector can only be achieved by improving training, jointly strengthening and linking different control and control mechanisms, in particular the inspection of the MIA, the Army, the communal police and the labor inspectorate, as well as the more intense control of clients over the execution of the contract.

Environmental crime is a serious crime, often committed by organised crime groups, that affects society as a whole, as its impact is felt not only in the health of humans and animals but also in the quality of air, soil and water. The EU Serious and Organised Crime Threat Assessment 2013 (SOCTA) identified environmental crime as a specific emerging threat that requires intensified monitoring.

Environmental crime also often involves a cross-border dimension, and the increase of international trade and the abolition of border controls within the Schengen area add to the scope of the problem.

Despite the potentially grave consequences of environmental crime, particularly in the areas of illegal trafficking of waste and trafficking of endangered species, its seriousness is still often underestimated at national and international level.

In this context, Eurojust took the initiative in 2013. to launch the ‘Strategic Project on Environmental Crime’. The goal of this report is to summarise the findings of the Strategic Project. It highlights the main problems encountered by the national authorities in prosecuting environmental crime and attempts to present suggestions for addressing some difficulties, particularly those linked to cross-border cooperation. Another goal of this report is to raise awareness among practitioners, policy makers and legislators of the necessity to improve, cooperation within the European Union and internationally in this important area.

I would like to express my gratitude to the Member States and to Norway for their valuable contributions to the Strategic Project. These contributions were essential in identifying andaddressing the main problems in the investigation and prosecution of environmental crime.

Particular thanks go also to the European Network of Prosecutors for the Environment, which co-hosted the strategic meeting on environmental crime in 2013. and to the Commission, Europol, INTERPOL, the IMPEL Trans-frontier Shipment Prosecutors' Task Force and the CITES Secretariat for their active participation and feedback during that meeting.

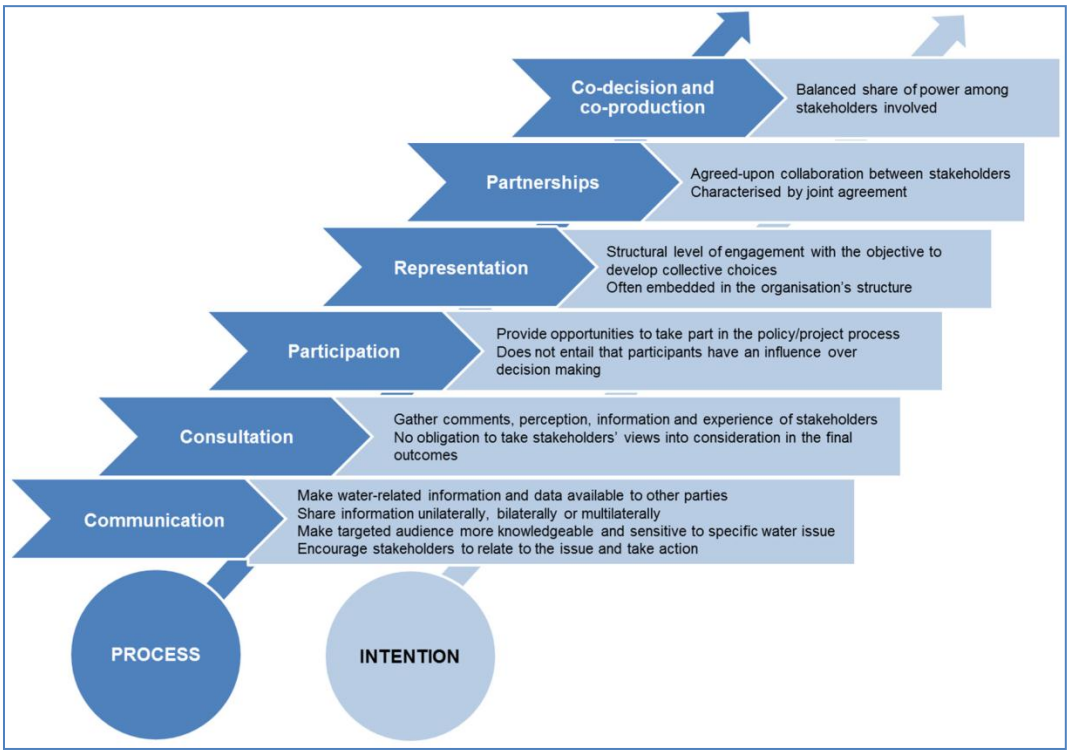

Figure 7. Environmental crime also often involves a cross-border dimension

7. CONCLUSION

Ecological safety has no limits and is a global problems, task and obligation. In the current geopolitical constellation of relations, the UN organization appears as the main (not the only) organization with capacities to take care of the eco-security of the region and the world.

In the context of modern challenges, risks and threats to security at the national, regional and global levels, which are reflected through modern forms of inter-ethnic crises and conflicts, it can be said that eco-security and sustainable development issues are gaining in importance.

Developing awareness of environmental issues and sustainable development, especially in areas where different ethnic groups of people live (multicultural areas) and coming into contacts that, historically viewed, are marked by conflicts, intolerance and conflicts, is linked to. The problems of upbringing and education for the protection of the environment and sustainable development in a pluralistic and multicultural society.

The cooperation of the countries of the region, continents and the world as a whole contributes significantly to the prevention of possible accidents in the field of eco-security and is limited to the economic power of the countries of the region. Fewer developed countries are unable to cooperate effectively with developed countries, especially if norms, standards and rules of co-operation are

permanently imposed on them, which they can not realize in a timely manner and "respond" to possible hazards.

Today, in the post-modern environment there is a certain disagreement from the aspect of participation in environmental degradation, which is determined by industrial, economic, technological, military, scientific and any other development of a certain state, as well as its size, population and natural resources. In this regard, it is necessary to find adequate solutions / answers on a global scale, with mandatory material and professional assistance from the leading countries in the world, along with the respect of small and medium-sized countries, and urgently plan priority tasks in the field of eco-safety, bearing in mind the vulnerability of the survival of the human species , Which grows every day and warns of the harsh reality of today.

In everyday activities, it is necessary to point out the importance of knowing the principles and measures of security protection of critical infrastructure (primarily public devices and their parts exposed to theft) and knowledge and proper use of legal protection mechanisms in order to preserve the integrity and credibility of public enterprises and companies, but also The interests of national and public security. Consideration should be given to security and criminal aspects, the problems of stealing parts of public utilities for heat, gas, energy, water, sewage and other resources, important for the supply of citizens and the functioning of the economy in the environment and rural areas.

Problems of illumination and proof of the theft that endanger critical infrastructure should be presented and analyzed through reviews of relevant criminal law, detection and resolution problems - difficulties in implementing regulations, as well as proving the theft of public equipment and parts in criminal proceedings.

This topic is primarily intended for executive management, responsible persons and managers of corporate security services, legal sector / service managers, that is, everyone who is in any way related to security and normative-legal affairs in corporate governance, local self-governments, enterprises and institutions, Companies and other organizations.

Making decisions with the conditions of modern dangers is complex, because in the environment a chaos is created, which prevents the normal functioning of the system. In order to prevent this, it is necessary to define in the peace the optimal methodology, which in this co-author's work is given as the O4-discovery (obscure) method, decides, orders, disables (informs).

The greatest efficiency is only possible in the context of military-security decision-making - integration of expert systems and decision support systems, which is now one of the major tasks of researchers in the defense and security system in the Western Balkans and the environment.

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PLURIPERSPECTIVE AND MULTIDISCIPLINARY APPROACH, AS A DEEPER UNDERSTANDING OF DIFFERENT SUSTAINABLE DEVELOPMENT DIMENSIONS

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Abstract

The UN General Assembly in December 2002, resolution 57/254, adopted United Nations Decade of Education for Sustainable Development (ESD) (2005 - 2014). The aim of this Strategy is to encourage UNECE (United Nations Economic Commission for Europe) member States to develop and incorporate ESD into their formal education systems. Achieving the objectives of the ESD at higher education is possible by installing appropriate courses in order to empower students as future leaders, scientist and engineers to make decisions and act in culturally appropriate and locally relevant ways to redress the environmental problems that threaten our common future.

The basic premise of this strategy is that avoiding the generation of wastes or pollutants can often be more cost effective and better for the environment than controlling or disposing of pollutants once they are formed.

This process must, however, start in the classroom where a cogent educational strategy must give rise to sustainable engineering curricula in all disciplines, ranging from hard sciences and engineering to management, law and education. Only by improving the next generations' ability to implement these principles we will create sustainability of our civilization and our way of life.

This paper is presenting the US EPA Program on Green Engineering: Environmentally Conscious Design of Chemical Processes, which will be installed into syllabus for graduate students with parallel organizing seminars for actual engineers, sociologists and managers. The textbook on the same title has been translated already into Bosnian.

Key words: environment, education, awareness, green engineering, sustainability, society and its environment

1. Uvod

Načelo održivog razvoja predstavlja pokušaj da se specificiraju obaveze i pravila koja obezbjeđuju da se potrebe i prohtjevi ljudi današnjice ne zadovoljavaju na štetu vitalnih interesa budućih generacija. Ovim formalnim principom pokreće se normativno pitanje: Koje su to vrijednosti koje ljudski život čine kvalitetnim i smislenim, te se na taj način kritički analizira sâm koncept održivosti. Prirodni resursi koje čovječanstvo koristi predstavljaju samo trenutno raspoloživa sredstva za postizanje određenih ciljeva koje ljudi smatraju vrijednim. U historijskom kontekstu, načelo održivog razvoja predstavlja modernu verziju konsekvencijalističkog, na ljude usmjerenog etičkog stanovišta, po kojem okoliš treba da štitimo zbog sopstvenih interesa, s tim što se moralno dostojanstvo sada proširuje i na buduće generacije.

Sociološko proučavanje koncepta održivog razvoja, osobito u subdisciplini socijalne ekologije, zahtijeva prije svega jasnu i preciznu razliku između perioda u razvoju sociološke misli. Moderna i postmoderna teorija je siginifikantnija za dublje promatranje koncepta održivog razvoja, klasici sociološke misli nezaobilazan su dio svakog promišljanja o razumijevanju odnosa između humanuma i njegove okoline, što je ujedno osnovna ideja socijalne ekologije. Klasična sociološka teorija enorman doprinos daje proučavanjima faktora rizika koji nastaje raskidom veze humanuma sa prirodnim svijetom, kakva je postojala prije ere racionalizacije i industrijalizacije. Razvoj savremene tehnike, tehnologije i informacionih sistema, produkovao je odvajanje humanuma od prirodnog svijeta, koje će proučavati Weber, Marx i Durkheim kao klasici sociološke misli, analizirajući termin alijenacija. Alijenirani identitet može se dezalijenirati jedino nastankom ekosocijalizma kao posebne vrste društvenog sistema, misli Marx, dok Weber i Durkheim predviđaju potpuno negativne posljedice radikalne tehnologizacije, u činjenici da dezalijenacija nije moguća**,** pa je njen krajni produkt otuđeni individuum. Izvori socijalne ekologije, kao mišljenje o konsekvencama odnosa humanuma prema njegovoj prirodnoj okolini, vidljivi su u čikaškoj i frankfurtskoj školi mišljenja.

1.1. Ekološki problemi 21. stoljeća

Ovakvo rezonovanje se zasniva na teoriji pravičnosti John Rawlsa (1971) i John Revlis (1997), koji ističe fundamentalni princip moralne pravde, sadržan u podjednakom pravu svakog čoveka na najšire osnovne slobode, koje ne protivuriječe slobodi drugih.

Sociološke nauke predstavljaju intradisciplinarno polje koje otvara pluralitet rješenja, znastvenih kognicija time dajući doprinos razvoju ekološke svjesnosti. U analizi ekoloških problema, sociologija prepoznaje periodizaciju kao signifikantan preduslov za razumijevanje razvoja socijalno-ekološke misli ili sociološkog proučavanja ekoloških kriza savremenog doba. Globalne ekološke nesreće i katastrofe postaju značajanim predmetom sociooloških rasprava 1980-tih godina, nastankom djela *Društvo rizika* sociologa Ulricha Becka, kao rane moderne misli. Klasici sociologije su tako postavili osnovu za nastanak takvog mišljenja i pružili priliku za uvođenje koncepta alijenacije usljed tehnologizacije. U okviru socioloških nauka ekologiju propituju subdiscipline socijalna ekologija, sociologija roda, klasične sociološke teorije, moderne i postmoderne (suvremene) sociološke teorije, što čini oblasti intradisciplinarnim poljem, a sociologiju suvremenom i razgranatom naukom u korpusu društvenih nauka uopšte.

1.2. Socijalna ekologija

Socijalna ekologija predstavlja subdsiciplinu sociologije koja se bavi međusobnom interakcijom humanuma i okoline, pri čemu se usmjerava na pozitivne i negativne koncepte. Razvija se iz ekologije, kao biološke discipline koja se bavi proučavanjem utjecaja živih organizma i njegove okoline. U okviru čikaške škole mišljenja, prvi put se počinje govoriti o humanoj ekologiji koja za predmet izučavanja ima interakciju humanuma sa okolinom. Humana ekologija, kasnije je preimenovana u socijalnu ekologiju. Značaj ove subdiscipline je makroskopski, jer se veći značaj pridaje diverzitetu, organizaciji i posljedicama, koje *humanum* ostavlja po okolinu. Naslijeđe humane ekologije su i mehanizmi, jednostavni principi upravljanja, i objašnjenja. Najveći značaj humane ekologije, kao preteče socijalne ekologije je transdisciplinarnost. Predmet izučavanja socijalne ekologije su kompleksni sistemi za koje su nužne spoznaje antropologije, ekologije, ekonomike, i fizike.

1.3. Sociologija roda

Druga značajna disciplina sociologije za proučavanje koncepta održivog razvoja je sociologija roda. Uz socijalnu ekologiju, sociologija roda, kao savremena disciplina**,** dodatno pomaže razumijevanju antropocentrizma kao elementarnog razloga za opresiju humanuma nad prirodom. Antropocentrizam predstavlja jednu od najistaknutijih prepreka u razvoju socijalno ekološke misli, jer se, za razliku od ekocentrizma kada je priroda bila centar, u centar stavlja humana egzistencija. Zaboravlja se da priroda nije sila koju je moguće kontrolisati, pa gospodarenje humane egzistencije prirodom završava ponekad katastrofalnim ekološkim nesrećama. Pri tom povratak na ekocentrične modele promišljanja stvarnosti nije moguć, pa je jedina strategija koja je prihvatljiva holistički pristup, kako ga vidi Jonas u svom djelu Princip odgovornost, gdje se najprihvatljivija realnost nalazi u vezi antropocentrizma i ekocentrizma kao prevazilaženje prvog i težnja ka drugom. Koncept održivog razvoja bi trebao ukazati na rodnu dimenziju ekoloških problema, nesreća i katastrofa. Pri tom je značajna sve veća feminizacija siromaštva, jer je koncept siromaštva direktno vezan uz slabiji pol što svoj izvor nalazi u patrijarhalnoj matrici identifikacije žena sa materijom, prirodom, neaktivnim, emotivnim, pa samim tim i slabijim principom. Ekofeministički pokreti su snažno kritikovali antropocentizam patrijarhalne kulture, identificirajući koncept patrijarhalne opresije nad prirodom sa konceptom opresije prema ženi što najjasnije pokazuje shematski prikaz 3. Muška kultura i antička koncepcija društva identificirala je ženski princip sa prirodom, majkom, submisivnim, podređenim, varljivim, promjenljivim, emotivnim, a muški princip sa kulturom, ocem, dominantnim, nadređenim, istinitim, nepromjenljivim, razumnim. Na ovakvoj matrici izgrađena je Zapadna znanstvena misao, koja je uzrokovala opresiju nad ženom na isti način na koji je opresirana priroda. Objektivikacija ženskog principa utjecala rezultirala je u nasilju nad ženama i nad prirodom. Logika dominacije je oprečna logici brige koja zajedno sa etičkim principima čini značajnu matricu za borbu protiv nasilja i diskriminacije. Autorice Vandana Shiva, Karen Warren i Val Plumwood su utjecale da se naglase rodne dimenzije ekoloških problema. U duhu postmodernizma transrodna kategorija postaje prevalirajući princip koja time produkuje ravnopravnost, uvodeći žene, kao ravnopravne, u inegrisano kolo, pa bi se i koncept održivog razvoja trebao mijenjati u pravcu rodne ravnopravnosti. Metzner predviđa da, nakon industrijskog doba, dolazi ekološko doba, koje zemlju postavlja u centar, a čije su socijalne vrijednosti ekofeminizam i socijalna ekologija. Ovim se socijalna ekologija i sociologija roda kao subdiscipline sociologije postavljaju kao signifikantna mjesta korekcije vladajućih

stajališta o odnosu prema okolini, ali i kreiranja novih principa poput principa žena ravnopravno integrisanih u sve odluke u budućnosti, kritike identifikacija žena sa negativnim problemima siromaštva, nasilja, kao onih koje su snažan katalizator mogućih budućih promijena u društvu, jer se ženska logika brige postavlja kao oponent muškoj logici dominacije. Pri tom je značajan aktivizam žena usmjeren ka smanjenju pojačanog nasilja nad ženama jer je u zemljama u tranziciji, položaj žena znatno oslabljen što rezultira pojačanim stopama kombiniranog[1] nasilja nad ženama (Mušić 2010). Osnovni pravac razvoja socijalne ekologije, je išao smjerom od istraživanja životinja ili zoologije, ka humanoj ekologiji koja završava u ekologiji individue(muškarca/homo ecologicus ili žene/femina ecologica), odnosno, humanoj ekologiji koja je na kraju preimenovana u socijalnu ekologiju. Ernst Haeckel je prvi pomenuo pojam ekologija, kao nauka koja se bavi proučavanjem okoline, a *socijalna ekologija podrazumijeva proučavanje uzajamnog odnosa između humane kategorije bivstvovanja i okoline, te promatranje tog međusobnog suodnosa.* Alijenirani identiteti koji postoje u gradovima nastaju kao rezultat otuđenja od samog sebe pa se javlja i šizoidnost, kako primjećuje Harvey. Uz blaziranost koju je primjetio Zimmel kao negativnu posljedicu tehnologizacije, u vidu osjećaja ispraznosti i besmisla unutar ličnosti, negativne posljedice ubrzanog napretka tehnologije na psihu humanuma su alijenacija i šizoidnost što je Myerson dodatno eksplicirao kao ekopatologiju u okviru postmodernističkog sociološkog razmatranja koncepata koji se tiču održanja humane okoline, i suoodnosa između humanuma i prirodnog svijeta. Ekološki problemi su dobili na značaju u drugoj polovini 20 stoljeća. Globalni rast populacije doveo je do velikog pritiska na svjetske prirodne izvore uključujući zrak i vodu, obradivo tlo i sirovine, a i moderno društvo je stvaralo povećanu potražnju za upotrebu industrijskih hemikalija. Upotreba ovih hemikalija je rezultirala velikom koristi u povećanju standarda života, produžujući ljudski život i poboljšanje okoline (Jaganjac 2007). Kako su ove nove hemikalije predstavljene na tržištu i postojeće hemikalije se nastavljaju koristiti, njihov ekološki i zdravstveni efekat je postao značajan. Hemijski i drugi industrijski procesi koji daju proizvode i materije bitne za modernu ekonomiju također daju velike količine otpada i emisije. Kako tretiranje emisija, čvrstog i tečnog otpada košta mnogo i nastavit će eskalirati, trebalo bi uvesti novi „zeleni“ prilaz u projektovanju i razvijanju procesa i produkata u visoko obrazovanje završnih godina studija i postdiplomskog studija za sve buduće inženjere, projktante i mendžere. Izazov za buduće generacije hemijskih i drugih inženjera u proizvodnom sektoru jeste da razviju i savladaju tehnološke alate i pristupe koji će ujediniti okolišne ciljeve u donošenju boljih odluka koje se odnose na projektovanje, proizvodnju i upotrebu hemikalija ili drugih materijala.Pošto je edukacija ključni element u razvoju svijesti o okolišu, nastavni programi bi trebali pokriti određen broj projektnih metodologija u sprečavanju zagađenja i smanjenja rizika koji su povezani sa relevantnom proizvodnjom. Slika 1. pokazuje pojmovno kako industrijski proces pretvara sirovi materijal u koristan proizvod uz upotrebu energije. Polutanti koji su nastali u hemijskoj proizvodnji bilo preradom ili primjenom oslobađaju se u okoliš tako da se ispuštaju u rijeke, ili u zrak ili se odlažu na zemljište. Često se otpadne materije tretiraju prije ispuštanja.

[1] Kombinirano nasilje je nasilje koje uključuje psihičko, fizičko, ekonomsko i seksualno nasilje. Nasilje nad ženama ali i muškarcima koji ne odgovaraju patrijarhalnoj hegemonijskoj slici muškosti je u korelaciji sa prethodno pojašnjenom matricom distinkcije muško/žensko koja oblikuje mizogenu patrijarhalnu perspektivu.

Na slici 1 je vidljivo da otpadne komponente mogu uticati na kvalitet vodenih tokova i rijeka, na zagađivanje zraka, kao i na dobrobit flore i faune. Koje su informacije potrebne inženjeru kada želi da odluči o prevenciji zagađivanja i smanjenju rizika? On/ona trebao bi biti upoznat na univerzitetu sa „zelenim“ projektnim metodama koje bi trebale biti uključene u odgovarajući nastavni program za studente završnih godina i postdiplomskih studija koji Jaganjac predlaže i za koji je nađen odgovarajući udžbenik (Jaganjac 2009).

Nakon razmatranja problematike kreiranja strategije održivog razvoja privrede u Bosni i Hercegovini (BiH), razmatramo jedan od mogućih programa edukacije budućih lidera za održivi razvoj.

2. Kako kreirati Strategiju održivog razvoja privrede u BiH

Odgovor na ovo pitanje je kompleksan i treba ga posmatrati, kada je riječ o BiH, u kontekstu aktivnosti njenog uključivanja u pregovore za pristupanje punopravnom članstvu u Evropsku uniju, čime nastaje i formalno-pravna potreba za prilagođavanjem okolišnog zakonodavstva načelima koja se primjenjuju u Evropi. U centru razvoja svake strategije je vizija poboljšanja obezbjeđenja i potrošnje energije na održiv način.

Uprkos niskoj potrošnji energije po glavi stanovnika, BiH je veliki rasipnik energije. Podaci pokazuju da BiH koristi gotovo 40% manje energije od prosjeka zemalja Jugoistočne Evrope; tri puta manje od prosjeka 25 zemalja Evropske unije i gotovo 40% manje od svjetskog prosjeka (Goletić, Šehić-Mušić 2009), ali BiH troši veliku količinu energije po jedinici društvenog proizvoda , gotovo 5 puta više od 25 država Evropske unije i 2,5 puta više od svjetskog prosjeka.

Specifična potrošnja energije u BiH, kako toplotne tako i električne, još uvijek je dosta visoka u poređenju sa razvijenim, ali i nekim zemljama u razvoju. Dokaz toga je specifična potrošnja energije u BiH u raznim sektorima kao štu zgradarstvo, usluge, industrije i dr. što se može jasno vidjeti preko indikatora (kWh/m2 god; kWh/stanovniku; kWh/kg proizvoda, itd.). Napr. u sektoru zgradarstva koji troši 50% ukupne finalne potrošnje energije u BiH, potrošnja energije za grijanje iznosi 160-180 kWh/m2 godišnje, što je tri do četiri puta više u poređenju sa razvijenih zemljama i novim standardima. (Energetska efikasnost u BiH: prilika ili obaveza, N. Harbaš, BGEN 2017.)

Liveni proizvodi, npr. vrlo su raznoliki po konstrukciji, namjeni i složenosti izrade, pa se i specifična potrošnja energije u pojedinim livnicama kreće u širokom rasponu od 14 do čak 60 GJ po jednoj toni odlivka, što djelimično ovisi o vrsti proizvoda i materijala koji se koristi, ali istovremeno ukazuje na manju efikasnost u iskorištenju energije (Studija energetskog sektora u BiH, 2008).

2.1. Održivost, gospodarske/ privredne aktivnosti, energija i efikasnost

Održivi razvoj ima redoslijed koraka pri uvođenju u praksu: definiciju za datu državu; postulate; indikatore; alate; kriterije.

Postoji tzv. IOO koji je namijenjen kao alat kompanijama iz različitih industrijskih sektora (Šehić-Mušić, Sadiković 2006). Indeks je zasnovan na kriterijima koji uključuju: efikasno,

efektivno i ekonomično korištenje ljudskih resursa; upravljanje kompanijom; proizvodnju; rast; konkurentnost i brzo reagiranje na socijalne promjene.

Indeks okolinske održivosti (IOO), predstavlja, ustvari, mjeru općeg progresa u svrhu razvijenosti okolinske održivosti.

Visok nivo IOO pokazuje da je zemlja dostigla viši nivo okolinske održivosti u odnosu na druge zemlje. Shematski prikaz (v. Shemu 1) upravo pokazuje i potvrđuje potrebu za multidisciplinarnim pristupom kod svih gospodarskih aktivnosti.

Potrošnja energije ovisi o razlicitim socio-ekonomskim i ekološkim aspektima. U literaturi Gelo, T.(2010) se kao glavne determinante potrošnje energije navode četiri faktora:

1. nivo ukupne gospodarske, odnosno, proizvodne aktivnosti,
2. struktura gospodarstva
3. visina dohotka, BDP-a ili proizvodnje po jedinici utrošene energije i
4. energijska efikasnost koja pokazuje kako se efikasno koristi energija

Dosadašnja provedena istraživanja pokazuju da je energetska učinkovitost vrlo bitna za procjenu trendova potražnje za energijom u budućnosti.

3. Elektro-energetski sektor u BiH

Razvoj energetskog sektora i povećana potrošnja energije uzrokuju negativne utjecaje na okoliš. Stoga je izrađena tehno-ekonomska analiza mjera za smanjenje emisije u zrak iz termoelektrana i toplana. Moguće su najbolje raspoložive tehnologije za smanjenje emisije SO2, NOx i čestica, koje bi trebale osigurati smanjenje koncentracija onečišćujućih tvari u dimnim plinovima na zakonom propoisani nivo (ESSBIH 2008). Investicijski troškovi za ugradnju tih postrojenja jesu visoki ali neophodni radi zaštite okoliša i zdravlja stanovništva. Nepravovremena ugradnja povlači za sobom multipliciranje troškova. Npr. Postrojenje za ODG u TE Ugljevik (Jaganjac,1987. 34,5mil.$ a sada skoro 3x više).

Na inicijativu Ministarstva vanjske trgovine i ekonomskih odnosa, tek ove godine (2018.), usvojena je Okvirna energetska strategija BiH, koja je deset je godina bila predmetom pregovora između dva BiH entiteta.

Temelj pri izradi Okvirne energetske strategije BiH činili su entitetski strateški dokumenti energetskog sektora.Vijeće ministara Bosne i Hercegovine (BiH) donijelo je odluku o usvajanju Okvirne energetske strategije BiH do 2035. godine.Ovim su stvoreni uvjeti za privlačenje IPA fondova i fondova iz Investicijskog okvira za Zapadni Balkan (WBIF) za sektor energije, kao i privlačenje ulagača u sektor.

Procjenjuje se da je BiH izgubila oko 200 miliona € u nedostatku strategije.

Usvajanje ovog strateškog dokumenta definira put razvoja BiH energetskog sektora do 2035. godine, što će pozitivno uticati na investicije, kao i na tržišne i regulatorne reforme u svim segmentima energetskog sektora.

Očekuje se da će strategija posredno pomoći u povećanju zaposlenosti, smanjenju javnog duga i poboljšanju konkurentnosti u BiH.

3.1. Energijska intenzivnost

Sami pokazatelji o potrošnji energije bez povezivanja s ekonomskim varijablama ne daju previše informacija onima koji provode ekonomsku politiku. Povezivanje mjera ekonomske i energetske politike služi u provedbi sveukupne gospodarske politike kako bi se energija koristila i trošila na energetski i ekonomski optimalan način. Odnos potrošnje energije i nivoa BDP-a se vrlo često koristi kao pokazatelj agregirane energetske učinkovitosti nekog gospodarstva.

Ukupna energijska intenzivnost u BiH (v.tabelu 1) je određena kao odnos ukupne potrošnje primarne energije i GDP-a, za određenu kalendarsku godinu. Naknadna istraživanja pokazat će da je energetska učinkovitost vrlo bitna za procjenu trendova potražnje za energijom u budućnosti.

3.2 Moderna i postmoderna kritika koncepta održivog razvoja u sociološkoj teoriji

Moderna kao proces sugeriše postojanje utvrđenih koncepta i obrazaca mišljenja, sistematsko objektivno promatranje naučnih činjenica, dok postmodernu odlikuje dekonstruktivistički pristup, razlaganje starih istina pod utjecajem pluraliteta mišljenja čime se i čitav koncept održivog razvoja postavlja problematičnim. Elementarno propitivanje ovog rada jeste smisao održivog razvoja u postmodernim i začetku postmodernog mišljenja u sociologiji autora Giddensa, Baudrillarda, Becka, Fukuyame. Djelo Dražena Šimleše svojim naslovom sugeriše promjenu spram koncepta održivog razvoja, *Ekološki otisak* odnosno *Kako je razvoj zgazio održivost*? Nastojeći dati odgovor na riješenje ovog pitanja Šimleša odgovara Caprinim konceptom ekopismenosti kao onog šo nas uči „kako zgaženo može ponovno oživjeti i živjeti održivo”(Šimleša 2010: 11). Dakle, održivi razvoj je kao koncept značajan, ali zaostaje u svojoj primjeni pa su neophodne njegove korijenite promijene. Ukoliko pođemo od definicije održivog razvoja kako je koncipira Neil Carter: „ korištenje okolinskih resursa razumno kako bi se priroda ostavila budućim generacijama a zasnovano na načelu etičnosti i demokratije”, možemo ustanoviti da ovakva definicija može biti validna isključivo ako svijet egzistira u skladu sa postojećim nivoom razvijenosti tehnike, tehnologije, i sistema informacija. A u protivnom, nephodno je uzeti drugačije perspektive u obzir. Giddens u svom djelu *Treći put*, oštro oponira konceptu održivog razvoja za budućnost, nalazeći u samoj definiciji kontradikciju, kontraverznost i neodrživost. Moderna misao u djelu Giddensa postavlja oštru kritiku koncepta održivog razvoja, kao neodrživog sa stanovišta kraja moderne a osobito postmoderne misli. Šimleša smatra da je razvoj zgazio održivost, pa je neophodno utjecati na jaču implementaciju održivog razvoja kako ne bi ostao samo teorijski koncept uključivanjem ekopismenosti, i jačeg aktivizma u polju ekološke svjesnosti. Njegov dekonstruktivistički pristup ukazuje na negativne momente koncepta održivog razvoja u cilju njegove promijene ka kvalitetnijim i primjenjivijim rješenjima u praksi. Koliko dugo može važiti ovakva definicija ukoliko znamo da je svijet podložan promijenama,pa Giddensova sintagma zmajevih kočija koje vrtoglavo jure predstavlja sinonim za predstojeći apokaliptični scenarij. Kako možemo ostavljati svijet za buduće generacije ukoliko ne znamo u kakvim svjetovima će takve

generacije živjeti. S druge strane, rizik ne mora uvijek biti negativan, ponekad može poticati na promijene, pa se pominje energizirajući momenat rizika (Giddens 1990:134). Za Giddensa je stvarnost u kojoj je načelo održivog razvoja utopijski realizam koji je neophodno promijeniti. Neophodno je da zadržimo težnju ka ostvarenju idealnog koncepta, ali da pri tom uvijek budemo svjesni rizika postojećih ekoloških problema (Giddens 1990:148-150). Napredak tehnike i tehnologije uslovio je nastanak bioetike, ksenobioetike, implantacije organizama, transplantacije, kloniranja, vještačkog produženja života, *in vitro* oplodnje, bržeg prenosa informacija na malim gotovo jedva vidljivim objektima. Baudrillard kao postmoderni filozof i sociolog govori o virtualnim stvarnostima odnosno svjetovima, koji su produkt konvencija, gdje priroda postaje virtualan prostor koji djeluje pod kontrolom vještačke inteligencije. Na djelu su simulacije istine, a usljed napredovanja rizika oštećenja ozonskih rupa zemljine kore, svjetlosnog zagađenja, radioaktivnog zračenja, ekoloških nesreća i katastrofa uslovljenih humanim nemarom, biotehnološkog otpada kao i utjecaja politike u domen uključenja određenih uređaja koji bi spriječili nesreće, postavlja se upitnim opstanak humane kategorije na zemlji koje predviđa i Fukuyama, svojim pitanjem šta dolazi na kraju historije humanuma, kakav je to posthumani individuum, kakav je to postmoderni individualitet? Ovdje se i nalazi primjena ili radikalizacija Giddensove teze o kritici „utopizma" koncepta održivog razvoja, ka Giddensovom, Beckovom mišljenju o potrebi ekološkog osvješćavanja odnosno društvene refleksije, koja bi humanum učinila svjesnim postojeće krize i time spriječila apokaliptični scenarij.

4. Edukacija – ključni element razvoja svijesti o okolišu

4. 1. Razvijanje nastavnog programa zelenog inženjeringa

Prema UNECE Strategy of Education for Sustainable Development (strategija obrazovanja za održivi razvoj) usvojenoj na Skupštini UN-a 2005. a u BiH 2007. godine je počela implementacija programa „Desetljeće obrazovanja za održivi razvoj", koji je preporučen svim zemljama da po njemu reformišu svoje obrazovne sisteme u cilju uključivanja interdisciplinarnih pristupa problemima okoliša kroz formalno i neformalno obrazovanje. Urađeni su odgovarajći programi i priručnici za edukaciju nastavnika na svim nivoima obrazovanja. Ovdje je dat primjer mogućeg univerzitetskog nastavnog programa tzv. Zeleni inženjering za inženjere hemije i tehnologije, studente završnih godina i postdiplomce kao i za inženjere u privredi prema najnovijem US EPA Programu.

4. 1.1. Hemijsko inženjerski vodić za ekološke propise i režime

Zbog povećanja cijena i strožijih standarda, tradicionalni pristup tzv. end-of-pipe, tretman otpada, postao je manje atraktivan pa se ističe strategija poznata kao svjesnost o okolišu od strane proizvodnje, eko-učinkovitost i prevencija zagađenja. Osnovna premisa ove strategije je bilo izbjegavanje stvaranja otpada i polutanata što može biti efektivnije i bolje za okoliš nego tretiranje ili odlaganje polutanata kad su već stvoreni. Zato je u prvom dijelu programa potrebno je predstaviti prilaze i metodologije za procjenu i poboljšanje uticaja hemijskih procesa i hemijskih produkata na okolinu razumijevanjem osnovnih problema okoliša i zakonskih propisa.

4. 1. 2. Upoznavanje s okolišnim problemima

U nastavku prvog dijela, a u ovom poglavlju bi trebali biti predstavljeni u širokom obimu okolišni problemi, i njihov uticaj koji je povezan sa proizvodnjom i upotrebom hemikalija. Problemi sežu od globalnih do lokalnih, sa naglaskom na tipove otpada i emisije koji dovode do udara na okoliš.

4. 1. 3. Koncepti rizika

Rizik je kombinacija dva faktora: vjerojatnost da se desi nepovoljan događaj i posljedice tog negativnog događaja. To je koncept koji se koristi u industriji. Procjena rizika je sistematična, analitička metoda korištena za određivanje vjerovatnoće različitih efekata. Postoje četiri komponente procjene rizika: procjena opasnosti, odgovor na doze, procjena izloženosti na radu i karakterizacija rizika.

4. 1. 4. Zakoni i propisi o okolišu: od izvora do prevencije polucije

Jedan važan skup pravila, jeste da bi svi inženjeri trebali biti svjesni zakona o okolišu, a koji su doneseni od strane vlade. Svrha ovog poglavlja je da osigura uvid u okvirne i pojedinačne propise za okoliš. Zakoni okoliša su zamišljeni tako da štite humano zdravlje, druga živa bića u okolišu kao i sam okoliš postavljajući granice za količinu i hemijsku obradu otpada koji se ispuštaju iz fabrike prilikom trajanja procesa.

4. 1. 5. Uloga o odgovornost inženjera i menadžera

Inženjeri i menadžeri preuzimaju različite uloge (inženjering procesa i proizvodnje, projektovanje procesa i kontrola, tehnička prodaja i marketing, odnos u zajednici i upravljanje), pa je jako važno da oni budu svjesni svojih odgovornosti prema javnosti, kolegama i zaposlenim, prema okolišu i prema svojoj profesiji. Pravila u okolišu treba da budu razmotrena ne samo sa konteksta proizvodnje, nego i tokom drugog nivoa kruženja toka hemikalije kao što je transportovanje, korištenje od strane kupca, aktivnosti recikliranja i konačnog odlaganja.

4. 1. 6. Procjena i poboljšanje performansi hemijskih procesa

Procjena uticaja hemijskih procesa na okoliš i poboljšanje okolišnih performansi hemijskih procesa su kompleksni zadaci koji uključuju široku raznolikost pojedinih koraka analize. Sistematski se procjenjuju okolišne performanse na osnovu detaljne blok sheme procesa i identificiraju moguća poboljšanja u okolišu kao i mogućnosti integracije energije i mase. Zatim se procjenjuje moguća emisija i uticaj na okoliš određenih konceptualnim procesom i najzad procjene okolišni troškovi procesa.

4. 1.7. Procjena sudbine hemikalija u okolišu: Ispitivanje bazirano na hemijskoj strukturi

Općenito je nemoguće procijenti tačno i precizno sve moguće uticaje na okoliš. Ipak, osnovno snimanje mogućih okolišnih uticaja hemikalija je moguće i potrebno. Da li će njena proizvodnja ili upotreba izazivati značajne rizike po okoliš ili na ljudsko zdravlje? Postoje li rizici, koji su načini izlaganja njemu? Hoće li se hemikalija degradirati ako se ispusti u okoliš ili će ostati trajna? Ako se hemikalija degradira, hoće li proizvod degradacije izazvati rizik po okoliš? Osnovno snimanje rizika pomaže biznismenima, predsjednicima agencija i javnosti da identificiraju problem emisije hemikalija i da potencijalno redukuju dati rizik.

4. 1. 8. Procjena izloženosti na radu

Uobičajena primjena metoda procjene rizika je da se evaluira ljudsko zdravlje i ekološki udari ispuštanja hemikalija u okoliš. Informacije prikupljene, posmatranje okoliša ili modeliranja su uklopljene u modele ljudske aktivnosti i izloženosti na radu, i formuliraju se zaključci na bazi najvjerojatnijih nepovoljnih efekata.

4. 1. 9. Zelena hemija

Zelena hemija, definirana kao projektovanje hemijskih produkata i procesa u cilju smanjenja ili eliminacije upotrebe i nagomilavanja opasnih tvari, je podijeljena na dva osnovna dijela – kvalitativni i kvantitativni. Metodologija Zelene hemije se odnosi na rješavanje problema: alternativnih sirovina, korištenje tzv.zelenih otapala, alternativnih sintetičkih puteva i uopće sigurniju hemiju. Karakterističan primjer je zeleno-hemijska intervencija u sintezi adipinske kiseline koja je potrebna za sintezu najlona: tradicionalni metod koristi benzen, koji se dobija iz fosilnih goriva, kancerogenu polaznu materiju. Nađeno je, da se može koristiti manje toksična i obnovljiva polazna tvar, potencijalo prihvatljiva alternativa po odnosu na okoliš – D-glukoza, koja je bezopasna. Alternativna sinteza ne koristi skupe katalizatore (Ni, Al_2O_3, Co, Cu, NH_4VO_3), kisik i HNO_3), te veliki utrošak energije, nego bakteriju E-coli i samo u zadnjem koraku sintetskog procesa malo povišen pritisak na platinskom katelizatoru. Vrlo elegantno, ekonomično i okolinski prihvatljivo rješenje.

4. 1. 10. Procjena okolišnih performansi za vrijeme procesa sinteze

Tradiconalno procjenjivaje djelovanja na okoliš se nije praktikovalo do zadnjih faza inženjerskog strukturnog procesa, kada je većina kritičnih odluka projekta već donesena. Bolji prilaz bio bi procjenjivanje djelovanje na okoliš u svakom koraku strukturnog procesa. Ovo bi, svakako, zahtijevalo hijerarhiju sredstava za procjenjivajne djelovanja na okoliš. Sredstva koja bi se mogla efikasno upotrijebiti za veliki broj alternativa, koristeći ograničene informacije, su neophodna za određivanje djelovanja na okoliš u najranijim strukturnim fazama. Detaljnija sredstva mogu biti korištena u razvojnim fazama, gdje su potencijalni emitenti, efluenti i čvrsti otpad identificirani. Konačno, detaljna procjena uticaja na okoliš biće definisana kako se proces bude približavao implementaciji.

4. 1. 11. Jedinice operacija i prevencije zagađenja

U razvoju blok sheme za proizvodnju poželjno je da se razmotri okolišno grananje svake operacione jedinice u procesu, što je bolje nego odlaganje ovog razmatranja dok se blok shema ne završi. U razmatranju prevencije za operacione jedinice u dizajnu hemijskih procesa, slijedeća razmatranja su bitna: odabir materijala, mehanizmi stvaranja otpada, uvjeti operacije, skladištenje materijala i prevoz, potrošnja energije i sigurnost procesa.

4. 1. 12. Procjena blok sheme tehnološkog postupka u cilju prevencije zagađivanja

Prije ispitivanja integracije procesa u detalje, korisno je primijeniti metode koje postoje za sistematičan pristup i poboljšanje okolišnog učinka dizajna procesa. Poznat je broj takvih metoda. Neke su analogne Studiji o opasnosti i operabilnosti tzv. HAZ-OP analizama. Druge metode se baziraju na hijerarhijskom dizajnu metodologija. Hijerarhijski poredak je tako

organiziran da odluke koje utiču na otpad i emisiju na svakom nivou ograničavaju odluke u nivoima ispod njih.

4. 1. 13. Procjena okolišnih performansi blok sheme

Nakon što se uspostavi blok shema procesa i primjene mjere efikasnosti energije i mase, prikladno je detaljnije obraditi procijenu projektovanja za zaštitu okoliša. Krajnji rezultat procijene uticaja bit će set okolišnih pokazatelja koji će reprezentirati glavne okolišne faktore ili rizike za cjelokupni proces. Bazirajući se na razumijevanju mjera rizika, koraci za mjeru u djelovanja na okoliš su grupirani u tri kategorije, a) procjene omjera ispuštanja svih hemikalija u procesu, b) proračun okolišne odredbe, transporta i koncentracija u okolišu i c) bilans za višestruke mjere od rizika koristeći toksičnost i informacije o bitnom ponašanju u okolišu.

4. 1. 14. Proračun troškova zaštite okoliša

Troškovi vezani za nezadovoljavajuće okolišne performanse mogu biti devastirajući. Suštinski su troškovi uklanjanja otpada, dozvoljeni troškovi i obavezni troškovi. Često je njihova visina za tretman otpada i emisija, utrošenih dodatnih sirovina, utrošena energije i smanjene proizvodnje su izgovor za neulaganje u zaštitu okoliša tj. primjene Zelenog inženjersta. Imidž kompanije i veze sa radnicima i društvvenom zajednicom mogu biti ugrožene ako su performanse zaštite okoliša ispod standardna. Općenito tradicionalne prakse proračuna su bile postavljene kao barijera za implementaciju projekata zelenog inženjeringa zato što skrivaju troškove za nezadovoljavajuće performanse zaštite okoliša. Konkretno treba obuhvatiti pet kategorija troškova:1-Troškovi koji su redovno obuhvaćeni inžinjerskom ekonomskom procjenom, 2 - Upravni i regulacijski okolišni troškovi koji nisu redovno pripisani posebnim projektima, 3 - Troškovi obaveza, 4 - Troškovi i dobiti, interni za kompaniju, vezani za poboljšan okolišni učinak, 5 - Troškovi i dobiti, eksterni za kompaniju, vezani za poboljšan okolišni učinak. Ekonomija upravljanja (ekonomija inženjerstva) se pobliže bavi ovim pitanjima.

4. 1. 15. Izlazak izvan kruga tvornice

Ovaj dio predstavljao je oruđa za procjenu i usavršavanje ekološkog učinka hemijskih procesa, ali analiza je završila na granici tehnološkog dijagrama. Osim što se inženjeri fokusiraju na blok shemu, gdje inženjer projekta hemijskog procesa ima najveću kontrolu, također je važno prepoznati da su hemijski proizvodni procesi u vezi i sa dobavljačima i sa kupcima, dakle izvan ograde tvornice, pa je sa zeleno-inženjerskog stanovišta potrebno imati u vidu kompletan životni ciklus proizvodnje i proizvoda.

4. 1. 16. Pojmovi životnog ciklusa, upravljanje proizvodom i zeleni inžinjering

Svi proizvodi, uslužne djelatnosti i procesi imaju životni ciklus. Za proizvode životni ciklus počinje kada su sirovine ekstrahirane ili prikupljene žetvom. Tada sirovine prolaze koz čitav niz koraka proizvodnje sve do isporuke kupcu. Proizvod se koristi, potom odlaže ili reciklira. Životni ciklus ima četiri koraka. Prvi je određivanje područja, gdje su granice određene i izabrane strategije za prikupljanje podataka. Drugi korak je popis ulaska i izlaska za svaki nivo životnog ciklusa. Slijedeći korak je procjena udara na okoliš, gdje su efekti ulaska i izlaska procijenjeni i zadnji korak je analiza poboljšanja.

4. 1. 17. Industrijska ekologija

Ekološka snaga hemijskih procesa ne zavisi samo od projektnog rješenja proizvodnog procesa, nego i od toga kako je proces ujedinjen sa drugim procesima tj. od sveukupnog menadžmenta ne samo sopstvenog nego i susjednih pogona. Proizvodne industrije su kompleksna mreža povezanih procesa. Individualni proces se oslanja na druge hemijske proizvodne procese i veže za sirove materijale i tržište za svoje produkte Jedan od klasičnih primjera mreža ovog tipa je grupa ustanova lociranih u tzv. Kalundborg Ekoparku u Danskoj. U Kalundborgu su ujedinjene: rafinerija nafte, fabrika sulfatne kiseline, proizvođač farmaceutskih proizvoda, termoelektrana, ribnjak, tvornica gipsanih ploča, koji međusobno razmjenjuju protok tvari i energiju. Time se i pojedinačno i sveukupno povećava i masena i energetska efikasnost.

5. Zaključna razmatranja

Stvarnost u kojoj je načelo održivog razvoja utopijski realizam koji je neophodno promijeniti ističe eminentni sociolog Giddens. Postmoderna misao, autori/ice Baudrillard, Derrida, Myerson, Haraway ukazuju da stvarnost nije više ono što je bila, pa „ostavljanje okoline budućim generacijama" gubi na značaju jer se u skladu sa Fukuyamom pitamo „ šta dolazi nakon humanuma"? Fukuyama, svojim pitanjem šta dolazi na kraju historije humanuma, kakav je to posthumani individuum, kakav je to postmoderni individualitet? Ovdje se i nalazi primjena ili radikalizacija Giddensove teze o kritici „utopizma" koncepta održivog razvoja, ka Giddensovom, Beckovom mišljenju o potrebi ekološkog osvješćavanja odnosno društvene refleksije kao jedinog mogućeg *modusa vivendi*, koja bi humanum učinila svjesnim postojeće krize i time spriječila apokaliptični scenarij, jer se čini gotovo nemogućim izaći iz *circulusa vitiosusa* virtualnih svjetova budućnosti, simulakruma, pluraliteta istina, mogućnosti kreiranja novih organizama, replikacije, reparacije, transplatacije, nuklearne nesreće, katastrofa, siromaštvo, svjetlosnog zagađenje, narušavanje ozonskog omotača zemljine kore i politizaciju odluka o ekološkoj legislativi. Alijenacija je najfrapantnija pojava koja nastaje kao rezultat raskida humanuma sa prirodnim svijetom. Hobo, blaziranost, šizoidnost, njeni su sinonimi koje pominju svi autori, što Myerson označava kao ekopatologiju postmodernog doba. Zatrašujući momenat sociološke dimenzije proučavanja ekoloških problema u savremenom dobu, utječe na promjenu svijesti i težnji ka aktivizmu u polju zaštite okoline koji ne mora isključivo biti zasnovan na konceptu održivog razvoja, potrebno je ojačati praktične mjere aktivizma i spriječiti uplitanje politike u odluke o ratificiranju određenih dokumenata i upotrebi određenih *aparatusa* ekopismenosti(uvodi je Fritjof Capra), eko-etike i bioetike. Socijalna ekologija i sociologija roda kao subdiscipline sociologije signifikantna su mjesta korekcije vladajućih stajališta o odnosu prema okolini, ali i kreiranja novih principa poput principa žena ravnopravno integrisanih u sve odluke u budućnosti, kritike identifikacija žena sa negativnim problemima feminizacije siromaštva i feminizacije nasilja. Žene su snažan katalizator mogućih budućih promijena u društvu jer se ženska logika brige postavlja kao oponent muškoj logici dominacije. Pravo, politologija i ekonomija su znanosti koje omogućavaju da se teorijska promišljanja sociologa/škinja upotpune sa adekvatnim mehanizmima i time snažnije nametnu i implementiraju u postojeće zakonske okvire.

Generalno gledajući, u skladu sa strategijom EU u oblasti energije i zaštite okoline, BIH mora da provede opsežnu akciju pripreme strateških planova za održivu energiju koja podrazumijeva

maksimalno iskorištenje obnovljivih izvora energije i unaprjeđenje energetske efikasnosti, uz inteligentno korištenje energije.Umjesto konvencionalno ograničenog razvoja i potrošnih modela, novi pogodniji i balansirani modeli moraju biti smišljeni. Ovi modeli bi trebali biti bazirani na sinergiji disciplina, od fizike i inženjeringa do zakonskih i političkih analiza. Pripremanje novih generacija menadžera, naučnika i inženjera zahtijeva globalnu edukacijsku strategiju. Ova strategija mora težiti za uključivanjem principa zelenog inženjeringa u edukaciju studenata završih godina i studenata postdiplomskog studija, jer je kompletan profesionalni vodić za efektivno projektovanje, komercijalizaciju i upotrebu industrijskih procesa, na način da se smanji polucija na izvoru, moćan novi pogledi unutar rizika po okoliš, baziran na razmatrenju projektovanja procesa, tehničkih rješenje i okolišne politike.

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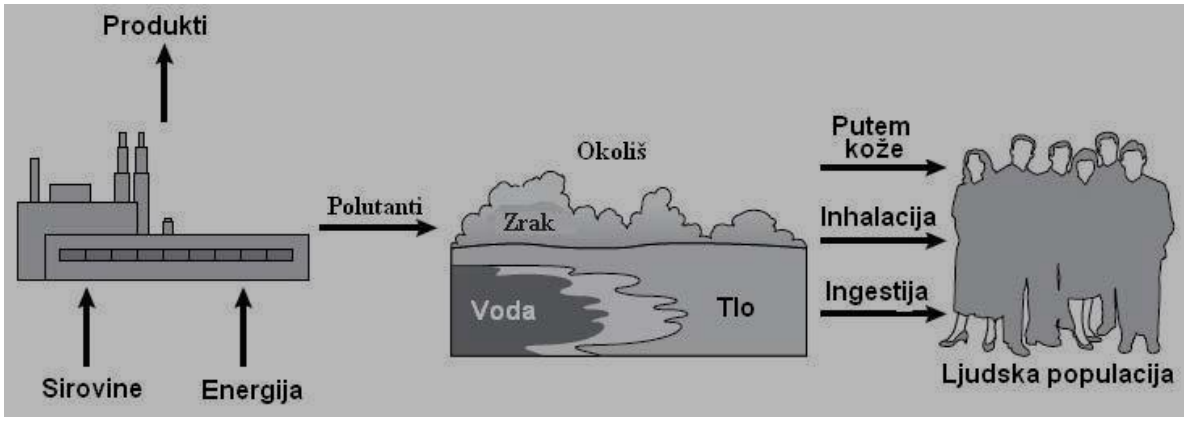
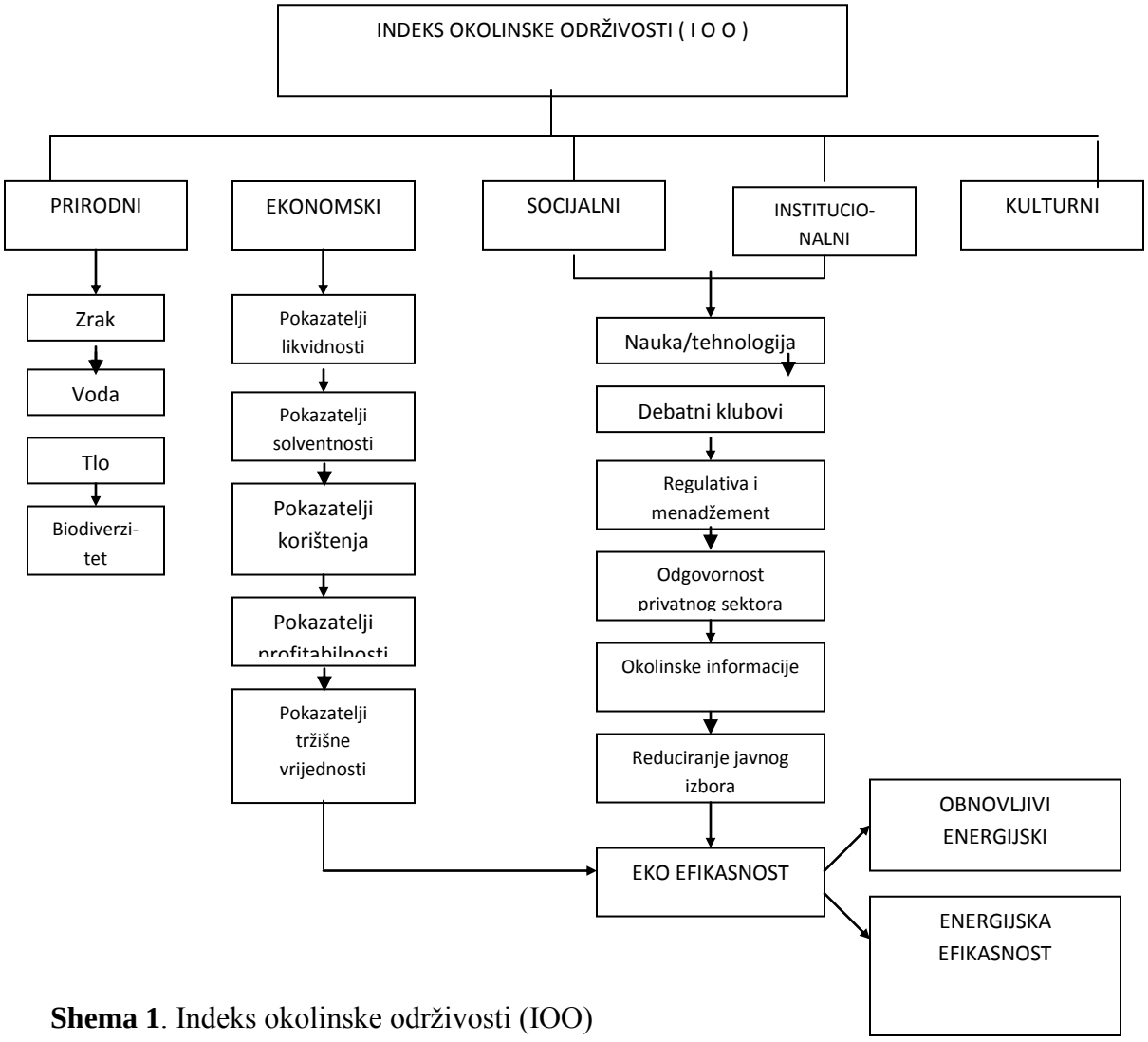


Slika 1. Opći scenario izlaganja humanuma zagađivanjima okoliša koji nastaju u toku industrijskih procesa i ispuštaju se u okoliš (preuzeto iz Jaganjac et al, 2009)

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
INDEKS Ukupna potrošnja energije	100	102,1	110,8	107,05	116,5	116,9	109,9

INDEKS GDP	100	120,5	128,7	137,4	152,7	161,3	192,2
INDEKS energijske intenzivnosti	100	84,8	86,1	78,3	76,3	72,5	57,2

Tabela 1. Potrošnja primarne energije, GDP i energijska intenzivnost za BiH,1998-2004. (1998. godina uzeta kao bazna-100)



Shema 1. Indeks okolinske održivosti (IOO)

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RESEARCH OF THE ORIGIN OF HEAVY METALS IN THE SOIL IN THE AREA OF ZENICA VALLEY

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ABSTRACT
This paper contains analysis of the results after monitoring the content of heavy metals (Pb, Cd, Fe, Zn, Ni, Cr and Mn) in sediment dust and agricultural soil in nine locations in the area of Zenica valley from March to August in 2016. The aim of the paper is to analyze and assess connection of the content of heavy metals in sediment dust and in soil surrounding steelworks Zenica in order to rate soil contamination caused by heavy metals that have been emitted from metallurgic plants, and in order to evaluate the industrial emissions effect on the environment and human health. It has been established that the biggest sample number of sediment dust is being loaded by Nickel and Cadmium, and soil samples by Nickel and Manganese. By applying Pearson coefficient, it has been concluded that there is a strong relation between Lead and Zinc, and a medium strong relation between Iron in sediment dust and soil, while other analyzed metals do not show significant correlation in terms of statistics. This shows that Lead, Zinc and Iron in the soil are probably of techno-genic origin, and the other metals are of primarily geological origin. The correlation analysis of metal substance in soil and sediment dust in measuring areas has shown that there is a statistically significant correlation between Zinc in sediment dust and soil in the following areas: Gradišće, Arnauti and Novo Selo, and correlation of Chromium in sediment dust and soil is present in Šerići.
Key words: sediment dust, soil, heavy metals, soil contamination

1. INTRODUCTION

Soil in industrial areas is often exposed to the influence of increased emissions of different pollutants from industrial machines. Research has registered higher concentrations of heavy metals in the soil than those naturally present, and very often this concentration is even higher than limit, which leads to deterioration of physical, chemical and biological characteristics as well as violations of soil usable values.
Also, the area of Zenica valley in central Bosnia for the past decades has been exposed to the influence of the high emissions of heavy metals and other pollutants emitted from industrial plants. Monitoring results identified a higher content of heavy metals in agricultural soil and in populations of different plants, which is a consequence of more than a couple decades of the environment being loaded by the emissions from industrial plants [1, 2, 3, 4].
Heavy metals from industrial sources are being emitted in the air and they are included into anthropogenic redistribution in the geosphere. The atmospheric deposits of heavy metals reach the soil, where they are accumulated and stored for decades. Heavy metals from the soil are taken out by the harvest and are washed by water and in that way they are included in the geobiocycle and food networks, through which

they can cause different consequences for all elements in food networks, including health consequences for the people. Harmful effects of heavy metals on ecosystems, especially on plants, are expected with higher concentration and are being reflected through different changes and disorders, which can reflect on human health [5]. Therefore, knowing all the factors affecting the redistribution of heavy metals in geosphere is of high significance for the protection of the environment, human health, and the stability of the eco-system.[5, 6, 7].

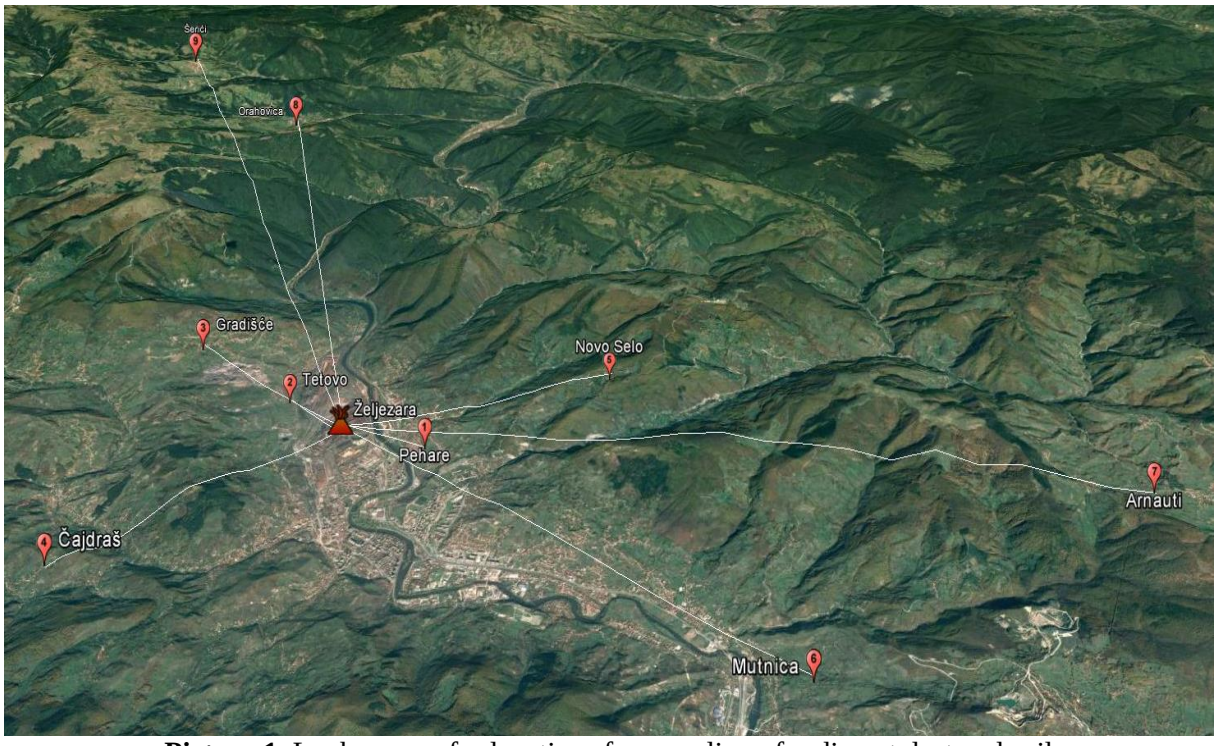
This paper contains analyzed results of heavy metals monitoring of (Lead-Pb, Cadmium-Cd, Iron-Fe, Zinc-Zn, Nickel-Ni, Chromium-Cr and Manganese-Mn) in sediment dust and agricultural soil in the area of Zenica valley. The aim of the analysis is to determine the origin of heavy metals in agricultural soil and the origin of soil contamination caused by heavy metals that have been emitted from industrial plants in order to assess the influence of industrial emissions to the environment and people's health.

2. MATERIAL AND METHODS OF WORK

Research has taken place in 9 locations (L) in the area of Zenica valley, in the Central Bosnia area. The locations are positioned in a cyclical scheme various distances (1,2 – 17,4 linear km) from industrial sources of emissions (Table 1 and Picture 1).

Table 1. Distance of locations from industrial sources of pollutants emission

Location	Distance (km)	Latitude	Longtitude	Altitude
Tetovo – L1	1,2	44^0 13'35" N	17^0 53'27" E	338 m
Pehare – L2	1,51	44^0 12'58" N	17^0 55'23" E	326 m
Gradišće - L3	3,18	44^0 14'13" N	17^0 52'8" E	528 m
Gornji Čajdraš - L4	4,41	44^0 11'16" N	17^0 51'49" E	520 m
Novo Selo - L5	4,13	44^0 13'34" N	17^0 57'60" E	696 m
Mutnica - L6	8,2	44^0 10'31" N	17^0 58'57" E	414 m
Arnauti - L7	11,7	44^0 12'3" N	18^0 2'37" E	680 m
Orahovica - L8	12,5	44^0 19'31" N	17^0 51'27" E	487 m
Šerići - L9	17,4	44^0 21'30" N	17^0 48'83" E	809 m



Picture 1. Lookup map for locations for sampling of sediment dust and soil

Sampling of sediment dust has been done in nine locations in the area of Zenica valley in continuously for a 6 months period, starting from March to August 2016. Sampling has been done with Bergerhoff's device for collecting sediment dust, which consists of a sampling bowl for collecting sediment dust and a stool with wire net. The stool is positioned so that the surface of the bowl is in horizontal position 1, 5-2 m above the surface of the soil. Measuring of the sediment dust has been done according to standard method [8, 9, 10].

Soil sampling has been done on representative surfaces set in the same locations (Table 1). Soil sampling and preparation of the samples have been done according to standard procedure [11]. In each location, average soil samples have been collected (approximately 2 kg) from more (10-20) single samples taken with chrome-plated probe and with hand plastic tools. The samples are taken from the surface layer of 25 cm in depth of agricultural soil, which has been used for food production for humans and cattle.

According to mechanical composition, the researched soil in 5 locations (L-1, L-3, L-4, L-5 and L-9) has a powder-clay structure, and in 3 locations (L-2, L-6 and L-7)there are argillaceous soil and in location L-8 there is sandy soil.

The chemical analysis of the content of total shape of heavy metals in sediment dust and soil have been performed in the laboratory for the following elements: Pb, Cd, Fe, Zn, Ni, Cr and Mn according to AAS method (Perkin Elmer Analytical Methods for Atomic Absorption Spectrometry). The content of metal in the soil is expressed in mg/kg, and in sediment dust in %.

The correlation between the content of heavy metals in sediment dust and agricultural soil has been done using statistical tools in the Excel programme.

The Pearason coefficient of correlation is used to determine how close observations are to the regression line which best describes linear connection of heavy metals in sediment dust and the soil.

Table 2. Shows the interpretation of linear correlation coefficient, upon which a conclusion on intensity and character of a connection between questioned variables is made.

Table 2. Criterium of intensity of linear connection between compared values expressed through Pearson correlation coefficient values

Correlation coefficient			**Intensity of connection among variables**
1			complete
0,80 ≤	r	< 1	strong
0,50 ≤	r	< 0,8	medium strong
0,20 ≤	r	< 0,5	weak
0,0 ≤	r	< 0,2	slight
0			completely absent

Connection intensity is the same for negative values of the correlation coefficient as well. For the determination of connectivity of chemical elements in sediment dust and agricultural soil, the correlation coefficients between elements (Table 8), and cluster analysis (Picture 2) have been used. The aim of the cluster analysis is to determine the the group of chemical elements (cluster) that shows that the elements inside the cluster are mutually alike more than the elements of the other cluster. Cluster hierarchy technique has been used in this analysis, which is based on correlation coefficient (r).

In order to assess values of total sediment dust and heavy metal concentration in sediment dust (Table 3), measured values are compared with limit values of polluting substance given in Annex XV: Limit and tolerant values for dedicated measuring according to [12].

Table 3. Limit values for total sediment dust and heavy metals in sediment dust

Polluting substance	Period of sampling	Average annual value (mg/m^2d)	High value (mg/m^2d)
Sediment dust-total	one month	200	350*
Lead (Pb) in sediment dust	one month	0,1	-
Cadmium (Cd) in sediment dust	one month	0,002	-
Zinc (Zn) in sediment dust	one month	0,4	-
Nickel (Ni) in sediment dust	one month	0,015	-

***Note:** It refers to the month in a year with the highest values of precipitation disposition

Limit values of heavy metals in agricultural soil are shown in Table 4, which are determined according to the national standards [13].

Table 4. Limit values of heavy metals in soil

Heavy metals (Total shape)	Limit values depending on soil texture (mg/kg soil)		
	Sandy soil	Powder-clay soil	Argillaceous soil
Lead (Pb)	50	80	100
Cadmium (Cd)	0,5	1,0	1,5
Nickel (Ni)	30	40	50
Chromium (Cr)	50	80	100
Zinc (Zn)	100	150	200

Limit values for Manganese and Iron, according to H.Resulović (Table 5). These limit values are presented in The Report on monitoring in the area of Municipality of Zenica for the period 2011-2015 [4].

Table 5. Limit values for Manganese and Iron according to H.Resulović

Manganese (Mn)	1000 mg/kg of soil
Iron (Fe)	5%

Limit values of heavy metals in the soil (Tables 4 and 5) refer to the soil areas with acid reaction. In alkaline and carbonated soil areas, limit values can be increased by 25%.

3. DISCUSSION AND RESULTS

3.1. Content of heavy metal in sediment dust

According to the data presented in Table 6, we notice that in locations L-1 and L-3 average values of sediment dust are higher than limit value of $350mg/m^2/day$. The highest maximum value has been recorded in these locations, which was expected since they are exposed to the highest pressures of industrial emissions due to the proximity to anthropogenic sources of the emissions and to the directions of dominant winds.

Average values of Pb concentrations in sediment dust are lower than the limit value of $0,1mg/m^2/day$, but maximum concentrations are exceeding limit values in localities L-1, L2, L-7 and L-9, which are located in the direction of dominant winds.

Average concentrations of Cd in sediment dust in most locations (L-1,L-2,L-3,L-5, L-7 and L-9) are higher than the limit value of 0,002 $mg/m^2/day$. Maximum concentrations of Cd in sediment dust are exceeding the proscribed limit value at almost all locations.

Average concentration of Zn in sediment dust in location L-1 (0,721 $mg/m^2/day$) was higher than limit value of $0,4mg/m^2/day$. Maximum values of Zn in sediment dust were higher in the same location with the value of 1,089 $mg/m^2/day$ and in location L-5 with the value of $0,491mg/m^2/day$.

In all researched locations, values of Ni in sediment dust are higher than the limit value of 0,015 mg/m^2/day have been recorded, and these varied from 0,016 – 0,107 mg/m^2/day. Maximum values of Ni in sediment dust varied from 0,053 - 0,484 mg/m^2/day.
For other heavy metals Fe, Cr and Mn, which are measured in sediment dust as well, the limit values are not prescribed nor does the criteria for their concentration assessment exist.

Table 6. Average and maximum values of sediment dust and heavy metal concentrations in sediment dust (mg/m^2/day)

	Sediment dust		**Pb**		**Cd**		**Fe**	
Location	**Average**	**Max**	**Average**	**Max.**	**Average**	**Max.**	**Average**	**Max.**
L1	**664**	**828**	0,0645	**0,137**	**0,0041**	**0,0215**	74,16	95,22
L2	279	**369**	0,042	**0,112**	**0,0024**	**0,0051**	34,03	65,75
L3	**367**	**635**	0,026	0,090	**0,0038**	**0,0150**	64,56	174,5
L4	198	264	0,035	0,082	0,0013	**0,0055**	7,705	10,59
L5	250	**630**	0,026	0,069	**0,0035**	**0,0057**	9,05	24,51
L6	203	274	0,024	0,088	0,00045	0,0019	8,56	13,25
L7	157	213	0,034	**0,136**	**0,00285**	**0,0077**	5,67	9,07
L8	188	298	0,0207	0,068	0,0018	**0,0062**	3,185	4,02
L9	350	**595**	0,027	**0,123**	**0,006**	**0,0114**	10,717	41,59
Limit value	350		0,1		0,002		-	

Table 6. (Continued)

	Zn		**Ni**		**Cr**		**Mn**	
Location	**Average**	**Max.**	**Average**	**Max.**	**Average**	**Max.**	**Average**	**Max.**
L1	**0,721**	**1,089**	**0,107**	**0,484**	0,054	0,084	4,163	5,395
L2	0,196	0,267	**0,019**	**0,055**	0,019	0,055	1,865	4,915
L3	0,285	0,382	**0,0365**	**0,053**	0,035	0,099	2,606	6,754
L4	0,145	0,182	**0,0325**	**0,130**	0,009	0,025	0,318	0,378
L5	0,172	**0,491**	**0,0275**	**0,113**	0,020	0,101	0,429	1,600
L6	0,111	0,135	**0,0295**	**0,079**	0,015	0,063	1,394	4,723
L7	0,112	0,173	**0,023**	**0,092**	0,003	0,002	0,135	0,215
L8	0,072	0,085	**0,016**	**0,078**	0,003	0,011	0,107	0,162
L9	0,1525	0,381	**0,039**	**0,173**	0,0073	0,027	0,5615	2,037
Limit value	0,4		0,015		-		-	

Note: Bolded values and shadowed fields in the table indicate that the limit values are exceeded.

3.2. Content of heavy metals in soil

The content of heavy metals in agricultural soils shown in Table 7, where we can see the increased presence of heavy metals in the area of Zenica valley, depending of the distance from the industrial sources, type of the soil and wind rose.
Average concentrations of Pb in the soil in zones up to 3,5 km surrounding steelworks Zenica (locations L-1,L-2 and L-3) were higher than the limit values shown in Table 4. Maximum concentrations of Pb in soil were higher than the limit values in five locations (L-1, L-2, L-3, L-8 and L-9).
Average concentrations of Cd in the soil were higher than the limit values in two of the locations (L-4 and L-7), while maximum concentrations of Cd were higher in most of the researched locations.
Average concentrations of Ni in soil were significantly higher than the limit values in almost all researched locations, which proves that the whole area is loaded with this pollutant.

Average concentrations of Cr in the soil were higher than the limit values in two locations (L-5 and L-7), and the maximum values were higher than the limit values in five locations (L-1,L-2, L-5, L-6 and L-7).
The highest concentrations of Zn in soil were recorded in zones up to 3,5 km surrounding steelworks Zenica (locations L-1, L-2 and L-3), and in location L-8 these were higher than limit values shown in Table 4.
In most locations the content of Mn in the soil was higher than the limit values shown is Table 5. Especially high concentrations have been recorded in location L-9, which is the farthest one from the industrial sources of emission to the air.
Analysis of heavy metals concentrations, in soil as shown in Table 7, clearly indicates that distribution of concentrations do not show a decreasing trend with moving from industrial sources of heavy metals emission. This is probably because of the origin of certain types of heavy metals, which is primarily geogenic, and secondarily anthropogenic, because of the configuration of the researched area and wind rose [4, 13]. The results of this research show increased values of certain heavy metals, especially of Mn, even in the farthest location tested.

Table 7. Average and maximum values of heavy metals concentrations in soil (mg/kg)

	Pb		Cd		Fe (%)		Zn	
Location	**Average**	**Max.**	**Average**	**Max.**	**Average**	**Max.**	**Average**	**Max.**
L1	**220**	**280**	<0,1	<0,1	4,94	**5,82**	**290**	**310**
L2	**92**	**110**	0,9	**3**	3,98	4,17	**247**	**260**
L3	**82**	**150**	0,41	**2**	3,13	3,58	**155**	**180**
L4	53,3	80	**1,23**	**6**	2,95	3,46	113,3	140
L5	35	60	0,91	**5**	3,67	3,83	76,6	110
L6	53,3	70	0,41	**2**	3,64	**5,12**	108,3	160
L7	40	60	**2,88**	**7**	3,95	4,27	83,3	100
L8	48,5	**70**	0,1	0,1	2,34	2,61	**103,3**	**120**
L9	58,3	**90**	1,06	**4**	2,26	2,48	116,6	130

Table 7. (Continued)

	Ni		Cr		Mn	
Location	**Average**	**Max**	**Average**	**Max.**	**Average**	**Max.**
L1	**125**	**200**	80	**130**	**1717**	**2130**
L2	**122**	**170**	92	**140**	**1647**	**1890**
L3	**70**	**110**	43	80	**1213**	**1280**
L4	**62**	**130**	40	80	743,3	830
L5	**136,6**	**200**	**91,6**	**120**	**1376,6**	**1640**
L6	**125**	**180**	90	**130**	873,3	920
L7	**198,3**	**250**	**158,3**	**190**	**1203,3**	**1360**
L8	**50**	**70**	15,16	30	**3110**	**3500**
L9	35	**80**	13,6	40	**6561,6**	**8200**

3.3. Investigation of the relationship between heavy metals content in sediment dust and soil

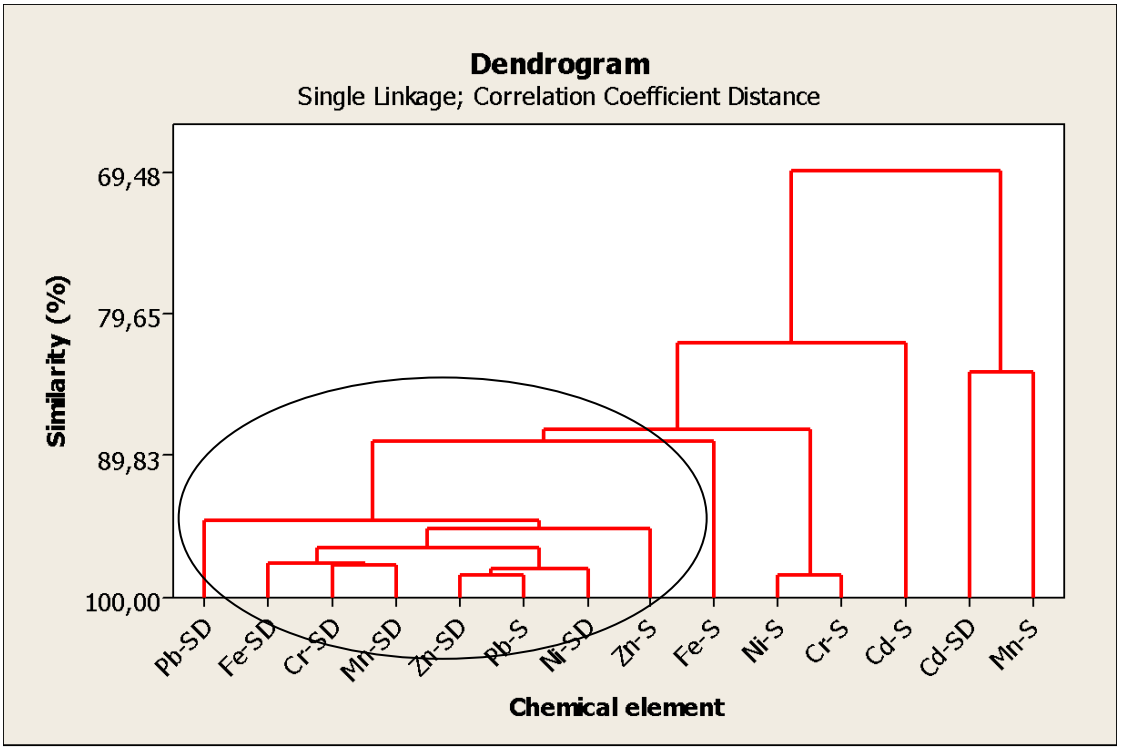
In Table 8 there is a survey of the correlation coefficient between heavy metals concentrations in sediment dust and soil.

Table 8. Correlation coefficient between heavy metals concentrations in sediment dust and soil

	Pb-SD	Cd-SD	Fe-SD	Zn-SD	Ni-SD	Cr-SD	Mn-SD
Pb-S	**0,891**	0,284	**0,837**	**0,967**	**0,920**	**0,867**	**0,906**
Cd-S	-0,061	0,043	**-0,430**	**-0,379**	**-0,342**	**-0,503**	**-0,508**
Fe-S	**0,777**	-0,074	**0,531**	**0,671**	**0,577**	**0,655**	**0,644**
Zn-S	**0,836**	0,197	**0,808**	**0,804**	**0,679**	**0,760**	**0,864**
Ni-S	0,381	-0,251	0,066	0,147	0,093	0,099	0,151
Cr-S	0,282	-0,197	-0,039	0,047	-0,010	0,031	0,029
Mn-S	-0,193	**0,676**	-0,180	-0,112	0,009	-0,263	-0,204

Note: Dark fields point out strong connections between the same metals in sediment dust (SD) and soil (S)

According to the data presented in Table 8 there is a noticeably strong connection between Pb (r=0,891) and Zn (r=0,804) in sediment dust and soil, while in the connection between Fe in sediment dust and soil is of medium strength (r=0,531). There is a noticeable strong connection between Pb, Fe, Zn, Cr and Mn in sediment dust with Pb and Zn in the soil, as it has been shown in dendrogram in Picture 2. This connection means that these researched chemical elements probably have the same origin and they come from industrial sources of emissions in the air. Ni, Cr, Mn and Cd do not show significant mutual connection in the samples of sediment dust and soil collected in the researched area of Zenica valley (Picture 2).



Picture 2. Dendrogram of cluster analysis– connection of the elements in sediment dust (SD) and soil (S)

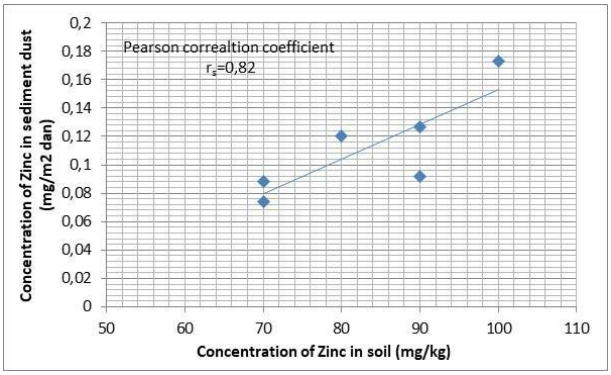
Correlation coefficients between heavy metals in sediment dust and soil in researched locations surrounding steelworks Zenica are presented in Table 9.

Table 9. Pearson correlation coefficient of concentration of heavy metals in sediment dust and soil in researched locations during the period of March-August 2016.

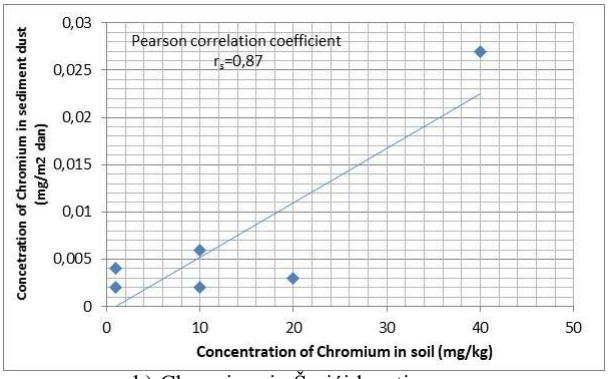
LOCATION	Pearson correlation coefficient						
	Pb	**Cd**	**Fe**	**Zn**	**Ni**	**Cr**	**Mn**
L1	-0,42	0	0,42	-0,01	0,45	0,40	-0,42
L2	-0,42	0,13	0,45	0,10	-0,15	-0,05	-0,33
L3	-0,45	-0,27	-0,51	**0,78**	-0,85	0,69	-0,45
L4	0,25	0,09	-0,58	0,60	-0,15	-0,58	0,36
L5	-0,34	0,35	0,51	**0,79**	-0,18	0,65	-0,16
L6	0,05	-0,17	-0,55	0,04	0,15	-0,07	-0,02
L7	-0,28	-0,08	-0,40	**0,82**	-0,30	-0,59	0,01
L8	0,55	0,00	0,28	0,70	0,28	-0,62	0,00
L9	0,41	0,11	-0,14	0,53	-0,39	**0,87**	0,08
Average values for all locations	0,89	0,04	0,53	0,80	0,09	**0,03**	-0,20

Note: Dark fields point out strong connections between heavy metal substance in sediment dust and soil

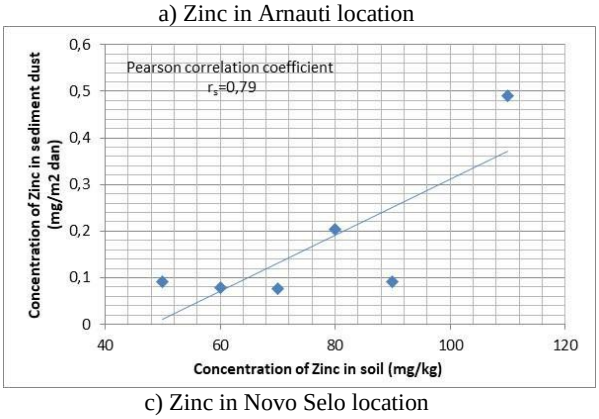
Statistical analysis of data, presented in Table 9, show that the correlation between heavy metal content in sediment dust and soil inside certain locations is weak (negative values are not taken into consideration),except for Zn in locations:L-3 in (Picture 3-d, r=0,78 – strong connection), L-5 (Picture 3-c, r=0,79 – middle strong connection) and L-7 (Picture 3-a r=0,82 – strong connection), and Cr in location L-9 in Picture 3-b, r=0,87 – strong connection). Therefore, statistically significant connections exist between the heavy metal content in the sediment dust and the soil for Zn in these locations: L-3, L-5 and L7, and for Cr in location L-9.



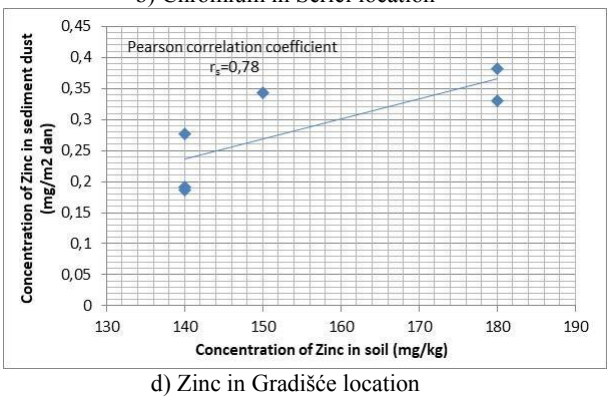
a) Zinc in Arnauti location



b) Chromium in Šerići location



c) Zinc in Novo Selo location



d) Zinc in Gradišće location

Picture 3. Diagram showing dissipation of heavy metals in sediment dust and soil

4. CONCLUSION

According to the monitoring of in agricultural soil and sediment dust in the area of Zenica valley, in central Bosnia, it was found that a large number of the samples of sediment dust were loaded with Ni (25 samples) and Cd (18 samples), with a total number of 54 samples collected. In addition, a large number of the soil samples were loaded with Ni (47 samples) and Mn (42 samples), with a total of 54 samples obtained.

Heavy metal content in sediment dust and agricultural soil in the area of Zenica valley shows increase levels compared to the natural state and goes beyond the maximum limit values allowed, which is a consequence of their anthropogenic redistribution caused by present emissions of heavy metals from metallurgic and thermal plants.

Application of Pearson correlation coefficient shows strong connection between Pb and Zn as well as a medium level connection between Fe in sediment dust and soil. Other elements that have been analyzed do not show significant statistical interrelation. This shows that increased content of Pb, Zn and Fe in soil is probably of technogenic origin because of industrial emissions of these elements.

Correlation analysis between the content of metals in soil and sediment dust in these researched locations has shown that there is a statistically significant correlation between Zn in sediment dust and soil in following locations: Gradišće, Arnauti and Novo Selo, and of Cr in sediment dust and soil in location Šerići.

The results of this research of the content and dynamics of heavy metals in agricultural soil of Zenica valley show that the soil quality is endangered and is risky for food production because of the heavy metal inclusion in food networks and the potential negative impact on human health.

Since this analysis has shown high variation of the results and high number of negative results, it is necessary, in further research, to lower the number of measuring places, increase the number of elements analyzed, and increase number of samples foe an extend research period. In this way, we would get more representative data, which would provide better correlation between the content of heavy metals in sediment dust and soil. Based on such detailed examination it is possible give recommendations for applying suitable technology and measures for remediation of the contaminated soil (e.g. phytoremediation or calcination or adding humus to the soil, etc.).

5. ACKNOWLEDGMENT

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The 8th International Scientific Conference Environmental and Material Flow Management "EMFM 2018" Zenica, B&H, 14-16 November 2018

MODELLING OF AIRBORNE DUST PM_{10} DISPERSION EMITTED FROM QUARRY IN ORDER TO ASSESS ITS IMPACT ON THE AIR QUALITY

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SUMMARY

The impact of exploitation and processing of technical stone on the environment may have different influence on emission levels and devastation of the environment depending on the applied technological process for obtaining rock mass and production of stone aggregates, and depending on the topography, meteorological conditions, applied environmental measures and technological discipline. The primary impact of working processes and operations on environment, in the surface exploitation and processing of the technical stone, is manifested through emissions of mineral dust. In order to determine the impact of the exploitation of technical stone on air pollution, a calculation of floating dust particles PM10 from the quarry which occasionally or in no way uses the measures to control the emission of dust during the production process and processing of technical stone, was carried out according to the EPA methodology . The modelling of the dispersion of floating dust particles from the area of the quarry for calculated values was also performed by the application of Aermod software.

Keywords: emission, floating dust pm10, dust emission calculation, dispersion modelling

1. INTRODUCTION

The technical stone is a mineral material derived from sedimentary, volcanic and/or metamorphic rocks used as a technical/construction stone. Unwanted ecological influences during the surface exploitation of technical stone arise at:
-removal of the overburden,
-exploitation of rock mass, and
-processing of stone aggregates.
First environmental influences when opening the quarry are appearing due to the removal of the plant cover and cutting of the trees which further directly, or indirectly, influences the changes in the ecosystem. Removal of overburden is the first phase which implies removal of the surface material covering the valuable deposit which must be disposed of, usually in the immediate vicinity with goal to reduce overall costs [1]. The construction of access roads and infrastructural objects and other necessary works for securing the smooth and continuous exploitation and processing of technical stone is also performed. Environmental impacts in the exploitation and processing of rock mass at the quarry are manifested through dust and noise emissions, vibrations, blasting effects, exhaust gases, waste production, etc. [2].
Process of obtaining the rock mass of technical stone is usually done by selective excavation of valuable deposit and by piling the overburden which is disposed on the external waste dump in the initial period, and on the internal waste dump at a later stages.
The primary impact of the working processes involved in the surface exploitation and processing of the technical stone on the environment is manifested through the emission of mineral dust.

The emission of dust from quarries are usually uncontrollable, which makes them difficult to determine and evaluate. This is why today are used the specific numerical models for the calculation of mineral dust emissions from the quarry area, i.e. from all processes and operations within the technological process of exploitation and processing of technical stone. By modeling the ambient concentration of the emitted dust from the quarry, decision-making (for the authorised institutions) in the process of issuing the permit for exploitation and processing of technical stone and in the process of issuing of the environmental permit can be greatly facilitated.
The confirmation of this assumption is that there is over 300 active quarries in the territory of the FBiH. There are several quarries in a narrow zone in some locations and some quarries are near the settlements that are significantly affected and endangered due to the nature of the activity at the quarry.

2. CALCULATION OF DUST EMISSIONS (PM_{10}) FROM THE QUARRY USING THE EPA METHOD.

Dust emissions from the quarry area have the character of fugitive emissions that are impossible to measure using the standard methodology and measuring equipment for emission measurement. Therefore, for the evaluation of the emission from the quarry, the methodology based on the calculation of emissions are used. This methodology take into account the key impact factors on emission levels [3].
For the time being, the adequate methodology for the estimation of emissions of dust from the quarry is not used in BiH. The introduction and application of methodologies for the assessment of dust emission, as described in this paper and defined by the environmental protection agency (EPA) and with the support of the Canadian Environmental Protection Agency (EC) and the Australian National list of pollutants (NPI), is rational, constructive and cost-effective solution that will ultimately lead to the establishment of a system that is appropriate for environment management systems at quarries and surface mines.
Parameters for calculation of dust particles pm10s at the quarry, in this paper, are selected experientially for the quarry that works throughout the whole calendar year and which has an annual production of more than the average production of quarries in BiH.
The adopted parameters are:

- Number of working months per year..... NMJ = 12
- Number of shifts per day..... NSMJ = 1
- Number of working hours per shift..... Nh/SMJ = 10
- Work efficiency..... KV = 85%
- Number of working days per month..... NRDMJ = 24

From the above conditions, the annual number of effective working hours is:

$$T_g = N_{mj} \times N_{smj} \times N_{h/smj} \times N_{rdmj} \times k_v = 12 \times 1 \times 10 \times 24 \times 0,85 = \mathbf{2.448,0}\ H_{ef}/yr$$

Projected capacity per hour for calculation purposes is 300 tonnes/hef, and we obtain the annual production capacity:

$$Q_{annually} = T_g \times Q_{t/h} = 2.448,0 \times 300,0 = \mathbf{734.400,00}\ \text{(tonnes/year)}.$$

2.1. Calculation of total floating dust according to technological processes and operations

By applying the methodology of the US Environmental Protection Agency (EPA) it is possible to perform a calculation of PM_{10} from all technological processes and operations contained in the process of exploitation and processing of technical stone, as shown below.

2.1.1. Removal of overburden

The equation for calculating the total floating dust of the overburden removal operation has the form of [4]:

$$PM_{10} = EF_{(PM10)} = \left(0,45 \cdot \frac{(s)^{1.5}}{(M)^{1.4}} \right) \cdot k$$

where:

M-surface material moisture content (%)
S- surface material silt content (%)
EF-emission factor (kg/hr)

2.1.2 Blast hole drilling

To estimate the emission rate for dust particles from the operation of blast hole drilling,, the equation that imply the dependence of dust particles emission and the total amount of the blasted material in the period for which the emission rate is assessed, is used [5].

$$E = E_f \cdot Q$$

where is:

E-emission of dust particles (in kilograms per year)
Q-quantity of all types of blasted material during the year (in tons)

2.1.3 Blasting

The equation for calculation of the emission of dust generation in the blasting process implies dependence of dust emissions from the size of the area that is blasted and the number of blasting operations during the year.

$$E = k \cdot N \cdot 0{,}00022 \cdot A^{1.5}$$

where:

K-particle size factor
N-number of blasting operations per year
A-the area blasted in square meters

2.1.4. Gravity transport from an upper to a lower bench

On surface mines where gravitational transport of useful mineral substances and overburden is used, the estimation of dust emissions can be carried out in two ways. For rough evaluation of dust emission, the expression for dust emission which is the function of the dust emission factor and the of the total number of working hours of equipment engaged on gravity transport, is used [6]:

$$E = E_f \cdot T;$$

For a more precise estimation of the dust emission from gravity transport operation, a form of expression for dust emission in which the emission factor must be calculated, is used. When calculating the dust emission factor, material silt content, moisture content in material and the estimation of material quantity transported by gravity, needs to be taken into account [6]:

$$E_f = 2{,}76 \cdot k \cdot \frac{s^{1.5}}{M^{1.4}}$$

Where:

T-total operating time of work equipment (hours)
K- particle size factor
M- moisture content in material (%)
At the selected quarry was assumed, that the gravity transport will not be used, and complete quantity of stone from benches will be hauled to a primary crushing plant, so that the dust emission of gravitational transport will not be calculated.

2.1.5. Operations of loading and unloading

For the evaluation of dust emissions generated from operations of loading and unloading is used the empirical expression which takes into account the mean wind speed at the location of the works, the moisture content in material and the estimated total quantity of material to be manipulated.

$$E = E_f \cdot Q_m; \qquad E_f = k \cdot 0{,}0016 \cdot \frac{\left(\frac{U}{2{,}2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$$

where:

Q_m-the quantity of material (annually in tones)
M- moisture content in material (%)
U-mean wind speed (meters per second)

2.1.6. Crushing and screening operations

Estimation of dust emissions from operation of crushing and screening is calculated separately for every stage. Primary, secondary (and tertiary) stages of crushing and screening operations are calculated according the following expression:

$$E = E_f \cdot T_m$$

where:

T_m-total quantity of processed material during the year (in tones)

2.1.7. Storage pile wind erosion

For a precise assessment of the dust emissions generated from the influence of wind to storage piles, expression that takes into account material silt content, the percentage of time during the year with the unobstructed wind speed exceeds 5.36 m/s at a mean pile height, the average number of days during the year when storage pile is soaked to a depth of minimum 0.000254 meters, and the area of the storage pile exposed to the wind, is used:

$$E = E_f \cdot A_m; \quad E_f = 1{,}12 \cdot 10^{-4} J \cdot 1{,}7 \cdot \left(\frac{s}{1{,}5}\right) \cdot \left(365 \cdot \frac{(365 - P)}{235}\right) \cdot \left(\frac{I}{15}\right)$$

where:

E-dust emissions, in tonnes per year
E_f- emission factor, tonnes per square meter
PM-warehouse area, sqm
J- particle size factor
s- material silt content
P- average number of days during the year when storage pile is soaked to a depth of minimum 0.000254 meters
I- percentage of time during the year with the unobstructed wind speed exceeds 5.36 m/s at a mean pile height

2.1.8. Truck transport on unpaved roads

For hauling operation on unpaved roads at industrial sites, dust emissions are estimated from the following equation which takes into consideration the average weight of the vehicle, the content of fine particles on the road surface, as well as the number of travelled kilometres.

$$E = E_f \cdot V$$

$$E_{f(PM10)} = k \cdot \left(\frac{s}{12}\right)^{0.9} \cdot \left(\frac{W}{3}\right)^{0.45}$$

where:

V- number of travelled kilometres per year
s-the contents of the small particles on the road surface
k- particle size factor (K=0,422 for PM^{10})
W- mean vehicle weight in tons

2.1.9. Influence of wind erosion of exposed areas and unpaved roads

Surface of unpaved roads and exposed areas at the quarry for which the emission of dust emissions is calculated is approximately 127.010,0 m^2. Emission factor is expressed as a function of vegetation on terrain, mean wind speed, friction and correction factor (which is derived value) [7].

$$E = k \cdot E_f \cdot A$$

$$E_f = 2{,}814 \cdot (1 - v) \cdot \left(\frac{u}{u_t} \right)^3 \cdot C_{(x)}; \qquad u_t = u_t^* \cdot u^*$$

where:

A-surface of unpaved roads and exposed areas on the quarry, in square meters
V-amount of vegetation, non dimensional number (from 0.0 to 1.0)
U-mean wind speed, meters per second
U_t-threshold wind speed, meters per second
$C_{(x)}$-correction factor, non dimensional number
u_t^* -friction speed threshold, meters per second
u^* -wind speed ratio depending on surface roughness

Results of the calculation of the emission of floating dust particles (PM_{10}) from the quarry, when the methods for control of dust emissions are not applied, at annual level of the assumed production capacity of 734,400 t/y (approximately 200,000.0 m^3 s.m.), are given in the following table.

Table 1: Calculation of dust emissions (PM_{10}) by using the EPA methodology

A technological process	TSP dust (t/year)
Overburden removal	0,0069
Blast hole drilling	0,7750
Blasting	16,2790
Loading and unloading	8,1080
Crushing and screening	7,4725
Storage pile wind erosion	1,1840
Truck transport on unpaved roads	56,9290
Influence of wind erosion of exposed areas and unpaved roads	17,1460
TOTAL PM_{10} (t/year)	**107,9004**

3. MODELLING OF THE AIRBORNE DUST PARTICLES (PM10) DISPERSION FROM SURFACE MINES

One of the biggest problems today is certainly the air pollution, and modelling of air pollution through the use of sophisticated mathematical models is one of the ways to assess air pollution [8].
Modelling of the dispersion of pollutants in the atmosphere is a mathematical simulation of pollutant dispersion mode in the atmosphere. Computer modelling is the cheapest and most commonly used method for analysis of all technological processes and operations and has become widespread in solving problems related to air pollution, and especially in the phase of research and development in the extracting industry.
Simulation mainly includes modelling of the physical processes and their analysis using computers. This analysis includes the method of trial and error applied to the model, tested on the actual physical processes, in order to assist in the model development. When this process is completed, a computer model can be used to identify the technological processes and operations with an increased emissions of dust into the atmosphere as well as focusing on finding solutions in reducing the impact of different technological processes and operations on the environment.
Computer modelling of the dust dispersion from surface mines can provide the identification of the potential danger from certain dust sources related to the aspect of endangering the health and safety of

the population. The model can also allow evaluation of dust emission control technique in order to identify the changes needed to improve the technique for dust emission control. By using method of modelling is important to accurately estimate the dispersion of dust in the air from each technological process and operation in the production and processing of mineral raw materials. Air quality modelling is used to determine and visualise the significance of the dust emission impact on the quality of the air and the environment. Models for air quality are estimations of dust concentrations on a large number of sites (receptors) on the area of the quarry. These models provide a cost effective way to analyse the effects on a wide area taking into account the factors that include meteorology, topography and the emission sources. Previously mentioned meteorological factors, are input data set and they are related to wind speed, wind direction, air temperature, etc.. On the basis of all input parameters, the model generates a prediction of the spreading of polluting substances from the source and estimating concentrations of pollutants in the atmosphere.

3.1. Description of the Applied Model in the Paper

AERMOD View is a complete and powerful air dispersion modeling software which incorporates the following current U.S. EPA air dispersion models into one integrated interface: AERMOD, ISCST3 and ISC-PRIME. AERMOD was developed by American Meteorological Society (AMS) and US Environmental Protection Agency. AERMOD View enables the estimation of emission propagation in the air taking into account the terrain, different height of the source, influence of the position of objects, etc. Also, the mentioned model provides the possibility to model a number of different types of emission sources in accordance with the Register of emissions to: line, point and surface sources (Figure 1).

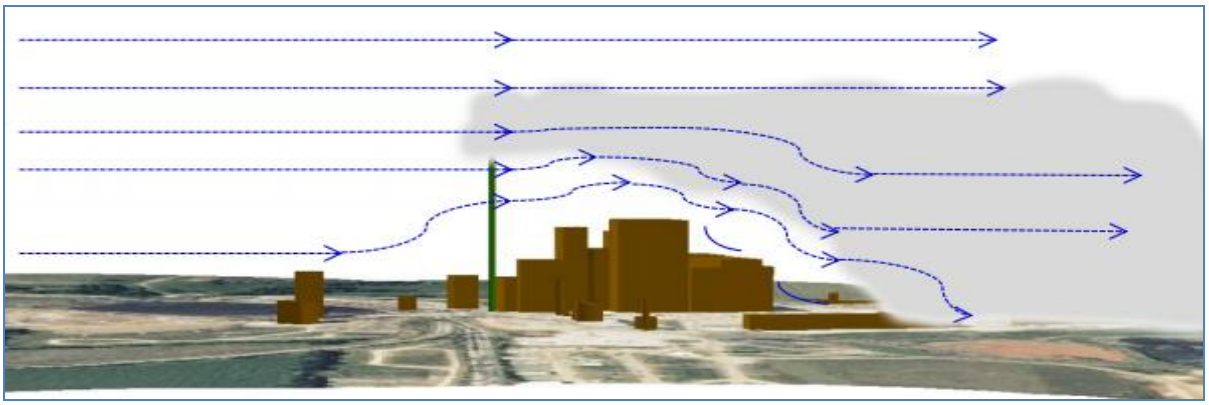

Figure 1: Influence of objects and buildings on wind flow

The AERMOD atmospheric dispersion modeling system is an integrated system that includes three modules:

-A steady-state dispersion model designed for short dispersion of air pollutant emissions from stationary industrial sources. The results of calculation of the PM10 dust emission from the quarry using EPA methodology are used as input parameters for modelling of total suspended particles distribution around the quarry.

-A Meteorological data of the preprocessor (AERMET): the impact of meteorological data in modelling is expressed through data about the parameters of the surface boundary layer and the profile data of variable meteorological parameters in which the wind speed, wind direction and turbulence parameters are included. Meteorological parameters needed for modelling are taken from the weather station Bjelave for 2016.

-A terrain preprocessor (AERMAP): terrain data are the key for the characterisation of the variability of the height of the terrain, of the sources, buildings and receptors in the model domain. The main purpose of AERMAP is to provide a physical connection between the characteristics of the terrain and the behaviour of the air pollution plume. The information collected from AERMAP is then passed on to the AERMOD as the location of the receptor, the receptor height above mean sea level and the terrain height. For purpose of modelling is selected quarry "Plješevac", nearby town of Kiseljak, with all parameters and data that are required for the AERMAP module.

3.2. Results of the Modelling

The following figure is representing the results of modelling of the average annual values of PM_{10} dust from the quarry which does not use techniques for dust emission control during production process of the stone aggregates.

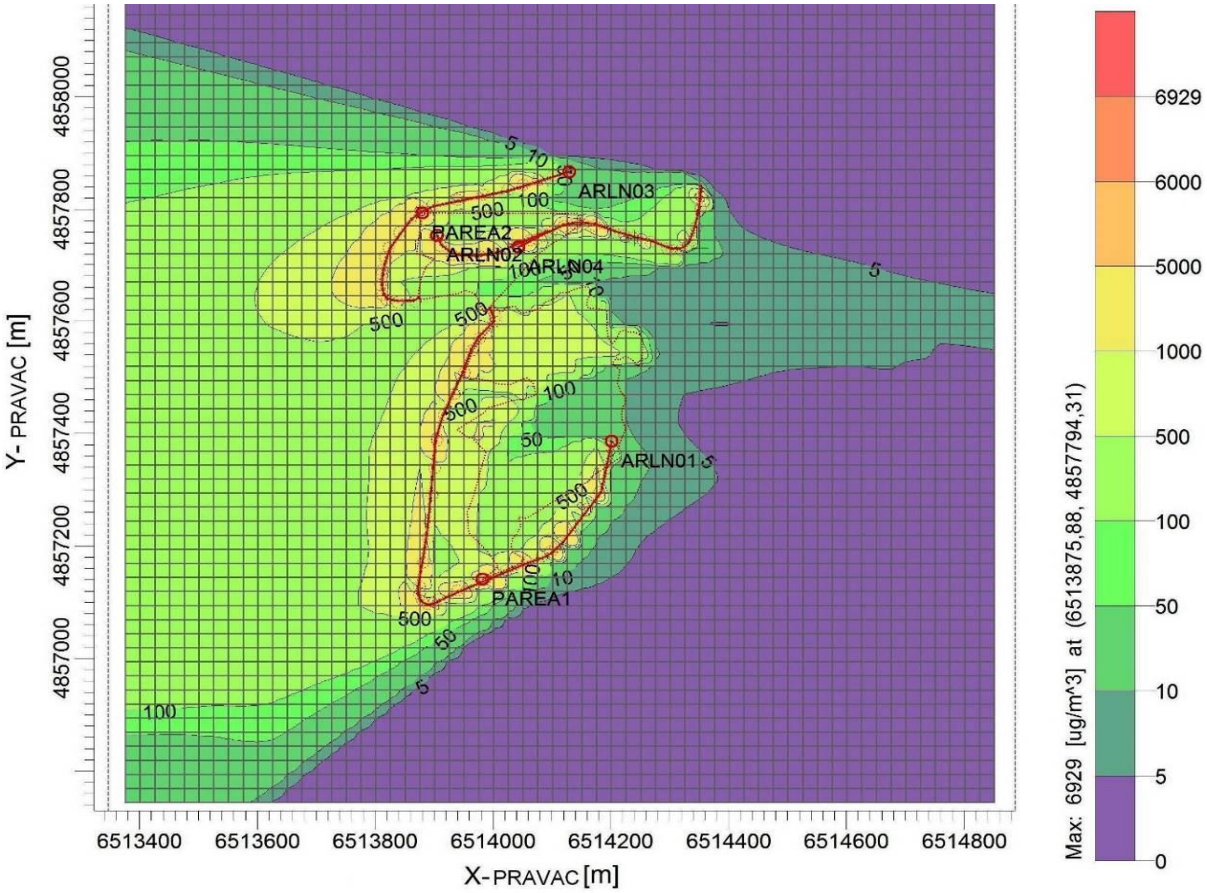

Figure 2: Spatial distribution of PM_{10} from area of the quarry that does not use dust control emission techniques

The following table shows the part of the AERMOD software output data for the PM_{10} from the quarry that does not use dust control emission techniques.

Table 2: the part of the AERMOD software output data for the PM10 from the quarry that does not use dust control emission techniques

X	Y	AVER. CONC	ZELEV	AVE	GRP
6.513.375,88	4.856.744,31	10,86646	923,00	PERIOD	ALL
6.513.400,88	4.856.744,31	11,72159	920,70	PERIOD	ALL
.....					
6.513.800,88	4.857.794,31	714,50236	728,70	PERIOD	ALL
6.513.825,88	4.857.794,31	999,03255	733,40	PERIOD	ALL
6.513.850,88	4.857.794,31	1.643,02969	736,60	PERIOD	ALL
6.513.875,88	4.857.794,31	6.928,82626	739,00	PERIOD	ALL
6.513.900,88	4.857.794,31	903,62034	741,30	PERIOD	ALL
6.513.925,88	4.857.794,31	504,19560	741,70	PERIOD	ALL
6.513.950,88	4.857.794,31	370,11414	741,90	PERIOD	ALL
.....					
6.514.825,88	4.858.219,31	0,00000	709,90	PERIOD	ALL
6.514.850,88	4.858.219,31	0,00000	702,60	PERIOD	ALL

** CONCUNIT ug/m^3
** DEPUNIT g/m^2

4. CONCLUSION

The growing trend of increasing in the number of quarries in BiH leads to emissions of large dust quantities into the atmosphere. Performing technological operations on quarries such as drilling, blasting, material handling, processing, classification and hauling are potential sources of dust air pollution. Therefore, detailed study of the source of emission and quantification of pollutants emission (especially dust) from the area of quarries is required.

In order to determine the impact of the exploitation and processing of technical stone on air quality, a calculation of dust emissions PM_{10} according to EPA methodology was made, and modeling of the spatial dispersion of the airborne dust particles PM_{10} in the air using the AERMOD software was carried out, and all of the above for the selected quarry which has an annual production (and processing) capacity of approximately 200,000 m^3.s.m of aggregates, whereby the dust emission control techniques are not used on the quarry.

From the obtained results of the calculations it is evident that the largest yearly amount of airborne dust was produced from truck transport on unpaved roads, from influence of wind erosion of exposed areas and unpaved roads and from blasting. It is also evident that dust emissions PM_{10} can be over ten times higher for a particular operation if techniques for dust emission control were not applied.

Observing the isolines of airborne particles spatial distribution in Figure 2. originating from the area of the quarry which does not use the dust emission control techniques in the course of the production and processing process, it can be seen that the concentration of PM10 in the air exceed the permitted limit over 10 times when observing the distances over 500 meters from the quarry.

The modelling results show that dust emissions from the surface mines can have a significant impacts on the air quality in the local area up to 650 meters air distance, so the minimum distance from the open pit to the populated areas and other objects and natural resources should not be less than 650 meters, in order to prevent negative impacts on the environment and local population.

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SUSTAINABLE MANAGEMENT OF ANIMAL WASTE IN SARAJEVO CANTON

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ABSTRACT

The problem of integral management of animal by-products and animal waste (ABP / AW) in BiH has been present for many years, but unfortunately, there are still no concrete and long-term solutions. The Canton of Sarajevo (CS) faces daily problems of such a nature. In this paper we briefly describe the current problems in the management of animal waste in the Canton of Sarajevo and options for solving problems in this area. The results of the project of establishing the animal waste register in the CS are also presented as an important segment for controlling the types and quantities of by-products and waste of animal origin.

Keywords: animal by-products, animal waste, incineration, register of animal waste, burial pit

1. INTRODUCTION

Treatment with animal by-products and waste of animal origin (ABP/AW) in Bosnia and Herzegovina (BiH) is currently not in accordance with the EU standards and veterinary and environmental standards. The problem of lack of integral management of (ABP/AW) in BiH has existed for a number of years. Problems, negative impacts and consequences on the quality of the environment as well as the risks to human and animal health due to lack of adequate infrastructure and uncontrolled disposal of ABP / AW are great. There are no up-to-date and accurate statistical data on producers and quantities in BiH, as they are still not regularly monitored.

In order to address numerous problems in the field of ABP/AW management in BiH, from June 2016 to June 2018, the EU financed project "Technical Assistance in the Control of Animal By-products and Animal Wastes Management in BH" was implemented. Unfortunately, this project has not resulted in the construction of required infrastructure for the provision of ABP /AW in BiH, but it did provide recommendations to be implemented in timely manner.

The problem of control of animal by-products and animal waste is demanding issue also in the Canton of Sarajevo.

The regional sanitary landfill Smiljevici, which has been at the same location since 1962, became officially part of the Regional Waste Management Center (RWMC) of Sarajevo Canton in June 2017. The problems of destroying expired date goods, animal by-products and animal waste are often solved by disposal to the active landfill site, leading to a number of problems of the regular functioning of the sanitary landfill. The Smiljevici landfill Program for reconstruction for the period 2016-2020 and the opening of the RWMC Smiljevici has evidenced problems in the management of special categories of waste that should not be disposed in the sanitary landfill. Through the 50 projects that are envisaged by the RWMC Smiljevici landfill rehabilitation program, priority is given to the problem of disposal of animal by-products and animal waste.

2. QUANTITIES OF ANIMAL BY-PRODUCTS AND ANIMAL WASTE IN CANTON SARAJEVO

The problem of lack of records of the total quantities and categories of animal waste in accordance with the veterinary and environmental legislation and adequate infrastructure for the collection and disposal of this special category of waste, including special vehicles for transport, in the Canton of Sarajevo is clearly identified in the key strategic document: The Cantonal Environmental Protection Plan (KEAP), which was adopted at the CS Assembly in October 2017.

As part of the EU project "Technical Assistance in the field of ABP/AW management in BiH", questionnaires were collected from some of major producers of this waste in the CS by the Cantonal Inspection. The Management Authority collected data through its veterinary staff in the period from September 2017 to May 2018 from 155 larger producers of ABP / AW. The Cantonal Inspection presented data collected for 6 months for 28 major producers and limited data from 17 poultry farms during the March-April 2018. The available data from the Cantonal Inspection for larger producers are presented in Table 1.

Ministry of Physical Planning, Construction and Environmental Protection CS (MPPCEP) during 2017/2018 funded the project "Development of Register of Animal Wastes in the CS" - project with the aim of obtaining more detailed and comprehensive data for the CS. [4] Survey of smaller ABP / AW producers in the CS (warehouses, wholesales, meat processing, fish farms, butchers and farms) was conducted by mailing a questionnaire. The survey lasted from December 2017 to April 2018. Out of a total of 810 respondents, 254 did not submit a response, of which the highest number of farms (211). Out of the 556 responses received, 180 producers submitted data on quantities and categories of waste produced and 187 producers reported no production of this type of waste.

For the purpose of obtaining general data on the production of ABP/AW in the CS in 2017 the estimate was made of the total quantities of all categories that may occur for poultry farms for which there were production capacity data (total of 22 farms). Also, for 65 farms of sheep, cattle and goats for which production capacity data existed, the estimate of total quantities of fertilizer production (category 2b) was performed on the same.

The total quantities of ABP / AW production in the CS for 2017 are given in Table 1.

Table 1. The quantities of ABP / AW production in the CS for 2017

No.	Sources	Total amount of AW (kg)
1.	EU project (28 major producers ABP / AW for 12 months) for the CS	2.388.480,00
2.	Project funded by MPPCEP CS (survey of 782 producers of ABP / AW) for 12 months of production	2.496.580,00
3.	Estimated quantities for 22 poultry farms (project MPPCEP CS) known production capacities	4.664.774.96
4.	Estimated quantities for 65 farms of cattle, sheep, goats (MPPCEP CS project) known production capacities	8.349.002,15
5.	Estimated quantities of 3rd service facilities (restaurants) (Faculty of Agriculture Sarajevo, 2017)	425.000,00
6.	Remaining identified producers (232) who have not submitted data for the MPPCEP CS project	0,00
	Total	18.323.837,11

Out of the total quantities of ABP / AW in 2017, 76.6% (14.041.852,20 kg) are classified as category 2b (fertilizers), while 23.4% (4.281.984,91 kg) are left to the remaining categories (1, 2a, 3) for which is required to seek transitional solutions for the CS.
It should be noted that the data collection questionnaires for both projects were harmonized so that it was possible to achieve the synergy and synthesis of all data obtained through the survey.
The report on the development of the Registry of ABP / AW was adopted at the Sarajevo Canton Government on September 20, 2018. and the conclusions that were set out are presented below in the paper.

3. MEASURES AND IMPLEMENTATION FROM REALIZED PROJECTS FOR ABP / AW IN BIH

The problem of lack of integral management of ABP / AW in BiH has existed for a number of years. For the first time, the problem was noticed by the EU Delegation in BiH in October 2007, when an the IPA project "Pre-feasibility studies - implementation of the bio-hazardous waste management model in BiH and the development of a program for the introduction of bio-hazardous waste management" was implemented. In the Environmental Protection Strategy of the Federation of Bosnia and Herzegovina (FBiH) for the period 2008 - 2018 and in the Federal Waste Management Plan for the period 2012-2017, the state and problems associated with this type of waste are clearly identified, with the planning of certain activities and measures for solving it. Problems, negative impacts and consequences on the quality of the environment as well as the risks to human and animal health due to lack of adequate infrastructure and uncontrolled disposal of ABP / AW are quite big.
Since 2014 FBiH has announced announcements of the construction of the ABP / AW processing plant. The Croatian firm Agroproteinka has established a subsidiary of Bioorganika's daughter in Kakanj with a view to launching a serious investment in the ABP / AW infrastructure management. They obtained all necessary permits, but the construction has not started yet, and it is questionable whether the realization will take place.
There are also several incinerators in the FBiH, in industrial facilities, which serve solely for the disposal of this waste generated in their production processes as well as for the needs of their subcontractors.
The project "Technical Assistance in the Field of Management of ABP / AW in BiH" was implemented. The result of the first component of the project was the "Strategy of the ABP / AW Management in BiH with the Action Plan for the period 2019-2023" [2], and the second component the "Feasibility Study of ABP / AW Management in BiH" which evaluates all technological options and proposes solutions for management of them. Unfortunately, this EU project has not resulted in the construction of a certain infrastructure for the disposal of ABP / AW in BiH.
In the subject Strategy [2], within the framework of strategic objective 3, program 3.1 „Establishment of functional transitional solutions (up to construction of the plant)“ has been defined. Through this program, the establishment of transitional solutions is envisaged. By building, approving and registering the burial pit and cattle graveyard, the preconditions for transitional solutions would be created. All these constructed facilities would continue to be used after the establishment of a central plant, but only in exceptional cases in accordance with the legislation, for the needs of communal zoo-hygiene, as well as for dead pets, horses and disposal of animal carcasses as part of disease control as well as for situations when there is no other way of disposing. Activities should start at Entity level and Brcko District BiH by implementation of relevant guidelines for the proper construction of the burial pits and cattle graveyards. The measures should result in the construction of the burial pits and cattle graveyards in FBiH, according to the regulations in January-March 2020. The competent veterinary authorities should undertake their approval and registration (in March-December 2020), and conduct regular inspections (by December 2023). At the same time, it is necessary to establish zoo-hygiene services in all units of local self-government and to purchase special vehicles for utility companies (January 2020 - December 2023). Temporary solutions in the form of a burial pits and cattle graveyards are not common practice in EU member states and are not in line with EU legislation, so they should be of an interim nature. [3] The strategy proposed as a systemic solution a central plant (dry batch rendering technology) with 5 service areas or intercoms (collection centres). The strategy envisages model for managing ABP / AW based on a public-private partnership , where

public bodies will provide standards, registration systems, official controls and traceability, as well as subsidies of certain categories, while the private investor will provide investments and execution of required and legally regulated activities on collection, transport and harmless treatment of ABP / AW [2].

The systemic solution, like the construction and equipping and the approval and registration of the animal sanitation facility for category 1 and 2a ABP/AW was planned during 2021. Further, the construction and equipping, approval and registration of the sanitation unit for category 3 was planned during 2023. Construction, approval and registration of interconnection facilities and the establishment of the collection network of ABP / AW, on a commercial basis, is planned for 2022.

Upon completion of the documents Strategy and Feasibility Study of ABP / AW Management in BiH both were submitted to project beneficiaries in the form of drafts, and they should be officially adopted by competent institutions in BiH in order to proceed with their implementation [2].

Regarding the proposed solutions and deadlines, there are already exist burial pits as well as control of animal by-products and animal waste in Sarajevo Canton but it is insufficient to consider the situation as satisfactory.

4. REHABILITATION OF THE SANITARY LANDFIL SMILJEVICI AND ISSUE OF ANIMAL WASTE DISPOSAL

In 2016, the Government of the Canton Sarajevo, based on the MPPCEP proposal, established an expert team for the preparation of the Program and monitoring the realization of a series of projects on rehabilitation and reconstruction of sanitary landfills and associated facilities within RWMC Smiljevici in period 2016 – 2020.

Priorities have been given on projects related to waste gas discharge and utilization, monitoring of leachate, reconstruction of leachate treatment plant, etc. Project implementation included the analysis of the composition and amount of waste that is being transported and disposed to the landfill body. Thus, significant amounts of waste of animal origin are also recorded that was disposed on the active cells of the landfill.

It must be emphasized that the disposal of animal waste on sanitary landfills of municipal solid waste is not allowed, just like the practice of destroying goods with an expiration date (e.g. liquid wastes such as milk, juices, fat such as oils, butter, gelatine produced in the meat industry) and others (Figure 1) [5]. All this has a direct impact on the unpleasant odours that spread around the landfill, the risk of infection, etc. Also, significant oscillations in the composition of the landfill gas and the composition of the leachate are noted, which leads to major problems in the operation of the gas exploitation plant and the treatment of the leachate. However, the problem itself is not only with controlled quantities of waste that come in accordance with the agreements with animal waste producers, but there are also significant daily problems with animal waste that comes with communal waste. Such mixed waste is a source of terribly unpleasant smells, and especially incidents have been recorded unfortunately during religious holidays, which is unacceptable and what the religious and local communities need to tackle and also raise public awareness. The approach of inspection to instruct to destroy everything on the active landfill site is not an appropriate approach and couldn't be considered as good practice.

As an example, one of the worst experiences relates to the destruction of milk with expired date, which has led to a failure of the leachate treatment plant at the Smiljevici. Unfortunately there are number of similar examples and therefore a series of meetings were held between MPPCEP CS, KJKP RAD (Public Utility Enterprise RAD), inspections, expert team and waste producers. The options for solutions problems with ABP/AW were provided in accordance with action plans [2,3].

Regarding the RWMC Smiljevic there is a Hygienic Service of the RJ "Kafilerija" as a part of the Public Utilities Company RAD (KJKP RAD) which carries out the tasks of harmless removal of animals, carcasses and animal waste. In accordance with the Veterinarian Station's decision, the carcasses of infected animals from diseases that can be transmitted to humans (zoonoses) after euthanasia are also plunged into the burial pit. The burial pits have been existing at the sanitary landfill Smiljevici since 1997. (Figure 2) In the past 20 years, four burial pits were built. Two burial pits have already been closed and their reuse is possible after mineralization of waste, 10-15 years after closing. There are currently in operation two concrete burial pits, each with volume of 300m^3.

Figure 1. Milk in the drainage system of leachate[5]

Figure 2. The first burial pit – closed 2002

Figure 3: Transport of poultry farms waste to landfill 2017

In order to emphasise size and complexity of the problem it should be noted that during the first nine months of 2018, 32.070,00 kg of animal waste was deposited in the burial pits and about 1.090 tons of waste of animal origin was recorded to be disposed on the active landfill. A special problem is the unidentified amount of animal waste that finishes into the landfill in the containers, mixed with household waste.

Program of rehabilitation and reconstruction of sanitary landfill and associated facilities within RWMC Smiljevici in period 2016 – 2020 includes the project for two new concrete burial pits, of 1000 m^3 capacity for the disposal of infected animal carcasses, euthanized pets (categories 1 and category 2a). The estimate is that with the available burial pits, including control and the records what has being disposed in the burial pits, the new pits could be used for another 4-5 years.

Since 2017, the MPPCEP CS has decided to build new two burial pits in accordance with the EU Strategy and Action Plans [2]. Those two burial pits together with two current ones should be use for disposal of part of animal waste production in the CS, but anyway it will be insufficient to receive significant amount of AW. Therefor some of the transitional measures were also considered, in line with EU action plans [2,3]. However, it is evident that implementation of action plans is not easy to be implemented on the ground. Besides to the construction of the new two burial pits, consideration was also given to finding the location for a cattle graveyard. Together with the constraints regarding the ownership, proximity to settlements, land quality, groundwater levels, one of the major problem was the size of the site taking into the consideration the needs and conditions for burial of carcass and animal waste. After considering all options, it was concluded that there was simply no area with enough space to meet all the conditions for establishing a cattle graveyard that could be used for at least 3-4 years in the CS so this option was abandoned.

Due to the many accumulated problems, the CS is obliged to seek for transitional solutions for ABP / AW disposal. Higher levels of government have shown in the past that they are reluctant to solve this problem quickly and to build an adequate infrastructure. For the purpose of preparing transitional solutions, in the past 11 months, the Ministry of Physical Planning, Construction and Environmental Protection, the Ministry of Economy, the Ministry of the Communal Economy and Infrastructure, the Cantonal Inspectorate for Inspection, and KJKP Rad have come up with more comprehensive data on categories and quantities of the animal waste in the CS [1]. Cross-cutting solutions for the ABP/AW management in the CS include a number of activities as outlined in the conclusions of the paper.

5. CONCLUDING REMARKS

A comprehensive solution that would be acceptable and functional across the entire territory of BiH requires a number of policy decisions in terms of harmonizing of primary and secondary legislations as well as allocation of significant financial resources to budgets at all levels of government, all of which can result in a time-consuming and uncertain period of implementation and comprehensive solution of this problem.

The EU project "Technical Assistance in the Management of ABP/AW in BiH" within the framework of the ABP / AW Management Strategy and Action Plan has planned the construction of adequate infrastructure in the FBiH only by 2024. For this reason, it is necessary to seek a long-lasting solution

regarding for ABP / AW management in FBiH and that this initiative is obligatory included in the strategic planning document for the rural development sector (IPA II program for BiH).

Regarding the subject issues on local level of the Sarajevo Canton the following options are considered as transitional solutions:

- Construction of two new burial pits at the RWMC Smiljevici site for the disposal of the ABP / AW
- Obligation for adequate sorting bin for animal waste categories by all identified ABP / AW producers in the CS.
- Procurement of a special vehicle for the KJKP "RAD" for transport of ABP / AW.
- Controlled disposal of ABP / AW for the needs of the ZOO park „Pionirska dolina"(meat products with an expiration date). The ZOO park „Pionirska dolina"currently has the possibility of thermal processing of animal food, with a capacity of about 1 ton / month. If there was a possibility of continuous delivery of this type of ABP / AW to ZOO Pionirska dolina, it would be necessary to increase the current capacity of the cooling chambers, where it would be temporarily storage, prior to ultimately being consumed for animal feeding.
- Disposal of waste at the facility Alba Zenica, which has all permits for incineration of certain categories of waste. Producers of waste could have this option available, depending on the capacity of the plant.
- Considering the options for implementing the procedure for selecting the service provider of ABP / AW in the CS in accordance with the applicable regulations by the Ministry of Economy of the CS.
- Raising public awareness and familiarizing the waste producers with the obligations of timely and adequate solutions and disposal of waste generated through the manufacturing process.

Implementation of transitional solutions until establishment and implementation of state level projects could lead to a controlled disposal, reduction and eventually the ban for animal waste disposal on active landfill sites. However, it is expected that there will be a lot of challenges to implement and control of ABP / AW management in BiH.

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SUSTAINABLE DEVELOPMENT BASED ON THE STRATEGY OF COMPANIES SOCIAL RESPONSIBILITY

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ABSTRACT
There is need to harmonize socio-economic development with respect to the environment, since it is a valuable heritage of the next generation. It relates to activities that contribute to the integration of economic, social and environmental aspects into a management model in order to ensure sustainability of the enterprise. A strategy based on the implementation of socially responsible activities creates a relationship with consumers and other stakeholders and enables relatively lasting competitive advantage, which ensures sustainable development. The target population in the conducted research was the final consumers, data collection was carried out by the questionare. The aim of this research is to examine consumer perceptions and their level of knowledge of the concept of corporate social responsibility. The data collected in this study were processed using adequate statistical methods, based on which the appropriate conclusions were made.

Keywords: Sustainable Development, Dimensions of Corporate Social Responsibility, Consumers, Strategy

1. INTRODUCTION
Corporate Social Responsibility (CSR) should be considered as a business strategy which is unavoidable in streaming to reach the goals, not as an obligation towards the environment or society. Only in that case, company will be fully devoted to the social responsible activities.
Corporate Social Responsibility may affect the strategy of the companies faced with the contemporary global market constraints and pressures of the social actors. The application of corporate social responsibility as part of the company's business strategy is focused on supplying goods and services, giving importance to brands and creating new business models. The integration of CSR and overall

business strategy generated new business models. The aim of CSR is to promote legitimacy and image of the company. [1] According to group authors, reputation is affective or emotional reaction, good or bad, weak or strong consumers, investors and employees in relation to an individual or entire business. Reputation is reflected in public image and it enables competitive advantage. [1] Accordingly, the main reason because of which more and more companies are becoming CSR oriented is improvement of their own reputation and image.
The aim of this article is to evaluate customers' perception of the Corporate Social Responsibility and determine how this concept can influence on their decision to buy products from social responsible companies. It is difficult to create adequate business strategy without considering four CSR elements (environment, economy, stakeholder and volunteerism) and their impact on social environment as a potential source of competitive advantage. Constant tendency of satisfying the customers' needs must be recognized as the main task of CSR.

2. MODEL AND HYPOTHESIS DEFINITION

Corporate social responsibility presents the commitment of the company to operate on economic, social and ecologic sustainable way by balancing between different stakeholder interests. Companies should accept responsibility for the impact they have on the society. Also, management should meet the requirements of the external environment and, at the same time, control consequences of those activities and their impact on the profit. CSR oriented strategy should reflect aspiration of the company to realize social impact of its activities in certain dimensions. According to the Alexander Dahlsrude the concept of CSR includes five dimensions: environmental, social, economic, stakeholders and volunteerism [3].

2.1. Environmental dimension

Generally, environmental dimension presents the level of negative impact that one business activity has on natural environment. From the aspect of individual organization, challenge that organizations are facing with is "How to achieve sustainability". The success in overcoming this challenge depends from the companies' perception of "green" issues. Today, public is very interested in benefits gained by environmentally sensitive companies. This is the reason why companies try to exaggerate their environmental activities and produce, so called, "green-washing" effect. [4]
Accordingly, following hypothesis has been defined:
Hypothesis 1: Environmental dimension has positive influence on social dimension from the aspect of consumers.

2.2. Economic dimension

During the investment in CSR, organizations are dealing only with short-term issues, while return in investment is possible. This type of investments is similar with other types, except of unreliable return period. However, direct business benefits derived from the corporate social responsibility concept become more apparent, because public opinion is becoming more sensitive to the issues of social responsibility in business. Accordingly, following hypothesis has been defined:
Hypothesis 2: Economic dimension has positive impact on social dimension from the aspect of consumers.

2.3. Voluntary dimension

In most of the world economies, organizations are expected to comply with CSR regulations. However, can we equalize simple compliance with regulations and social responsibility? Should organizations have to undertake some additional activities? Numerous organizations emphasize their volunteerism in the process of adoption and implementation of CSR concept. Accordingly, following hypothesis has been defined:
Hypothesis 3: Voluntary dimension has positive impact on social responsibility from the aspect of consumers

2.4. Stakeholder dimension

Regarding the stakeholder dimension, it should be emphasized the differences between influence of stakeholder groups on business activities. Also, there are two very important questions. The first of them is: "Which of the basic CSR principles have to be analyzed in the process of business decision making?" This means that economic criteria are not enough for achieving social acceptable results. The second dilemma is connected with different expectations and perspectives of stakeholder groups. These differences are consequence of their cultural background, as well. Accordingly, following hypothesis has been defined:

Hypothesis 4: Stakeholder dimension has positive impact on social dimension from the aspect of the consumers.

Based on the analysis of the existing literature, conceptual model was developed (Figure 1). Presented model indicates the presence of four independent variables (environmental, economic, stakeholder and voluntary dimension), that have direct impact on dependent variable - social dimension of CSR.

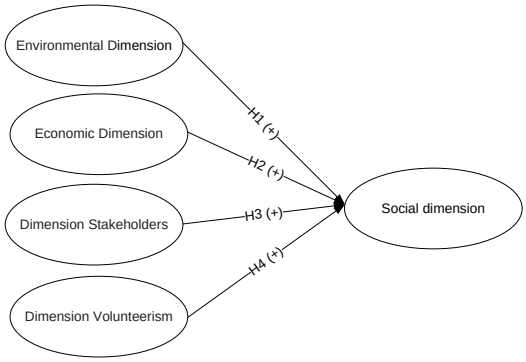


Figure 1. . Conceptual model

3. METHODOLOGY

3.1. Sample and collection of data

For the purpose of this research, survey method was used. Applied questionnaire has been developed by group of experts, members of international academic network – Resita. Survey was conducted on the territory of Bor Municipality. In this study, end consumers were target population. The aim of this research was to determine if the consumers are familiar with CSR concept. The questionnaire is consisted of 37 questions grouped in 5 groups. For gradation of the answers, the Likert five-point scale was used. The proposed hypotheses were tested by using regression analysis and by applying software package SPSS v.18.

3.2. Analysis and research results

In order to determine internal consistency, Cronbach's coefficient ά was used. [5] The obtained values of reliability coefficients for all groups of questions are within the recommended values [5], where Cronbach's coefficient ά for environmental dimension 0.871, social dimension 0.900, economic dimension 0.908, and dimension volunteerism 0.766, except the dimension stakeholder, where the values are below the recommended (<0.70) ά=0.465. Accordingly, the internal consistency was confirmed.

Correlation analysis could help us to recognize the specific indicator which points out the level of quantitative matching of two variables or data sets. In this case, positive values of correlation coefficients were obtained. That indicates the existence of proportional connection between variables. Coefficients of correlation between variable groups are presented in Table 1.

Table 1. Coefficients of correlation

Construct	Environmental Dimension	Social Dimension	Economic Dimension	Dimension Volunteerism	Dimension Stakeholders
Environmental Dimension	1				
Social Dimension	0.761**	1			
Economic Dimension	0.816**	0.811**	1		
Dimension Volunteerism	0.678**	0.790**	0.640**	1	
Dimension Stakeholders	0.406**	0.360**	0.388**	0.492**	1

** Correlation is significant at the 0.01 level (2-tailed)

Further, in order to determine functional correlation between two or more variables regression analysis was conducted. The simplest form of functional correlation is linear, where dependent variable is expressed by the independent X variable. In this article, the influence of CSR social dimension on other CSR dimensions was examined.

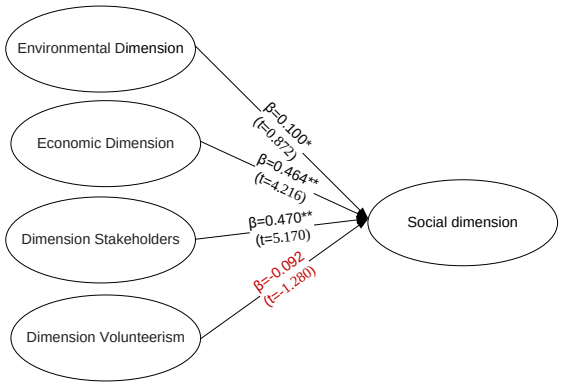
Table 2. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	,889[a]	,791	,776	,25638	,791	51,101	4	54	,000

a. Predictors: (Constant), Environmental Dimension, Social Dimension, Economic Dimension Dimension Volunteerism, Dimension Stakeholders

b. Dependent Variable: Social Dimension

From the results presented in Table 2, it can be seen that the value of R Square Change is 0,791. This indicates that 79,1% of variation of dependent variable (social dimension) is explained by controlled variables listed below the table. Adjusted R Square is an attempt to take account of the phenomenon of the R^2 automatically and spuriously increasing when extra explanatory variables are added to the model. Statistical analysis was used in order to prove if the independed variables have a significant influence on the social dimension of CSR. In Table 4 it is presented the value of VIF which explains the level of multi-colinearity. [6] Based on the defined conceptual model (Picture 1), hypotheses which are tested by regression analysis and path analysis (Table 3 and Picture 2). Path analysis indicates that all of the analyzed variables (environmental dimension, economic dimension, voluntary dimension and stakeholder dimension) directly affect the social dimension.



β (t); p>0.05, *p<0.01, **p<0.00

Figure 2. Structural model

Table 3 Coeficients beta regression.

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
	B	Std.Error	Beta	T	Sig.	Tolerance	VIF
1 (Constant)	0.962	0.277		3.468	0.001		
Environmental Dimension	0.091	0.105	0.100	0.872	0.387	0.292	3.426
Economic Dimension	0.379	0.090	0.464	4.216	0.000	0.319	3.134
Dimension Volunteerism	0.402	0.078	0.470	5.170	0.000	0.468	2.135
Dimension Stakeholders	-0.79	062	-0.092	-1.280	0.206	0.747	1.339

a. Dependent Variable: Social Dimension

Beta coefficient is unstandardized measure of sensitivity or correlation between variables. On the Picture 2 it is shown that stakeholder dimension of CSR has the highest impact on social dimension $\beta=0.470$; $t=5.170$; $p<0.01$, that confirms hypothesis H3. Dimension volunteerism has positive influence on the social dimension. Lower influence is recognized when it comes to economic dimension, where the values are $\beta=0.464$.; $t=4.216$; $p<0.01$. Accordingly, hypothesis H2 "Economic dimension has positive impact on social dimension from the aspect of consumers" is confirmed. Regression analysis showed that Beta value between environmental dimension and social dimension is positive $\beta=0{,}100$, with presence of low level of statistical significance ($t= 0{,}872$). These results indicate that the hypothesis H1 "Environmental dimension has positive influence on social dimension from the aspect of consumers" is confirmed because of its positive direction. Finally, hypothesis H4 "Stakeholder dimension has positive impact on social dimension from the aspect of the consumers" is rejected because of a negative value of Beta coefficient ($\beta= -0.092$) and absence of statistical significance ($t= -1.280$).

4. CONCLUSIONS

In the last decades, growing importance of Corporate Social Responsibility concept in the business world has been detected. Corporate social responsibility implies activities undertaken by an enterprise that are outside the making profit - activities with positive impact on the environment, society, ecology, human resources. [1]

The amount of natural resources of the Earth is constantly getting lower. This is the main cause of increasing attention directed towards the corporate social responsibility. Companies that do not take care of the environment, of employees' working conditions, of the resources they dispose with and stakeholders, have been increasingly condemned by their consumers, clients and business partners. [7]

Due to the increasing pressure, companies are forced to deal with issues and activities of corporate social responsibility. Corporate social responsibility has growing influence on the company's reputation and it is often used by companies to gain competitive advantage in the market.

The aim of this research was to investigate whether the customers from Bor municipality are familiar with the concept of corporate social responsibility. After collecting the data by using regular questionnaires, a comparison of the obtained answers helped in recognizing corporate social responsibility dimension which is the most important for respondents. It was concluded that environmental dimension, economic dimension and volunteer dimension have a positive impact on the social dimension, while stakeholder dimension doesn't have a statistically significant influence on social dimension.

Finally, it can be concluded that there is a need for raising the humans' awareness of the corporate social responsibility importance. Also, it is necessary to encourage companies to adopt this concept

and to implement it in business practice; not only because of the legislation, but of the other benefits this concept brings to the companies and end consumers.

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BRINGING INNOVATION WITH SUPPLIERS DURING NEW PRODUCT DEVELOPMENT: DOES ENTERPRISE SIZE MATTER?

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ABSTRACT

This paper presents the analysis of an enterprise size importance for the most favourable supplier choice in the process of new product development (NPD). Product development is an innovative process at the beginning of product life cycle, however, this segment is highly important for further flow of new product development. The active engagement of suppliers plays an important role for the success of a new product development venture and every enterprise has to pay special attention to the supplier's quality in the early development stages that would help new product to become more competitive at the market. By examining a data sample of almost 350 enterprises from the Republic of Serbia and using one-factor analysis of variance, we come to the conclusion that it is not possible to single out concrete factors when choosing a supplier. Although we have obtained certain results that are statistically significant, the real differences between enterprise size and basic factors of choice are trivial.

Keywords: *Supplier chain management, New product development, Supplier relationship management*

1 INTRODUCTION

Competitiveness of an organization cannot be reached without innovation of products, services and/or processes. Sources of innovation are located not only in the company: a large number of companies today are trying to create qualitative and long-term relationships not only with their clients but with their key partners (such as suppliers) as well. Suppliers' involvement in processes of design and development of a new product and good management of this process is increasingly important for competitive advantage [1]. Development of new product is a strategy which helps companies to reach new market that offers better opportunities for profit and enterprise survival. However, new product means a large dose of risk. One of the ways to decrease risk is to plan product life cycle in detail. The problem with new product launching is that its potential substitutes could be easily placed by main competitors. The role of suppliers is of great importance when launching a new product, since they can offer an existing supply channels. The performance of the new product development can be influenced by CRM (customers relationship management) and SRM (suppliers relationship management), since both CRM and SRM tend to facilitate the role of customers and suppliers in new product development [2].

Therefore, when designing a new product, every company has to pay a special attention to the most favourable supplier choice. Once one takes into consideration different sizes of enterprises, this process becomes even more complex. In this respect, this paper examines concrete factors when choosing a supplier related to the enterprise size.

Numerous studies in the area of relevance of the supplier's involvement in the process of creating a new product are mainly directed at developed countries and large companies. This paper presents an attempt to present the importance of the process of determining the key factors of suppliers involved in the process of

creating a new product. In this paper, 6 different characteristics of suppliers were selected: readiness to participate in the construction of innovative relationship with customers; level of technological capacity of the supplier; willingness to share key technological information; readiness to support development and progress of production process; willingness to show pro-activity in approach; development of supplier's project management. The choice of these characteristics was determined on the basis of a conceptual model for studying a supplier's contribution to buyer innovation [3].

In the next section the theoretical background and research questions are explained, followed by the research tools and methods. The last two sections present discussions and conclusion.

2 THEORETICAL BACKGROUND

In last 30 years, research in area of managing supplier involvement in new product development (NPD) and innovation has greatly expanded, since more and more companies are outsourcing parts of their NPD activities to suppliers [4]. Hoskinsson et al. [5] claim that emerging markets, characterized by rapid economic development, create a wide range of opportunities and challenges for supplier-buyer collaboration. In their research, Wang et al. [6] found that product co-development process in companies from emerging markets is often circumstantial because of the institutional environment, which is not the case in the companies from developed countries.

Apart from technical characteristics of a new product, attention must be paid to higher number of other factors when developing a new product, such as: market conditions, supply chains, financial tools to stimulate sales, advertising, PR campaigns, etc. [7] Therefore, it is important to carefully introduce a new product; timing is of the utmost importance in order to maximize profit and minimize negative impacts. Contemporary supply chain is based on modern technological achievements and developed infrastructure today. Efficient supply chain management implements all transfers of tangible property and services needed to deliver goods to the final customer. The chain functions while their links are connected. Supply chain management represents one of the greatest challenges in modern management; it is a field that operational researches deal with, asserting the concept of optimal management, with the implementation of multi criteria analysis. It is a task of every supplier to satisfy the demand for certain product on their market [8]. Based on the above mentioned, it could be concluded that supply chain management is a complex job and many enterprises have turned to logistics outsourcing as a way to restructure their distribution networks and gain competitive advantages [9].

Numerous studies consider NPD as a critical factor in ensuring continuous growth and survival of enterprises and claim that enterprises often integrate suppliers in the NPD through joint education and training activities, feasibility studies, set up of common performance goals and product design assessment [10,11]. On the other hand, results of some research show that there are some disadvantages every time a company tries to involve supplier in NPD process: greater bureaucracy, lower efficiency, additional time for coordination, even higher cost in some part of NPD process [12, 13, 14,15,16,17].

3 RESEARCH TOOLS AND SAMPLE

Two basic methods for collecting and analyzing data were used in the theoretical framework of research: the method of theoretical analysis and the survey method. The method of systematic non-experimental research (Survey method) has been applied as the best way to efficiently collect data from target groups of respondents through closed or open-door instruments (questions / assumed attitudes). Respondents were invited to participate in the survey via bulletin and e-mail containing the link on the questionnaire page. The survey and interview methods were used in this research. For the research needs, one independent variable regarding the enterprise size was single out as well as six claims that the respondents answered by circling the answers regarding the level of agreeing. Before we created the survey, we conducted the interview. According to the interviews with experts in new product research and logistics, we identified several important functions that suppliers have to possess. In our survey questions, initial functions that suppliers have to possess are presented.

The research comprised of 347 enterprises on the territory of Republic of Serbia in different industry sectors. The population that we are interested in is employees who had or currently have experience in new product development and/or have experience in supply chain management. The sample was chosen according to the method of probability sampling, in every enterprise at least 10% of employees were interviewed in order to obtain relevant results.

Before the research was carried out, a protocol was developed that will provide the conditions of eliminating environmental dependence problems. The interviewers were supposed to survey the respondents individually and from different departments. In this way, the respondents' answers were not conditioned by the answers of

the group. Due to developed research protocol it was possible to use ANOVA test for identification of statistically significant difference between groups and respondents.

As an independent variable we used the enterprise size as a basic factor for basing the future model. All three sizes (small, medium, big) of enterprises have certain advantages and disadvantages. *Small enterprises* can more easily and rapidly reach niche market. *Large enterprises* have much bigger financial power, stronger human potential and may more easily make strategic partnerships. *Medium enterprises* have certain benefits that are characteristics of small enterprises.

According to the literature review, so far conducted researches and preliminary research results six research questions are constructed.

Research question 1: Is there statistically significant difference between enterprise size and *supplier's readiness to participate in construction of innovative relationship with customers*?

Research question 2: Is there statistically significant difference between enterprise size and *the level of technological capacity of supplier*?

Research question 3: Is there statistically significant difference between enterprise size and *supplier's readiness to share key technological information*?

Research question 4: Is there statistically significant difference between enterprise size and *supplier's readiness to support development and progress of production process*?

Research question 5: Is there statistically significant difference between enterprise size and *supplier's readiness to show pro-activity in approach*?

Research question 6: Is there statistically significant difference between enterprise size and *development of supplier's project management*?

As an answer to the first question in the questionnaire we set a claim "Supplier gives contribution in construction of innovative relationship with customers." Respondents graded this claim by five offered answers. These, as well as other questions relevant to the set research questions, survey respondents surveyed through a five-point Likert scale to evaluate suppliers. The first answer/grade was incomplete and indicates that supplier does not give any contribution, the next grade was poor contribution, then good contribution, almost full contribution and the final one was full contribution. In this way, respondents gave their opinion about supplier's significance in construction of innovative relationship with customers.

For the second research question we used the question of "the level technological capacity." This question tests the influence of supplier's technological capacity on the support of new product design and the shift of logical function.

For the third research question we will get the answer by analysing the question "Supplier's readiness to share key technological information." In this question we also had five offered answers; these answers are the same as in the first question: incomplete, poor, good, almost complete and complete. This question gives us the answer to what extent the suppliers are ready to support us in our strife to win new technologies. Sharing of new key technological information can lead to significant decrease of implementation time of new logistic solutions but also time contraction of new product development.

The answer to the forth research question will be obtained by the analysis of question "Supplier's abilities to support development and progress of production process." For this question we provided the anticipated answers in five categories: low, poor, good, satisfying and high. In this question we will obtain the image of supplier's possibilities to monitor enterprise in their strife to extend their production programme.

In fifth research question we analyzed the question "Supplier is continually pro-active in approach." The anticipated answers are: high, satisfying, good, poor, low. In this question we reveal how much the suppliers are agile in strife to accept innovative ideas and be the first to implement new way of business.

In sixth question we analyzed the question "Supplier has developed project management abilities." Through answers on this question we obtained information about suppliers' possibilities to link project strife of a company to develop new product. This is a crucial question from the monitoring project activities point of view. Suppliers, having a high level of project management abilities, can more easily understand needs of enterprises that entered the project.

All mentioned questions give us a part of the image that is needed to create a model of adaptation of logistic functions to new product. The answers to questions give us the guidelines about the most important characteristics that suppliers should possess. Some respondents have significant internal characteristics while others have marked external characteristics. Through statistical analysis we will obtain the complete image of attitudes regarding the suppliers and their role in the adaptation process of logistic functions. The emphasis is on the grade of the respondents that are due to their characteristics acquainted with problems of enterprise logistic function. Every question contains many functions that suppliers have to possess. For instance, the question that

tests the abilities of suppliers' project management contains functions such as team work management, the ability of management to assign responsibility and to control the project course in efficient and meaningful way.

The size of the company also affects the respondents' responses, as employees in large companies have a completely different logistics, in a different way they realize processes and communicate with suppliers, from those who are employed in small businesses. The survey attempts to equally include respondents from various companies in order to get the most valid answers.

Table 2 Enterprise size

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	small	66	19,0	19,0	19,0
	med.	87	25,1	25,1	44,1
	big	194	55,9	55,9	100,0
	Total	347	100,0	100,0	

The respondents are divided according to the enterprise size in which they work (Tab. 1). 66 respondents (19%) come from *small enterprises*, 87 respondents (25,1%) from *medium enterprises* and 194 respondents (55,9%) from *big enterprises*.

The Company's activity has a profound effect on the test results, so that some hypotheses that are extremely important for one activity, may be insignificant to another. In order to avoid such situations, all activities in the sample of research are attempted to be equally represented. (Tab. 2).

Table 2 Industry segment

	Manufacturing	Service	Total
Frequency	158	189	347
Percent	45,53	54,47	100

The first question in the questionnaire was "Supplier gives contribution in construction of innovative relationship with customers." From the total of 347 respondents 8 (2,3%) respondents answered that suppliers give incomplete contribution in construction of innovative relationship with customers, 43 (12,4%) give poor contribution, 181 (52,2%) good, 100 (28,8%) almost full and 15 (4,3%) full contribution. From such results it could be seen that suppliers give relatively good contribution in construction of innovative relationship with customers. It could also be noted that there were very small number of answers that suppliers provide full contribution in construction of innovative relationship with customers.

The second question was that "Level of technological capacity". From the total of 347 respondents only 2 respondents (0,6%) answered that suppliers have low level of technological capacity, 38 (11%) poor, 136 (39,2%) good, 135 (38,9%) satisfying and 36 (10,4%) high level of technological capacities. This question gives us the image of suppliers and their technological strength. Since the majority of answers were in the range from good to satisfying, it could be concluded that suppliers are relatively technologically ready and competent.

The third question was "Supplier's readiness to share key technological information." Out of 347 respondents in total, 9 (2,6%) of them chose the answer incomplete, 47 (13,5%) chose poor, 172 (49,6%) good, 100 (28,8%) almost full, 19 (5,5%) full. From these results it could be concluded that suppliers are mainly ready to share key technological information with companies they cooperate with.

The fourth question was "Supplier's abilities to support development and progress of production process." Out of 347 respondents in total, 6 (1,7%) answered low, 36 (10,1%) poor, 180 (51,9%) good, 99 (28,5%) satisfying, 27 (7,8%) high supplier's ability to support development and progress of production process. It is important to emphasize in this question that every new product implies changes of production process. It could be concluded from this question that the majority of suppliers are able to support development and progress of production process.

The fifth question was "Supplier is continually pro-active in approach." From the total of 347 respondents, 22 (6,3%) respondents circled high, 78 (22,5%) circled satisfying, 151 (43,5%) good, 83 (23,9%) poor and 13 (3,7%) circled low pro-activity in supplier's approach. This question provides an image of suppliers as integral partners in accepting innovation. It could also be concluded that the majority of respondents have an attitude that the suppliers are continually pro-active in performance.

The sixth and also the final question that we analyzed for the purposes of this paper was that "Supplier has developed project management abilities." Out of 347 respondents in total, 15 (4,3%) answered that suppliers do

not possess developed project management abilities, 56 (16,1%) answered that suppliers possess developed project management abilities in lesser degree, 146 (42,1%) possess in higher degree and 32 (9,2%) possess all developed project management abilities. It is important to emphasize in this question that supplier's developed project management abilities lead to easier way of including suppliers into innovation projects.

The ANOVA method, used in this research, assesses the relative size of variance among group means (between group variance) compared to the average variance within groups (within group variance). When the between group variances are the same, mean differences among groups seem more distinct in the distributions with smaller within group variances compared to those with larger within group variances [18].

Table 3 Results of ANOVA test

		Sum of Squares	df	Mean Square	F	Sig.
Supplier gives support to construction of innovative relationship with customers	Between Groups	2,338	2	1,169	1,844	,160
	Within Groups	218,135	344	,634		
	Total	220,473	346			
Level of technological capacity	Between Groups	2,051	2	1,025	1,443	,238
	Within Groups	244,491	344	,711		
	Total	246,542	346			
Suppliers' readiness to share key technological information	Between Groups	4,746	2	2,373	3,417	,034
	Within Groups	238,897	344	,694		
	Total	243,643	346			
Suppliers are able to support development of production process	Between Groups	12,308	2	6,154	9,566	,000
	Within Groups	221,311	344	,643		
	Total	233,620	346			
Supplier is continually pro-active in approach	Between Groups	21,157	2	10,579	13,027	,000
	Within Groups	279,356	344	,812		
	Total	300,513	346			
Supplier possesses developed project management abilities	Between Groups	13,767	2	6,884	7,600	,001
	Within Groups	311,587	344	,906		
	Total	325,354	346			

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By the use of one-factor analysis of variance, the influence of enterprise size on supplier's readiness to share key technological information is examined. The enterprises are divided according to the size into: small, medium and big. Statistically significant difference is determined at the level $p<0,05$ in relation to enterprise size $F(2, 344)=3,417$. In spite of statistical difference, the real difference between mean values of groups is very small. The size of this difference, expressed by eta squared indicators is 0,019. Further comparisons, conducted by Games–Howell test, showed that mean values of the first group (small enterprises) (M=2,97; SD=0,911) is significantly different from the third group (big enterprise) (M=3,27; SD=0,770).

By the use of one-factor analysis of variance, the influence of enterprise size on supplier's readiness to support development and progress of production process is examined. The enterprises are divided according to the size into: small, medium and big. Statistically significant difference is determined at the level $p<0,05$ in relation to enterprise size $F(2, 344)=9,566$. In spite of statistical difference, the real difference between mean values of groups is very small. The size of this difference, expressed by eta squared indicators is 0,052. Further comparisons, conducted by Games–Howell test, showed that mean values of the first group (small enterprises) (M=3,03; SD=0,841) is significantly different from the third group (big enterprise) (M=3,47; SD=0,770). Then the second group (medium enterprise) (M=3,15; SD=0,843) is significantly different from the third group (big enterprise) (M=3,47; SD=0,770).

By the use of one-factor analysis of variance, the influence of enterprise size on supplier's pro-activity is examined. The enterprises are divided according to the size into: small, medium and big. Statistically significant difference is determined at the level $p<0,05$ in relation to enterprise size $F(2, 344) = 13,027$. In spite of statistical difference, the real difference between mean values of groups is very small. The size of this difference, expressed by eta squared indicators is 0,07. Further comparisons, conducted by Games–Howell test, showed that mean values of the first group (small enterprises) (M=3,23; SD=0,880) is significantly different from the third group (big enterprise) (M=2,75; SD=0,935). Then the second group (medium enterprise) (M=3,17; SD=0,838) is significantly different from the third group (big enterprise) (M=3,47; SD=0,770).

By the use of one-factor analysis of variance, the influence of enterprise size on suppliers' project management developed abilities is examined. The enterprises are divided according to the size into: small, medium and big. Statistically significant difference is determined at the level $p<0,05$ in relation to enterprise size $F(2, 344)=7,600$. In spite of statistical difference, the real difference between mean values of groups is very small. The size of this difference, expressed by eta squared indicators is 0,04. Further comparisons, conducted by Tukey HSD test, showed that mean values of the first group (*small enterprises*) (M=2,83; SD=1,046) is significantly different from the third group (*big enterprise*) (M=3,36 ; SD=,829).

4 DISCUSSION

In the first part of research section of the paper, descriptive analysis of the survey was presented. This section shows that suppliers are expected to show more engagement in company's effort in the process of new product design. In further segment of the research we used ANOVA test (Tab. 3) to find statistically significant differences between groups. According to this statistical analysis we can formulate answers to research question.

In the first research question we have not found statistically significant difference between enterprise size and supplier's readiness to participate in construction of innovative relationship with customers. Although descriptive statistics showed that suppliers should make more contribution, suppliers are still relatively far away from the final customers. In this way, we can explain the lack of statistically significant difference.

In the second research question we have not found statistically significant difference between enterprise size and the level of supplier's technological capacity either. The majority of respondents' answers were between good and satisfying level of supplier's technological capacity. The level of technological capacity is an internal supplier's factor that depends on internal strategy and business policy of the supplier. However, technological capacities are constantly changing and new technological solutions are emerging constantly on the free market.

In the third research question we have identified statistically significant differences between enterprise size and suppliers' readiness to share key technological information. In this question, small enterprises are statistically different from big enterprises. This is understandable due to the fact that small and big enterprises are different in many aspects. However, although we have statistically significant difference, eta–square shows us that this difference is, in fact, small. The influence of the internet and easy data access is the main reason for such result.

In the fourth research question we have identified statistically significant differences between enterprise size and suppliers' readiness to support development and progress of production process. In this question we obtained statistically significant differences between small and big enterprises. Eta–square shows us that the real difference is from small to medium intensity. The influence of the supplier on development of production process is an important segment for small and medium enterprises that have to rely more on suppliers. On the other hand, development of production technique is such that more efficient and cheaper new production solutions could be reached in an easy way.

In the fifth research question we have identified statistically significant differences between enterprise size and suppliers' readiness to show pro-activity in approach. As it was seen in the previous questions, eta–square shows us that the real difference is small. In this question, we also have statistically significant differences between small and medium enterprises and also between medium and big enterprises. Small and medium enterprises are more focused on cooperation in order to fill disadvantages of their organisational structure.

In the sixth question we have also identified statistically significant differences between enterprise size and development of suppliers' project management. Unfortunately, eta–square shows us that real differences are trivial in this question, as well. Statistical difference is identified between small and big enterprises.

From the research effort, we can conclude that it is very difficult to identify functions even groups of functions that suppliers should possess. This could be well noticed by the analysis of partial eta–squares that showed in all statistically significant questions small differences, in fact. The problem lies in the fact that in some time segments, some supplier's functions become more important. The suppliers themselves also, at some time period transform under the influence of competition, technology and market development.

According to the conducted research, we have seen so far that it is not possible to single out concrete factors when choosing a supplier. Although we have obtained certain results that are statistically significant, the real differences between enterprise size and basic factors of choice are trivial. Nevertheless, we have obtained similar results in the research when we used instead of enterprise size an enterprise type, profitability in the previous period, frequency of research and development efforts (R&D). Those will be presented in the future research.

5 CONCLUSION

From the conducted research, it could be seen that it is practically impossible to create final list of characteristics that suppliers have to possess. Supply chain is of great importance not only for current products that secure survival of the enterprises but also for the new products that secure the development of enterprises. These two components, survival and development, are inextricably linked for business environment which is under more and more stress by competitors. Those who are not capable of proper managing of development and logistic functions may expect the appearance of superior competitor that may take over the market.

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IMPORTANCE OF ENVIRONMENTAL SUSTAINABILITY FOR BUSINESS SUSTAINABILITY

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ABSTRACT
Social and environmental issues that are imposed on companies in contemporary business in the upcoming period will turn out to be a great challenge for all economies. Environmental protection becomes an essential precondition for gaining the sustainable competitive advantage and integral part of proactive managing of companies. New tendencies in businesses have significant impact on the need for building stronger relationships and partnerships with all stakeholders which creates the complex entity, with the common goal of achieving a global impact on all aspects of human life. The research presented in this paper was carried out in Russia and Serbia. It is about attitudes of employees over the business' justification of implementation of the environmental activities within the new business agenda called "sustainability". For the collection of data, the structured questionnaires are used and data analysis was conducted by applying SEM (Structural Equation Modeling) methodology. Results show that environmental activities implemented as a part of sustainable management positively influence the parameters of companies' success.
Keywords: environmental protection, company's success, sustainability

1. INTRODUCTION
Relationships in modern business are permeated with principles of ethics through social security, justice and equality with the permanent aspiration to the high level of welfare [1]. But, these commitments are, in some way, imposed on companies by society because the foundation of economic development is tightly connected to the people and the environment. Many companies strive to generate profit and by increasing the well-being believe that they fulfill their responsibilities to society and the environment. However, acting in this manner is not necessarily environmentally sound and doesn't guarantee business success in the long run. The exhaustion of vital natural resources, accelerated consumption of goods, limited success in the attempts to close cycles of energy and materials flow, increasingly damage the environment [2]. Sustainability is the issue that connects awareness of necessity for long-term economic development with controlled influence on people and the environment. "The people" should be understood as workers, consumers, suppliers, shareholders, community, etc., that significantly influence the abilities of a company to function now as well as in the future. "The environment" stands for a climate systems, living condition and habitats, energy systems [3], resources depletion and availability and consumption in the manner that enables economic prosperity and earth's general health.

This paper explores how environmentally responsible governance influences the sustainability. It presents an empirical analysis of the state of implementation environmentally responsible and sustainable activities in companies in Russia and Serbia from the employees' point of view. Therefore, what has been explored, are companies that voluntarily accepted the environmentally responsible operating by implementing the measures for decreasing the negative environmental impact and how those activities influence the company's results.

The main question is: according to the opinion of employees, whether the measures for mitigating the negative influences on environment affect the parameters that mean the long-term success of a company, namely, whether the environmental sustainability provides the business sustainability?

2. MODEL ASSUMPTIONS

In definitions of sustainable development and their interpretation, there are a lot of varieties [4]. The most common elements appearing are the meeting the needs of stakeholders without jeopardizing the future while fulfilling the economic goals, contributing to society and preserve the environment [5]. Sustainability also defines a business model that encompasses many elements of companies' performances whit contribution to environmental and social progress [6]. Sustainability is set as a multidimensional concept most precise defined by the United Nations that is implemented through taking in concern the three main pillars - environmental, social, economic [7]. Other definitions basically converge to this fundamental definition with three pillars [8,9].

An important role in achieving the sustainability of a business is played by environmental protection. Generally speaking, the environmental sustainability should have the long-term perspective taking into account the evolution of business systems and feedback, the necessity to be flexible and adaptable, with constant attention to the local and global condition and respecting the living nature end biological diversity [3].

In the new business agenda sustainability becomes the new strategic direction of many companies. Also, seems to become growing managerial trend to include the sustainability in decision making [10]. This is due to the emerging necessity for strategic managing the relationships with stakeholders and more severe demands from surrounding concerning the environmental issues. Also, many international organizations and governments emphasize that protecting the environment is an essential precondition for the aforementioned social justice and economic development [9]. Therefore, there are numerous signs of the companies' willingness to exceed the frames of their normative duties and to proactively putt the efforts towards improving environmental conditions.

Company's dedication to environmental protection often goes beyond the legal requirements or, even, solving the problems caused by the company itself. By voluntary implementing the activities on protection and improving natural surrounding, environmental sustainability becomes an integral part of strategic planning. Environmental sustainability synthesizes the economic growth and environmental protection in the way that means investments in resources saving and natural capital preservation with achieving benefits from the development of new cleaner sustainable technologies and production. Many authors dealing with this topic pointed out that besides financial benefits [11], intangible performances originated from spending financial resource for environment protection lastly worth the efforts [12].

The proposed parameters for evaluation of the environmental sustainability can differ dependently of institutions or scholars. For this research the concrete activities of the companies had been chosen for evaluation: the energy performance [13], using renewable energy source, product and process lifecycle assessment, maintaining the integrity of ecosystems through the efficient management of natural resources [3], etc.

The production has a great influence on the environment due to the utilization of various natural resources, unused residues and waste. To alleviate environmental burden caused by operations, companies plan optimization of all stages of the product lifecycle including transportation and electricity generation [14,15]. Lifecycle assessment assumes bearing in mind all phases from material extraction to disposal [15], and in the terms of sustainability, the environmental impact and possibilities for improvements in design and manufacturing that reduces it [10]. Considering the theoretical framework following hypothesis can be defined:

H1: Dedication of companies to environmental protection cause increased implementation of measurements for decreasing the environmental impact.

Some authors don't believe that the most efficient way of achieving the sustainable business success goes through the managing the environmental consequences of operations and satisfying the needs of society [16]. According to others, sustainability is a valuable approach that improves the competitiveness of the company [12]. Companies that stand for environmentally responsible are more preferable as business partners because they gain higher profit and create greater value for different stakeholders. Also, the image of the company is improving resulting in positive market reaction to the company's environmental performance [17].

The adoption of environmentally sustainable initiatives often causes the change in product pricing and demand. The studies showed that consumers responses on the environmental performance of the company were positively correlated [18]. The need for managing environmental impact often results with investments in innovations and generate the cleaner processes and products that are more desirable for customers. Preferences of the consumers are often directed to "green products" because they are perceived as of better quality [19] therefore the demand depends on the manner of performing manufacturing activities and, although this aspect is often neglected, the modeling of the sustainable supply chain. Furthermore, placement of product before competitors and using resources more efficiently increase the company's delivered value and decrease costs.

Striving to create value for all stakeholders through the development of ecological products, optimization of the production process using renewable energy sources and recyclable materials can result in increasing the awareness especially among consumers over the environmental responsibility of the company and influence theirs decision about loyalty to the company. In accordance with previous statements following hypothesis is been set:

H2: Implementation of measurements for decreasing the environmental impact positively influence the success and sustainability of company.

In order to address the mentioned questions and evaluate the hypothesis, based on reviewed literature, the following model was proposed, Figure 1. The theoretical model was developed based on 12 research items to assess the three constructs with established interrelations.

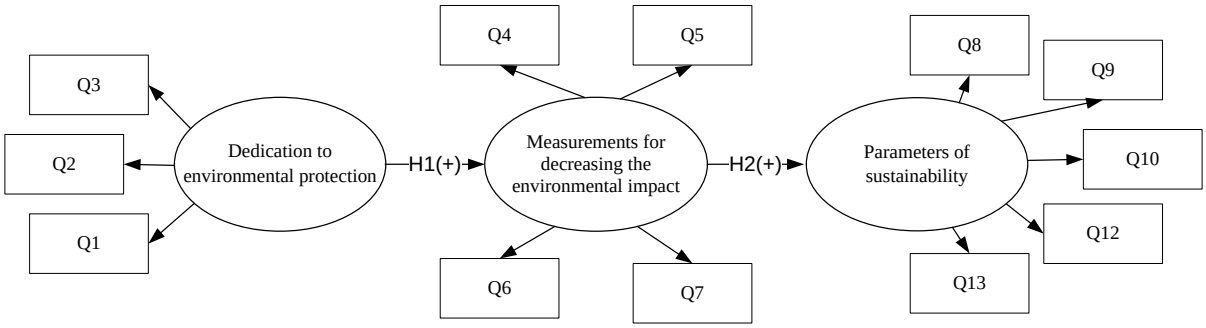


Figure 1. Conceptual model of the impact of environmental protection on sustainability of companies

3. METHODOLOGY

In this survey were participating the employees from Russia and Serbia, where research was conducted from December 2016 to March 2018. Employees answered questions from a structured questionnaire where five-point Likert's scale was used for assessments of given statements (1 stands for absolutely disagree – 5 stands for absolutely agree). They were asked to assess the expressed dedication of companies toward environmental responsibility. Also, the implementation of measures for mitigating the environmental influence was evaluated, and finally, some indicators that represent long-term performances of the company had been rated. After data collection, the further analyses were carried out using SPSS v.17 and AMOS v.18 and the following results were obtained.

4. RESULTS

Analyzed data pool consisted of 353 properly filed questionnaires, where 169 (49.9%) of respondents were from Russia and 184 (52.1%) of respondents were from Serbia. One of the descriptive characteristics of the sample was Age, where the most of respondents belonged to age group 26-35 years with 42.2%, followed with group 46-55 (20.1%) and 36-45 (18.1%). Considering Gender, 61.5% of respondents comprised women and 38.5% men. When it comes to Size of companies the employee is working for, the most respondents have been working in companies with more than 1000

employees 27.2 % then 21.8% worked in companies with11-50 employees and the third group were the employees from companies with 51-100 employees, 13.3%. During the data collection, it was taken care of that respondents belong to different business sectors in order to achieve greater heterogeneity of the sample and thus better representativeness of data.

For checking the reliability of scales, Cronbach's alpha has been computed. For Dedication to environmental protection, the value of scale reliability is .792. The reliability of Measurements for decreasing the environmental impact has value .871 and for Parameters of sustainability, reliability value is .846. All scales have substantial reliability since the values of Cronbach's alpha are very high [20].

The analysis reported in this paper follow a two-phase procedure recommended by Anderson and Gerbing (1981) [21]. The first phase involves using confirmatory factor analysis (CFA) to develop an acceptable measurement model that provides an acceptable fit to the data. Once the tested measurement model shows that indicator variables effectively measure constructs of interest, the analysis goes to the second phase where the theoretical model and hypotheses are tested to show whether certain latent constructs predict other latent constructs.

The measurement model was estimated using the maximum likelihood method. First, χ^2 and χ^2 / df ratio were being observed to check the overall fit of the model to the data. The value of χ^2 for proposed model is 127.696 with 50 degrees of freedom where the ratio χ^2 / df =2.55. Schermelleh-Engel and Moosbrugger (2003) stated that this ratio indicates good fit when it produces 2 or a smaller value while it indicates an acceptable value when it produces a value of 3 [22].

There is no universal consensus which indices provide the best reflection of model fit. Instead, common practice entails reporting at least three goodness-of-fit indices, at least one absolute index, one parsimony index and one incremental index [23]. CFI (Comparative Fit Index) values between .90 and .94 suggest adequate fit, but values greater than .94 are more ideal [23]. In the case of the proposed model value of CFI is 0.961. The RMSEA (Root Mean Square Error of Approximation) value is .066 while values between .055 and .08 suggest fair model fit [24]. RMR (Root Mean Square Residual) value less than .08 is generally considered a good fit. For the tested model value of RMR is .079. IFI (Incremental Fit Index) has value .961 while cutoff for good fitting models value should be at list .95 [25]. For TLI (Tucker-Lewis Index) general rule of thumb is more than 0.90 for acceptable and more than 0.95 for excellent fit [26]. TLI for the observed model has value .948. As can be noticed the presented values provide a good indication that the overall structure of the model fits the data.

Next, the standardized factor loadings along with their respective *t* values had been observed. The standardized factor loadings range from .61 to .85, and their high *t* values in range 5.951 – 12.116 with statistical significance $p < .001$ for each. Before accepting the model as the final model, evaluating reliability and validity of constructs was performed.

The composite reliability (CR) for construct Dedication to environmental protection is .79, for construct Measurements for decreasing the environmental impact is .87 and for construct Parameters of sustainability, the value is .84. Composite reliabilities for all constructs exceed the required value of .70 as minimally acceptable level and even reach over the .80 as preferable level. Fornell and Larcker (1981) suggest that constructs should have variance extracted estimates greater than .50 [27]. Variance extracted estimates for the three studied constructs exceed the .50 criterion with values .56 for Dedication to environmental protection, .63 for Measurements for decreasing the environmental impact and .52 for Parameters of sustainability. The average variance estimate (AVE) is .57 across the factors. Convergent validity is estimated by studying the *t*-tests for the factor loadings. Since all factor loadings for the indicators measuring the same construct are statistically significant this suggests the convergent validity of those indicators [28]. Discriminant validity is confirmed if for the two factors of interest both variances extracted estimates are greater than the squared correlation between them. In the study, discriminant validity is confirmed for all factors.

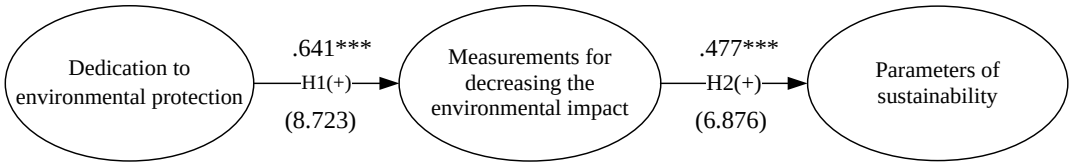
With all conditions fulfilled, the measurement model can be considered to have an acceptable fit. The second phase is a specification of relationships between variables and testing the proposed theoretical model by performing SEM (Structural Equation Modeling). First, the assessment of the fitting for the theoretical model was performed, that resulted in indices of fitting which were been in accordance with recommended values (χ^2=128.19, χ^2/df=2.51, CFI=0.96, RMSEA=0.066 TLI=0.95, RMR=0.082).

Table 2 represents the summary of path analysis and hypotheses testing. The hypothesis 1 (H1) assess more intense implementation of measurements for decreasing the environmental impact as a consequence of the dedication of companies to environmental protection. The path has a positive coefficient of .641 with the high level of significance t=8.723, p<.001, therefore the hypothesis H1 is confirmed. The path for hypothesis 2, that stands for implementation of measurements for decreasing the environmental impact which positively influences the success and sustainability of the company, has a positive coefficient of .477 with the significance level of t=6.876, p<.001, therefore, hypotheses 2 is also confirmed. Figure 2 depicts standardized path coefficients and t-values for the studied theoretical model.

Table 2. The results obtained from SEM

	Path			Standardized regression coefficient	t	Status
H1	Dedication to environmental protection	→	Measurements for decreasing the environmental impact	.641	8.723***	Confirmed
H2	Measurements for decreasing the environmental impact	→	Parameters of sustainability	.477	6.876***	Confirmed

*** statistical significance at the level p<.001



*** statistical significance at the level p<.001

Figure 2. Standardized path coefficients and t-values for the studied theoretical model

5. DISCUSION

The main goal of this paper was to investigate the influence of environmental commitment of companies on business sustainability. There is a general assumption that companies that take care of environmental impact and consequences achieve better business performances [18]. The findings in this paper indicate the same through proving both hypotheses from the proposed theoretical model. The employees from Russia and Serbia are in agreement that expressed and demonstrated commitment of the company to preserve and not harm the environment trigger more investments in environmental activities which is proved with hypothesis 1. The environmental efforts are an important input in many aspects of companies' success and sustainability, proved with the hypothesis 2. This is due to the fact that those are very visible to the employees and improve the quality of products, work conditions and life. It is indicated that all stakeholders perceive the progress in the business system and consequently the companies are encouraged to act in a good manner toward nature and society.

By reviewing the individual influence of some items and their constructs can be concluded that the most important influence on latent variable Dedication to environmental protection has the observed variable "We participate in activities related to the protection and improvement of our natural environment", implying that the very important role for employees' perception is the demonstrated devotion of companies to environmental issues, not only declared. On factor Measurements for decreasing the environmental impact, that included different activities that company undertakes in the direction of environmental protection, the most influential activity is: "Management of environmental system" which is in accordance to the fact that employees better perceive the activities that are under their influence or directly influences on them.

6. CONCLUSION

The emerging business model named sustainability successfully integrates limited economic resources with social concerns and environmental protection. Different stakeholders developed mechanisms to

pressure the companies to consider all three pillars of sustainability in the decision-making process. Also, the company's performance measurement has been changed by moving, besides financial performances, toward more subtle measurements. This paper was dealing with the environmental devotion of company and the consequences of this behavior. According to the results of the SEM analysis can be stated that companies in Russia and Serbia integrate environmental concerns in their business practices and employees are very aware of those activities. The positive relationship between the implementation of environmentally friendly activities of the company and the company's results is also been confirmed. Summarized results point the justification of pressures on companies because pursuing the environmental sustainability in long-term, eventually, leads to better financial results and other preferable outcomes.

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USING MCDM METHODS FOR EVALUATING HARVESTING ZONE SCENARIOS IN FOREST PLANNING FROM ENVIRONMENTAL MANAGEMENT PERSPECTIVE

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ABSTRACT
Forests are the natural wealth of each country because they, except economic significance, have a great importance in preserving the environment. Therefore, the selection of a sustainable forest management strategy is a very important and complex problem, whose solving requires considering the impact of more criteria. That is why, this article proposes a multi-criteria approach for the evaluation of sustainable resource management strategies, which is based on the use of the TOPSIS method. The usability and efficiency of the proposed approach have been presented in the case of selecting a sustainable forest resource management strategy in the National Park Djerdap. In this case, the alternative strategies have been formed based on the reduction and / or increase of the allowed timber production zone. At the end, the relevant conclusions are given.
Keywords: forest management, sustainability, TOPSIS.

1. INTRODUCTION

Forests can be considered as the national wealth of each country because they have a significant impact on the carbon dioxide absorption from the atmosphere and the production of oxygen that is necessary for life on the Earth. Forests are also significant to produce biomass, which can be used later in the construction and wood industry as well as for heating. In addition, forests have a very high importance in terms of protection against erosion and flood protection.

The increasing need of people to use forest resources more intensively in order to meet its needs leads to a reduction in the area under the forests, as well as changing characteristics of these forests. In order to meet its needs, people reduce the area under the forests, resulting in very undesirable effects, such as erosion, landslides, water torrential floods and floods, increase of carbon dioxide in the air, etc.

The problem of managing the forest exploitation becomes more complex if other important factors are also considered, such as conservation of: biodiversity, wildlife habitats, landscapes, and so on.

Based on the above said, it is clear that important activities should be carried out in order to determine strategies for rational and sustainable use of forest resources.

It is also evident that the evaluation of possible forest management strategies represents a complex multiple criteria decision-making (MCDM) problem, which is why a MCDM model for analysis different scenarios of forest resources exploitation is proposed in this article. The proposed MCDM model is based on the use of the TOPSIS method, and its verification was carried out using a similar MCDM model based on the PROMETHEE method.

Therefore, this article is organized as follows: Section 2 is to address the basic elements of forest management and Section 3 consider multiple criteria decision making and its usage in forest management. Section 4 presents the TOPSIS, and the framework for evaluating the strategies based

on the use of the TOPSIS method presented in Section 5. In Section 6, a case study is considered in order to present the applicability and effectives of the proposed approach. The conclusions are given in the final section.

2. FOREST MANAGEMENT

"Forest conditions today are influenced by events that took place many decades ago. Likewise, management decisions we make now will have long-term consequences for future generations." [1]
What does forest management actually mean? In order to meet its needs, people need more and more biomass, which leads to an increase in forest exploitation. EU members have noticed this problem long time ago, especially in countries which are rich with forests, such as Finland. Heinonen et al. [2] consider the mentioned problem of forest resource management in the case of forest exploitation in Finland, where they considered different scenarios of exploitation of forests, as well as the impact of such scenarios on the environment.
The effects of increased exploitation can be mitigated in the long term and even almost eliminated by adequate forest exploitation and afforestation policies. In the other words, it is possible to form mathematical models on which basis it is possible to calculate the area of the forest on which cutting will be allowed each year while maintaining the existing surface of the forest. Simply said, it is necessary to determine the area of the forest where exploitation is allowed so that the seedlings can provide enough time for growth before they are cut.
By applying such models, the surface can be preserved under the forests, but not the existing condition. In such areas there will be old forests, which are exploited, the area where afforestation is carried out, and the area of young forests, that is, the forests that will be exploited in the future.
However, Heinonen et al. [2] also noted that such forest exploitation models could have an impact to the environment, and in countries with significant areas under forests the application of such forest management models could have significant impact on the level of carbon dioxide in the air, as well as biodiversity. According to Heinonen et al. [2], in areas with such method of forest exploitation, the so-called "artificial forests", there is a much smaller number of trees that died out before cutting, dry trees, and significantly smaller variety of tree species, since in this model of exploitation priority is given to certain types of seedlings. As a consequence, the overall biodiversity in such forests is smaller.
Based on the above, it can be concluded that the preservation of areas under the forests is not the only problem with which we meet when solving the problem of sustainable forest management. Certainly, there are other factors to be considered.
Except of the area under the forest, Shifley et al. [1] define other significant infuental factors that need to be considered, such as:

- Maintenance of the existing structure of forest species, i.e. the ratio between the areas on which they are spreading, as well as the landscape.
- Maintenance of existing forest biodiversity.
- Maintenance of quality and quantity of water in the forest area.
- Maintenance of soil productivity and reduction of soil erosion or contamination.
- Maintain, or even increase, the areas on which the exploitation of trees and other forest products is carried out, as well as the economy based on the exploitation of trees and other forest products.
- Manage the number of employees and the local economy based on the exploitation of forests.
- Managing the tourism potential of the area under the forest.

Somewhere between the sustainable exploitation of forests, i.e. cutting of trees, conservation of biodiversity and interests of the local community is a solution of sustainable forest management.
In 1713 Hans Carl von Carlowitz [3] defined the sustainability principles like: "Therefore, it is highly essential to combine research, hard work and planning, that aims at protection and planting of forests in our country, that makes a continuous, and sustainable use of our forests possible; all this is necessary to ensure the future of our country". [3, 4] The base of sustainability is to people satisfy their current needs without affecting future generations to meet their needs. It is important to conserve

current forest resources and leave them in better conditions than they were, as the needs for forest products and ecosystem services are not decreasing.
Ministerial Conference on the Protection of Forests in Europe (MCPFE) defines sustainable forest management as: “The stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems”. [5]
It can be said that the fundamentals of forest fund management are planning. According to Kangas [5], the goal of forestry management can be defined as: "Providing forestry decision support in ways that inputs and outputs in forestry provide the best possible accomplishment of planned objectives".
Also, according to Kangas et al. [5] and Kangas et al. [6], the following stages can be identified as some of the most important stages in the planning forest resources forest data acquisition and assessing the present state of the forests,

(i) clarifying the criteria and preferences of the decision-maker(s) regarding the use of forests and, in participatory planning, clarifying the criteria and preferences of other interested parties,
(ii) generating alternative treatment schedules for forest stands within the planning area and predicting their consequences,
(iii) producing efficient production programs for the forest area, and
(iv) choosing the best production program from among those deemed to be efficient with respect to the criteria and preferences as clarified in phase (ii)

Forests should produce reasonable incomes while at the same time promoting conservation and recreational considerations. [6]

3. MULTIPLE CRITERIA DECISION MAKING

MCDM can be defined as the process of evaluating a set of available alternatives, that is, selection of one and / or the ranking of an alternative based on a set of, often mutually opposing, criteria. [7]
MCDM can be considered as one of the most important areas of management science, and also one of the fastest developing areas. So far, the importance of the number of MCDM methods has been proposed as a result of intensive development in the field of MCDM and its use for solving a wide range of different decision-making problems.
As some of the more important MCDM methods can be mentioned ELECTRE [8] and PROMETHEE [9], which have been developed and are widely used in Europe. As often used MCDM methods can also be mentioned: Simple Additive Weighting (SAW) method (MacCrimmon, 1968) [10], Linear Programming Technique for Multidimensional Analysis of Preference (LINMAP) method [11], Method of Ordering Preference by Similarity to Ideal Solution (TOPSIS) method [12], Analytic Hierarchy Process (AHP) method [13], Analytic Network Process (ANP) (Saimes, 1980) [14], ELIMINATION and Choice Expressing REALITY (ELECTRE) method [15], TODIM (whose name represents the acronym of the Portuguese word interactive decision making process) [16, 17], Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE) method [18], Measuring Attractiveness by a Categorical Based Evaluation Technique (MACBETH) method [19], VIKOR [20], etc.
A detailed overview of these MCDM methods, as well as their characteristics and usage, can be found in Hwang and Yoon. [12]

3.1 An overview of the usage of MCDM methods in forest management

The above MCDM methods are used to solve a number of decision problems, such as: evaluation of airline service quality [21], evaluation of green suppliers [22], evaluation of banking performance [23], and so on.

MCDM methods are often used for solving a number of decision-making problems related to forest management. A brief overview of literature related to the methodology and application of the MCDM methods in the field of forest management is given in Table 1.

Table 1. An overview of literature related to the methodology and usage of MCDM in the field of forest management

Author(s)	Focus	Specific area	Outranking methods
Abedi and Ghamgosar [24]	Determining the effective management strategy for Hyrcanian forest in the Asalem of Guilan	Forest management	ELECTRE
Al-Rashdan et al. [25]	The use of PROMETHEE method for prioritization of environmental projects	Environmental impact assessment	PROMETHEE
Hamadouche et al. [26]	Conserving the biodiversity in protected areas	Natural resource management	ELECTRE III and PROMETHEE
Jactel et al. [27]	Identifying optimum tree harvesting scenarios	Forest management	PROMETHEE II
Kangas et al. [28]	The use of ELECTRE and PROMETHEE in strategic natural resource planning	Natural resource planning	ELECTRE III and PROMETHEE II
Kangas et al. [29]	Discussion about drawbacks and benefits of these different approaches for forest management.	Forest management	ELECTRE and PROMETHEE
Schuler et al. [30]	The use of PROMETHEE in order to find the best approach for converting monocultures to mixed-species and thus increase forest productivity and resilience of ecosystems	Forest management	PROMETHEE
Shang et al. [31]	Evaluation of cumulative effects of forest management	Forest management	PROMETHEE
Arsic et al. [32]	Prioritization of sustainable development strategies in NP Djerdap	Forest management and ecotourism	ANP and fuzzy ANP
Arsic et al. [33]	Forest ecosystems management in NP Djerdap	Forest ecosystems management	ANP

3.2 MCDM methodology

Different authors identified different phases in MCDM. As some of commonly identified phases, the following phases could be identified:

- Defining the objectives of the MCDM evaluation of alternatives, i.e. defining the goals that should to be achieved by using MCDM.
- Identification of the evaluation criteria on which basis the evaluation will be carried out
- Identification of available alternatives
- Determination of the significance of evaluation criteria
- Assigning the ratings of the alternatives in relation to a selected set of evaluation criteria
- Aggregation, determining the relative importance of alternatives and ranking alternatives
- Selection of the most acceptable alternative.

4. TOPSIS METHOD

TOPSIS method, or Technique for Order Preference by Similarity to an Ideal Solution, was proposed by (Hwang and Yoon, 1981) [12]. The TOPSIS method is based on the idea that the best alternative should have the shortest distance from the ideal point and the farthest distance from the anti-ideal point in Euclidean space.

The computational procedure for solving a MCDM problem containing *m* alternatives and *n* criteria using the TOPSIS method can be shown as follows:

Step 1. Construct decision-making matrix *D* as follows:

$$D = [x_{ij}]_{m \cdot n} \tag{1}$$

where x_{ij} denotes rating of alternative *i* in the relation to criterion *j*.

Step 2. Calculate normalized decision-making matrix $N = [r_{ij}]_{m \cdot n}$ as follows:

$$r_{ij} = \frac{x_{ij}}{\left(\sum_{i=1}^{m} x_{ij}^2 \right)^{\frac{1}{2}}}, \tag{2}$$

where r_{ij} denotes normalized rating of alternative *i* in the relation to the criterion *j*.

Step 3. Determine the ideal A^+ and anti-ideal A^- point as follows:

$$A^+ = \{r_1^+, r_2^+, \ldots r_n^+\} = \{(\max_i r_{ij} \mid j \in \Omega_{\max}), (\min_i r_{ij} \mid j \in \Omega_{\min})\}, \tag{3}$$

$$A^- = \{r_1^-, r_2^-, \ldots r_n^-\} = \{(\min_i r_{ij} \mid j \in \Omega_{\max}), (\max_i r_{ij} \mid j \in \Omega_{\min})\} \tag{4}$$

where: $\Omega_{\max}$ and $\Omega_{\min}$ denote the set of benefit and cost criteria, respectively.

Step 4. Calculate the relative distance of each alternative from the ideal point d_i^+ and the anti-ideal point d_i^- as follows:

$$d_i^+ = \left\{ \sum_{j=1}^{n} \left(w_j (r_{ij} - r_j^+) \right)^2 \right\}^{1/2}, \tag{5}$$

$$d_i^- = \left\{ \sum_{j=1}^{n} \left(w_j (r_{ij} - r_j^-) \right)^2 \right\}^{1/2}, \tag{6}$$

where w_j denotes the weight of criterion *j*.

Step 4. Calculate the relative distance C_i of each alternative to the ideal solution as follows:

$$C_i = \frac{d_i^-}{d_i^+ + d_i^-}. \tag{7}$$

According to the TOPSIS method, the alternative with the highest value of C_i is at the same time the best alternative.

5. FRAMEWORK FOR EVALUATING THE STRATEGIES

Many complex decision-making problems require the participation of more experts and / or decision-makers in selection of the most appropriate alternative. Therefore, in this section, a framework for the evaluation of the forest resource management strategies, based on group decision-making and the TOPSIS method, is considered.

The selection process involving *m* alternatives that are evaluated on the basis of *n* criteria by *K* decision maker can be presented in detail using the following steps:

Step 1. Form a team of experts and / or decision-makers who will evaluate strategies.

Step 2. Define the objectives that need to be achieved by the chosen strategy. In this steep, the team of experts and / or decision-makers define the objectives to be achieved.

Step 3. Define the possible strategies. In this step, the team of experts and / or decision-makers define possible strategies.

Step 4. Form a set of evaluation criteria. In this step, the team of experts and / or decision-makers selects the set of criteria on which basis the evaluation of the strategies will be carried out.

Step 5. Determine the significance of the criteria. In the literature, many techniques for determining the weights of criteria are proposed, such as pair-wise comparisons [34], Delphi Method [35], SWARA [36], Best-worst method [37].

In this approach, each expert and / or decision-maker evaluates the criteria by applying one of the above-mentioned techniques, after which the group weights are determined as follows:

$$w_j = \frac{1}{K}\sum_{k=1}^{K} w_j^k \,, \tag{8}$$

where w_j^k denotes the weight of criterion *j* obtained from expert / decision-maker *k.*

Step 6. Evaluate the strategies in relation to the set of criteria. In this step, there are two approaches to determine ratings of strategies in relation to the set of evaluation criteria. In the first approach, each expert and / or decision-maker forms his / her decision matrix, after which the group ratings are calculated as follows:

$$x_{ij} = \frac{1}{K}\sum_{k=1}^{K} x_{ij}^k \,, \tag{9}$$

where x_{ij}^k denotes the rating of alternative *i* in relation to criterion *j* obtained from expert / decision-maker *k.*

The second approach involves the formation of a common, group, decision matrix, whereby the ratings of strategies are determined on the basis of the consensus of experts and / or decision-makers.

Step 7. Evaluate strategies. In the step, the evaluation is done using the TOPSIS method.

Step 8. Analyze the results and select the most acceptable strategy. The alternative with the highest value of the relative distance from the ideal point is the best placed alternative based on the TOPSIS method. However, in the case where two or more alternatives have approximate value of relative distance, either the experts and / or decision-makers consider that the obtained results are not adequate, the evaluation procedure can be repeated starting from some previous step in the range 2 to 5.

6. NUMERICAL ILLUSTRATION

In this section, six selected forest exploitation strategies in the National park Djerdap were evaluated on the basis of the following set of criteria:

- Maintaining habitats of game animals (C_1)
- Nature tourism (C_2)
- Conservation of biodiversity, i.e. existing plant species (C_3)
- Preserving the cultural heritage of the national park (C_4)
- Income and employment opportunities provided by controlled exploitation of forests (C_5)
- Recreation of local inhabitants and for people living nearby (C_6)

Alternative strategies for managing the exploitation of forest resources in NP Djerdap were formed on the basis of the variation of the currently allowed surface of the forest exploitation, where retaining the existing explanation surface represented the first alternative.
The alternatives A_2 and A_3 were formed on the basis of the assumption that the allowed exploitation zone will be reduced by 10% and 20% respectively. In contrast, the alternatives A_3, A_4 and A_5 means an increase in the permitted exploitation zone by 10%, 20% and 30%, respectively.
The previously mentioned criteria were selected based on the articles published by Kangas et al. [28], Abedi and Ghamgosar [24], as well as consultations with Professor Jyrki Kangas during student exchange at the University of Eastern Finland in 2016.
The weight of the selected criteria, determined using the AHP method based on the attitudes obtained from three experts from NP Djerdap, are shown in Table 2.

Table 2. The weights of the evaluation criteria

Criteria	w_j
C_1	0.15
C_2	0.12
C_3	0.32
C_4	0.27
C_5	0.08
C_6	0.05

The initial decision-making matrix and normalized decision-making matrix are shown in Table 3 and Table 4.

Table 3. The ratings of evaluated the alternatives

	C_1	C_2	C_3	C_4	C_5	C_6
	0.15	0.12	0.32	0.27	0.08	0.05
	max	*max*	*max*	*max*	*max*	*max*
A_1	4	3	4	5	5	4
A_2	5	4	5	5	4	4
A_3	6	5	7	5	2	5
A_4	3	2	2	4	6	4
A_5	2	1	2	4	6	3
A_6	1	1	1	3	7	3

Table 4. Normalized decision-making matrix

	C_1	C_2	C_3	C_4	C_5	C_6
A_1	0.42	0.40	0.40	0.46	0.39	0.42
A_2	0.52	0.53	0.50	0.46	0.31	0.42
A_3	0.63	0.67	0.70	0.46	0.16	0.52
A_4	0.31	0.27	0.20	0.37	0.47	0.42
A_5	0.21	0.13	0.20	0.37	0.47	0.31
A_6	0.10	0.13	0.10	0.28	0.54	0.31

In next step, on the basis of values from normalized decision-making matrix, the ideal and anti-ideal points are determined. The ideal point and anti-ideal point, determined by (3) and (4), are shown in Table 5.

Table 5. The ideal and anti-ideal point

	C_1	C_2	C_3	C_4	C_5	C_6
A^+	0.63	0.67	0.70	0.46	0.54	0.52
A^-	0.10	0.13	0.10	0.28	0.16	0.31

On the basis of data from Table 4 and Table 5, the relative distance of each alternative from the ideal and anti-ideal point are calculated, by using (5) and (6). Finally, the relative distance of each alternative is calculated by using (7). The distances from the ideal and anti-ideal point, as well as the relative distance of each alternative are shown in Table 6. In Table 6 also is shown ranking order of considered alternatives obtained by using TOPSIS method.

Table 6. Ranking results obtained on the basis of TOPSIS method

Alternative	d_i^+	d_i^-	S_i	Rank
A_1	0.11	0.12	0.54	3
A_2	0.07	0.16	0.69	2
A_3	0.03	0.22	0.88	1
A_4	0.18	0.06	0.25	4
A_5	0.19	0.05	0.21	5
A_6	0.22	0.03	0.12	6

As it can be seen from the Table 6, the best ranked alternative based on the TOPSIS method is alternative denoted as A_3, that is the strategy that implies a 20% smaller tree harvesting zone.
In order to verify the obtained results, the evaluation was performed again using the PROMETHEE method, whereby the PROMETHEE method was chosen because it is often used to solve various decision-making problems associated with forest management. The results obtained by PROMETHEE method are accounted for in Table 7.

Table 7. Ranking results obtained on the basis of PROMETHEE and TOPSIS method

	PROMETHEE				TOPSIS	
Alternative	ϕ_i^-	ϕ_i^+	ϕ_i	*Rang*	C_i	*Rang*
A_1	0.14	0.37	0.24	3	0.54	3
A_2	0.11	0.43	0.32	2	0.69	2
A_3	0.08	0.62	0.53	1	0.88	1
A_4	0.30	0.64	-0.24	4	0.25	4
A_5	0.37	0.33	-0.34	5	0.21	5
A_6	0.56	0.05	-0.51	6	0.12	6

7. CONCLUSION

A multiple criteria decision-making model for the evaluation of sustainable forest management strategies is proposed in this article.
In this article, six strategies have been defined which implied the increase or decrease of the zone in which the exploitation of forests is carried out. Strategies were evaluated on the basis of six criteria, and for the purpose of evaluation, the TOPSIS method was used.
The results achieved using the proposed approach indicated that the strategies that imply the increase in the forest exploitation zone are unacceptable in the case of NP Djerdap. More precisely, alternatives that involve the reduction of the forest exploitation zone are better ranked than others.
Based on the ranking results, it can also be noted that greater benefits can be achieved by preserving the natural beauties and potentials of NP Djerdap and their sustainable exploitation, such as various forms of tourism, and monitored hunting and fishing species that are not protected. Of course, a similar research, which might involve changing the used criteria, as well as a larger number of respondents, could more precisely confirm this assumption.

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ANALYSIS OF FUNCTIONING OF THE ENVIRONMENTAL MANAGEMENT SYSTEMS IN METAL SECTOR ORGANIZATIONS

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SUMMARY

The paper presents the results of the study of the functioning of the environmental management system according to ISO 14001, the effects and possibilities for improving the functioning and introduction of this system in the metal industry sector organizations. The results show that the ISO 14001 standard is a very good tool for the establishment and functioning of the environmental management system, as its application achieves the reduction of harmful emissions into the environment and the improvement of ecological performance as the core objectives of the environmental management system. In addition, significant benefits to the organization include increasing image, greater customer satisfaction, and energy-efficient business. This standard can be applied in manufacturing organizations in various branches of the metal industry sector. Most of the research organizations are planning to make fuel substitution and use of raw materials and materials that produce less emissions and byproducts, and introduce a health and safety management system according to OHSAS 18001 as well as standards defining the requirements of a quality management system specifically developed for the needs of the global automotive industry ISO / TS 16949.

Key words: environmental management system, ISO 14001 standard, environmental emissions.

1. UVOD

Sistem okolinskog upravljanja EMS (engl. Environment Management System) je sistem kojim organizacije poboljšavaju svoje karakteristike, minimiziranjem štetnog uticaja na okoliš. Ostvaruje se kontrolom aspekata okoliša koji negativno utiču na okoliš. [1] EMS se može definisati kao: Dio ukupnog menadžment sistema organizacije koji se koristi za razvijanje i primjenu politike zaštite okoliša i upravljanje aspektima okoliša. Prvi korak u uspostavi EMS je identificiranje aspekata okoliša, zatim definiranje njihovog značaja, te pokretanje sistema provedbe aktivnosti s ciljem smanjenja njihovog uticaja na okoliš. [2, 3] Razlikuju se dva sistema okolinskog upravljanja: ISO 14000 i EMAS.[1] ISO 14000 je najpoznatiji sistem okolinskog upravljanja koji se primjenjuje širom svijeta. EMAS **(**engl. Eco Management and Audit Scheme) je sistem nastao iz preporuke vijeća EU broj 1836/93[2] u vezi dobrovoljnog uvođenja mjera okolinskog upravljanja. Posjedovati certifikat za sistem okolinskog upravljanja predstavlja prednost pred konkurencijom i omogućava zadovoljavanje zahtjeva dobavljača. Zbog toga mnoge organizacije, koje još uvijek vrše proizvodnju po neprihvatljivim uvjetima za okoliš, moraju djelovati u pravcu minimiziranja zagađenja jer će tržište biti otvoreno za zdravu konkurenciju. Opstat će samo one organizacije koje će biti u stanju da prihvate konkurenciju na evropskom i svjetskom tržištu, a koja podrazumijeva djelotvorno i odgovorno implementiranje okolinskih mjera i zahtjeva.

Koristi koje organizacija može imati implementacijom EMS prema standardu ISO 14001 su:

- smanjenje troškova upravljanja otpadom i smanjenje štetnog otpada,
- uštede u potrošnji energije i materijala, te izborom adekvatne opreme za rad,
- usklađenost procesa za zakonskom regulativom i bolji odnos sa inspekcijskim organima,
- razvijanje i podizanje okolinske svijesti zaposlenih,
- sposobnost odgovora i definisanje mjera za suzbijanje okolinskih incidenata,
- proaktivno i preventivno djelovanje na sprečavanju pojava okolinskih rizika,
- aktivan doprinos zaštiti zdravlja i bezbjednosti zaposlenih i šire zajednice,
- povećanje imidža na domaćem i ino tržištu,
- izbjegavanje isticanja odštetnih zahtjeva usljed izazivanja okolinskih incidenata,
- stvaranje okvira za stalno unapređenje procesa i dugoročno interesno povezivanje,
- pristup fondovima EU za "zelenih tehnologija" i dobar izbor novih tehnologija,
- pridobijanje klijenata sa razvijenom okolinskom sviješću. [4, 5]

Uspjeh sistema okolinskog upravljanja ovisi o opredjeljenosti na svim nivoima i funkcijama organizacije, na čelu s upravom. Osnova pristupa koji je temelj sistema okolinskog upravljanja počiva na konceptu „Planiraj-uradi-provjeri-djeluj" (Plan-Do-Check-Act – PDCA[3]). PDCA model pokazuje ponavljani proces koji organizacije primjenjuju kako bi postigle stalno poboljšavanje. Može se primjeniti na sistem okolinskog upravljanja i na svaki njegov pojedini element. [6] Sektor metalske industrije obuhvata sve proizvodne i uslužne djelatnosti, čiji procesi rada podrazumijevaju: izradu, preradu, montažu dijelova, sklopova ili struktura velikih razmjera od metala kao i sve djelatnosti koje se bave projektovanjem, razvojem i optimizacijom istih. Metalska industrija zauzima ključno mjesto u strukturi industrije i privrede svake industrijski razvijene zemlje. [7] U ovom istraživanju je analizirano 18 organizacija sektora metalske industrije koje su implementirale sistem okolinskog upravljanja prema standardu ISO 14001.

2. ANALIZA I OCJENA FUNKCIONISANJA SISTEMA OKOLINSKOG UPRAVLJANJA

Standard ISO 14001 od svih organizacija zahtjeva sveobuhvatno i kontinuirano preispitivanje i poboljšavanje uvedenog sistema okolinskog upravljanja u cilju poboljšanja okolinskih efekata i postizanja najpovoljnijih mogućnosti za okoliš. Zbog toga se nameće potreba i opravdanost

[1] Predstavlja sistem okolinskog upravljanja i neovisnog ocjenjivanja kojim organizacije procjenjuju uticaj njihove djelatnosti na okoliš, informiraju javnost o trenutnoj procjeni stanja uticaja i unapređuju efikasnost rada u skladu sa zaštitom okoliša.

[2] Preporuku vijeća EU broj 1836/93 je uvela Evropska Ekonomska Zajednica 1993. g., koja je stupila na snagu 13.7.1993. g.

[3] Metodologija neprekidnog poboljšavanja koja se temelji na Walter Andrew Shewhart principu kojeg je William Edwards Deming (1900-1993) učinio poznatijim pod nazivom Demingov krug (PDCA krug).

istraživanja mogućnosti za unapređenje djelovanja i utvrđivanje efekata uvođenja sistema okolinskog upravljanja u organizacijama metalskog sektora. Obzirom da su istraživane organizacije implementirale standard ISO 14001, važno je njihovo iskustvo u primjeni ovog standarda i funkcionisanju sistema okolinskog upravljanja. U Tabeli 1. izneseni su stavovi i mišljenje odgovornih osoba u organizacijama o efektima uvođenja standarda ISO 14001 u istraživanim organizacijama za koje je proračunata aritmetička sredina, standardna devijacija i varijansa. Aritmetička sredina odgovora je relativno visoka i iznosi 4,222 a standardna devijacija 1,114, na osnovu čega se može konstatovati da je standard ISO 14001 veoma dobar alat za uspostavljanje i funkcionisanje sistema okolinskog upravljanja te se njegovom implementacijom omogućava adekvatno smanjenje emisija a time i zaštita okoliša.

Tabela 1. Mišljenje ispitanika u organizacijama o standardu ISO 14001

Mišljenje ispitanika o standardu ISO 14001	**Broj organizacija**	**Aritmetička sredina**	**Standardna devijacija**	**Varijansa**
Da li je kao alat standard ISO 14001 u organizaciji efikasan sistem za okolinsko upravljanje	18	4,222[4]	1,114	1,242
Standard je teško primjenjiv u organizacijama metalskog sektora	18	1,722	0,669	0,448
Poptuna implementacija standarda u organizaciji omogućava adekvatno smanjenje svih emisija i zaštitu okoliša	18	4,222	0,732	0,536

Prema vrijednosti proračunate aritmetičke sredine svih odgovora koja iznosi 1,722, može se konstatovati da je ovaj standard moguće primjeniti u organizacijama koje se bave proizvodnjom u različitim granama sektora metalske industrije, čime se postiže smanjenje emisija štetnih materija u okoliš i poboljšanje ekoloških performansi što je temeljni cilj EMS-a. Daljim istraživanjem su razmatrane koristi od uvođenja EMS-a prema ISO 14001. Najveći broj ispitanika je potvrdio da je najznačajnija korist po organizacije porast imidža (u 16 organizacija), veće zadovoljstvo kupaca i energijsko efikasnije poslovanje (po 14 organizacija), što potvrđuju podaci iz Tabele 2. Za poslovanje organizacija također je izražena veća podrška lokalne zajednice kao i iskorištenost sirovina i repromaterijala (što potvrđuje 13 odnosno 12 organizacija).

Tabela 2. Koristi uvođenja standarda ISO 14001

Koristi za organizaciju i okoliš uvođenjem standarda ISO 14001	**Broj organizacija**
Veći finansijski efekti organizacije	7
Bolja organiziranost procesa proizvodnje	9
Iskorištenost sredstava za rad je veća	6
Iskorištenost sirovina i repromaterijala je veća	12
Energijski efikasnije poslovanje	14
Kupci proizvoda su zadovoljniji	14
Prodaja proizvoda je veća	6
Veći broj kupaca i poslovnih partnera	8
Veće zadovoljstvo zaposlenih	7
Mogućnost većeg ulaganja u edukaciju i stručno usavršavanje	8
Značajniji imidž organizacije u poslovnom okruženju	16
Rentabilnije i efikasnije rukovođenje organizacijom	8
Veće zadovoljstvo i podrška lokalne zajednice	13

[4] Proračunate vrijednosti deskriptivne statistike su dobivene na osnovu prikupljenih podataka prema odgovorima organizacija,
kao ocjena stepena slaganja sa tvrdnjom prema petostepenoj Likertovoj skali (1-apsolutno se ne slažem, 2- ne slažem se, 3-nisam siguran, 4-slažem se, 5- apslolutno se slažem) na postavljena pitanja.

U Tabeli 3. dati su podaci o planiranim poboljšanjima u cilju smanjenja emisija u okoliš a time i manjeg uticaja na okoliš. Većina istraživanih organizacija (14 organizacija) planira izvršiti supstituciju goriva sa gorivima koja produkuju manje emisije (lož ulje, zemni plin i sl.), te primjenu sirovina i materijala koji produkuju manje emisije i nusprodukte. Također, organizacije planiraju veća finansijska ulaganja u filterska postrojenja (13 organizacija), edukaciju zaposlenika, redovan monitoring te provedbu okolinske politike i poboljšanja.

Tabela 3. Poboljšanja koja organizacije planiraju za smanjenje negativnih uticaja na okoliš

Koja poboljšanja planirate poduzeti da bi uticaj na okoliš bili manje	**Broj organizacija**
Edukacija zaposlenih o mjestima nastanka emisija zagađivača	12
Dosljedna provedba okolinske politike	10
Korištenje goriva koje produkuje manje emisije zagađivača	14
Prelazak na upotrebu energije iz obnovljivih izvora	3
Primjena sirovina i materijala koji produkuju manje emisije i nusprodukte	13
Povećanje finansijskih ulaganja u opremu i filterske uređaje	13
Sprovođenje kontinuiranih poboljšanja	10
Redovniji monitoring i mjerenje	10
Potpuna implementacija mjera i pravovremeno djelovanje	10
Poboljšanja po Demingovom krugu (PDCA)	8
Češća kontrola aktivnosti od strane internog i eksternog audita	6
Kontinuirano preispitivanje od strane rukovodstva	4

Većina istraživanih organizacija (10 organizacija) planira uvođenje sistema upravljanja zaštitom zdravlja i sigurnosti na radu prema OHSAS 18001, te standarda koji definiše zahtjeve sistema menadžmenta kvalitetom posebno razvijenog za potrebe globalne automobilske industrije ISO/TS 16949 (4 organizacije), kako je prikazano u Tabeli 4.

Tabela 4. Organizacijsko-menadžerske aktivnosti za primjenu ISO 14001 i drugih standarda

Buduće organizacijsko-menadžerske aktivnosti u pravcu potpune implementacija EMS-a prema ISO 14001 i uvođenja drugih standarda	**Broj organizacija**
Uvođenje standarda za sistem kvaliteta prema ISO 9001	3
Uvođenje sistema upravljanja zaštitom zdravlja i sigurnosti na radu OHSAS 18001	10
Primjena modela TQM[5]	1
Uvođenje standarda za emisije stakleničkih plinova iz organizacija ISO 14064	2
Drugo:-Primjena ISO/TS 16949, i -Energijska efikasnost	4 2
Razlozi zbog kojih smatrate potrebnim provođenje gornjih aktivnosti	
Konstantna poboljšanja procesa organizacije i upravljanja, efikasnijeg rada	2
Osvajanje tržišta, veći imidž i pridobivanja ino-kupaca	2
Zbog budućih generacija	1
Zbog veće sigurnosti i brige o zaposlenicima	2
Zbog koristi zaposlenika od OHSAS 18001, ISO 16949 (zahtjeva kupac-Mercedes)	1
Stalni napredak i povećanje konkurentnosti	1
Smanjenje stakleničkih plinova i unapređenje upravljanja otpadom	1

Prema podacima iz Tabele 4. primjenu modela TQM (engl. Total Quality Management), koji ostvaruje sinergiju svih menadžment sistema, odnosno integrira sisteme upravljanja ispunjavanjem zahtjeva najmanje dva standarda, planira 1 organizacija a uvođenje ISO 9001 planiraju 3 organizacije. U tom pravcu je potrebno usmjeriti buduće organizacijsko-menadžerske aktivnosti zbog konstantnih poboljšanja upravljanja, osvajanja tržišta i pridobivanja inostranih kupaca u cilju veće sigurnosti i brige o zaposlenicima. U Tabeli 5. prikazani su podaci o razlozima zbog kojih se planirane

[5] Potpuno upravljanje kvalitetom - je način upravljanja organizacijom usredotočen na kvalitetu, utemeljen na sudjelovanju svih članova organizacije koji zadovoljavnjem želja kupaca teži za dugoročnim uspjehom organizacije.

organizacijsko-menadžerske aktivnosti ne mogu realizirati u cilju efikasnije primjene ISO 14001 i drugih standarda.

Tabela 5. Razlozi zbog kojih se organizacijsko-menadžerske aktivnosti ne realiziraju

Razlozi zbog kojih se neophodne organizacijsko-menadžerske aktivnosti ne mogu realizirati	**Broj organizacija**
Manjak finansijskih sredstava	7
Finansijska sredstva nisu planirana na vrijeme	1
Slaba zainteresiranost zaposlenika	4
Neadekvatnost tehničke podrške za realizaciju navedenih aktivnosti	2
Slaba zainteresiranost menadžera za okolinsko upravljanje	4
Prezauzetost drugim poslovima rukovodstva organizacije	7
Izraženi problemi u isporukama lanca dobavljača	1
Slaba stimulacija i zainteresiranost lokalne zajednice	3
Neredovnost plaćanja od strane poslovnih partnera i kupaca	1
Ne postoje razlozi	7

Na osnovu podataka prikazanih u Tabeli 5. uočava se da organizacije iznose kao najvažnije razloge zbog kojih se organizacijsko-menadžerske aktivnosti ne mogu realizirati: nedostatak finansijskih sredstava i prezauzetost drugim poslovima menadžmenta organizacija (po 7 organizacija), a zatim slabu zainteresiranost zaposlenika i menadžera za okolinsko upravljanje, slabu stimulaciju i zainteresiranost lokalne zajednice i sl..

3. ZAKLJUČAK

Analizom funkcionisanja sisema okolinskog upravljanja po standardu ISO 14001 utvrđeno je sljedeće:

- standard ISO 14001 je veoma dobar alat za uspostavljanje i funkcionisanje sistema okolinskog upravljanja, jer se njegovom primjenom postižu pozitivni efekti u smislu smanjenja emisija štetnih materija u okoliš i poboljšanje ekoloških performansi organizacija, što je temeljni cilj EMS-a,
- ovaj standard je moguće primjeniti u organizacijama koje se bave proizvodnjom u različitim granama sektora metalske industrije,
- većina istraživanih organizacija je potvrdila da je najznačajnija korist po organizacije: porast imidža organizacije u poslovnom okruženju, veće zadovoljstvo kupaca i energijski efikasnije poslovanje,
- većina organizacija planira izvršiti supstituciju goriva sa gorivima koja produkuju manje emisije (lož ulje, zemni plin i sl.), te primjenu sirovina i materijala koji produkuju manje emisije i nusprodukte,
- organizacije planiraju veća finansijska ulaganja u filterska postrojenja, edukaciju zaposlenika, redovan monitoring te dosljednu provedbu okolinske politike i poboljšanja,
- većina organizacija planira uvođenje sistema upravljanja zaštitom zdravlja i sigurnosti na radu prema OHSAS 18001, te standarda koji definiše zahtjeve sistema menadžmenta kvalitetom posebno razvijenog za potrebe globalne automobilske industrije ISO/TS 16949,
- prema datim analizama potrebno je usmjeriti buduće organizacijsko-menadžerske aktivnosti zbog potrebe konstantnih poboljšanja upravljanja, osvajanja tržišta i pridobivanja inostranih kupaca u cilju veće sigurnosti i brige o zaposlenicima,
- najvažniji razlozi zbog kojih se organizacijsko-menadžerske aktivnosti ne mogu realizirati su: nedostatak finansijskih sredstava i prezauzetost drugim poslovima menadžmenta organizacija, te slaba zainteresiranost zaposlenika i menadžera za okolinsko upravljanje, slaba stimulaciju i zainteresiranost lokalne zajednice i sl.

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CONNECTION BETWEEN MATERIAL FLOW ANALYSIS (MFA) AND POTENTIAL IMPACT ON HEALTH OF PEOPLE AND DESIGNING A DEVICE FOR POLLUTED AIR PROCESSING, THE EXAMPLE - COMPOSTING DEVICE

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ABSTRACT

Air pollution control, with clear limitations, is one of the areas of application of flow analysis (MFA). In practice, there are few works aimed at quantifying the long-term impact of emissions on human health. According to the ISO 140312 I EN ISO 14031 guidelines, human health impact assessment is qualitatively described through the expected life of the population, the number of people with a certain chronic illness and the like. For the first time in this paper, we present our approach to quantifying the impact of emissionSa of key substances from the analysis of material flow to human health for a period of 40 years. Unlike conventional design methods based on regulations on permitted concentrations of pollutants, we have also used the Health risk (HR) and Cancer Risk (CR) to select the best air pollution control technology for the treatment of emissions from municipal sludge composting process.

Keywords: Material flow analysis, engineering ethics, composting process, factors impacting health

1.0 UVODNA RAZMATRANJA

Jedan od primarnih problema ugrožavanja zdravlja ljudi u svijetu postao je onečišćeni zrak. Rješavanju ovog problema pristupilo se i na svjetskom nivou:

1. Normiranjem u području upravljanja okolišem (Druga konferencija UN-a o okolišu 1992.) Ustanovljen je sistem upravljanja tokovima tvari (MFM) kao politički instrument. Njemački „Bundestag“ je u specijalnom izvješću istakao da ciljeve ovakvog pristupa povećanja efikasnosti korištenja tvari, njihovih tokova i energije treba promatrati sa:
- ekološkog,
- ekonomskog i
- socijalnog stanovišta.
2. Standardizacijom u sustavu upravljanja organizacijama (Standardi ISO 14000ff)
3. Zakonskom regulativom prilikom izbora najbolje raspoložive tehnologije (NRT) za pročišćavanje štetnih tvari koje se ispuštaju u okoliš.

Za EZ su karakteristična najmanje dva značajna procesa kad je riječ o zaštiti okoliša:
- decentralizacija političkih aktivnosti vezano za zaštitu okoliša,
- uključivanje građana u odlučivanje o okolišu.

I pored velikog značaja koji se pridaje rješavanju ovog problema, u direknoj zaštiti ljudskog zdravlja nije došlo do značajnih rezultata. Prema našem mišljenu razlozi za to su:
- da zaštita ljudskog zdravlja nije postavljena kao primarni cilj kod planiranja, odlučivanja, izbora najboljeg rješenja i projektiranja.
- nepostojanje definiranog kvantificiranog faktora rizika za zdravlje ljudi koji bi pravovremeno ukazao na hitnost rješavanja problema opasnosti na zdravlje

2.0 ANALIZA TOKA TVARI (MFA), KODEKS ETIKE I PROJEKTIRANJE U ZAŠTITI OKOLIŠA

Povijesno gledano, upravljanje tokovima tvari (**MFM**) je relativno novi metod. On se može shvatiti kao napredak u primjeni metodologije analize toka tvari (**MFA**).

MFA se koristi kao prvi neophodan korak i osnova kod inženjerske zaštite okoliša. Poslije ovakve analize slijedi odlučivanja i projektiranja. Prema većini kodeksa inženjerske etike u svijetu projektant treba u svom radu najveću brigu posvetiti zaštiti zdravlja i sigurnosti stanovništva. S druge strane, zakonska regulativa nalaže izbor najbolje raspoložive tehnologije(NRT) koja je zasnovana na principu održivog razvoja .

Održivi razvoj kao pojam sadržan je u svim nabrojenim zakonskim regulativama o zaštiti okoliša. On obuhvaća:

- ekonomsku uspješnost,
- društvenu odgovornost i
- zaštitu prirodnih i ljudskih resursa.

Time se izbjegava pitanje etike (1) i pretpostavlja da su okolišni i ekonomski ciljevi kompatibilni. Primjenom MFA sa pronalaženjem ključnih štetnih tvari na zdravlje ljudi može se umanjiti „sukob“:

- ekonomije i ekologije (zdravlje ljudi),

- u realnosti prisutne inženjerske etike - zasnovane na osobnom interesu,
- interesu poslodavca

Inženjer projektant mora postaviti norme za projektiranje koje su strožije od zakonodavstva, što se indirektno zakonski omogućuje kroz MFA.

Pojam inženjera u ovom radu se koristi dvojako :

- kao bilo koji profesionalni znanstvenik, tehnolog ili inženjer koji koristi svoje vještine i naobrazbu kako bi razvio praktične primjene u stvarnom svijetu i
- inženjer projektant koji mora imati odgovarajuću naobrazbu i zakonska dopuštenja za tu djelatnost.

2.1 ODABIR KLJUČNOG PARAMETRA ZA MFA I ZAŠTITA LJUDSKOG ZDRAVLJA

Potpuno defininanje ljudskog genoma nije dovelo do korisnih rezultata koji bi se mogli u značajnoj mjeri koristiti u zaštiti ljudskog zdravlja. Zašto je to tako može se slikovito doživjeti u realnom vremenu na sljedećem videu. Samo jedna pogreška u radu DNK, stroja koji je prisutan u bilionskom broju u ljudskom organizmu,može izazvati više stotina oboljenja. Zbog toga oslonac u rješavanju akutnog problema utjecaja onečišćenog zraka na zdravlje ljudi ne možemo se fokusirati isključivo na naučna istraživanja nego konkretnijim fokusiranjem na:

- epidimiološke studije,
- dugoročne biološke pokusa na životinjama,
- kratkotrajne testove genotoksičnosti i druga relevantna svojstva,
- farmakokinetičke i metaboličke studije,
- odnose strukture i aktivnosti.

.

https://www.youtube.com/watch?v=IFNerq675EU

Samo ovakvim konkretnijim fokusiranjem na rezultate ovih istraživanja može se kvantitativno procijeniti utjecaj štetnih tvari na zdravlje ljudi.

3.0 PRIMJER PRIMJENE MFA ANALIZE KOD PROJEKTIRANJA UREĐAJA ZA OBRADU ONEČIŠĆENOG ZRAKA IZ PROCESA KOMPOPSTIRANJA

Zakonskim odrednicama (na primjer TA Luft) definirani su uvjeti za ispust onečišenog zraka iz procesa kompostiranja:

- Minimalno odstojanje do prvih kuća 100 m
- Ukupne organske tvari 0.4 g/m^3 (težiti 0.25 g/m^3)
- Prašina 10 mg/m^3
- Neugodni mirisi 500 JM/m^3
- NRT - Biofilter ili istovrijedna tehnologija

Za našu MFA analizu odabrali stožije uvjete i odabrali smo zaštitu ljudskog zdravlja kao glavni cilj

3.1 MFA ANALIZA

MFA analizom definirane su štetne tvari koje mogu imati utjecaj na zdravlje ljudi i prikazane su u sljedećoj tablici

	Kemijski spoj		Mol.tež.	Utjecaj	Udio spoja	Konc-mg/m3
BENZENI	Toluen	C7H8	92.14	Zdravlje	33.0%	33.00
	Etilbenzen	C8H10	106.17	Zdravlje	5.7%	5.70
	Ksilen	C8H10	106.17	Zdravlje	19.0%	19.01
ALKANI	Izopentan	C5H12	72.15		1.8%	1.81
	Undekan	C11H24	156.32		1.1%	1.12
	Butan	C4H10	58.12		0.8%	0.83
ALKENI	1 Butan	C4H10O	74.12		3.5%	3.45
	1-2 Butan	C4H10O2	90.12		25.8%	25.82
	1-Penetene	C5H10	70.13		4.0%	4.02
HALOGENATED	Freon 11	CCl3F	137.37		0.5%	0.49
COMPOUNDS	Ugljikov tetraklorid	CCl4	153.82	Zdravlje		
	Triklor etilen	C2Cl4	165.83		4.8%	4.75

Kao ključni parametar odabran je ugljikov tetraklorid koji može imati utjecaj na pojavu malignih oboljenja.

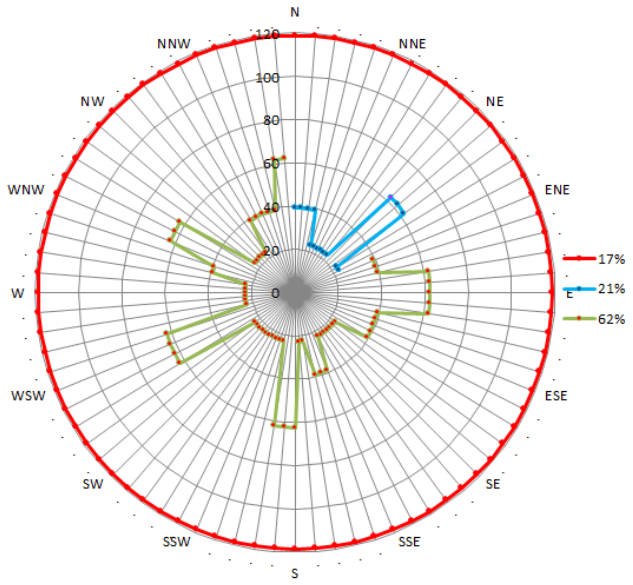
3.2 MODELIRANJE DISPERZIJE

Za definiranje potrebne efikasnosti pročišćavanja provedeno je modeliranje disperzije ugljikovog tetraklorida za različite vremenske uvjete, ulazna opterećenja i efikasnost pročišćavanja.

Na temelju rezultata modeliranja disperzije i izračuna faktora rizika za zdravlje ljudi (HR i CR) definirana je potrebna učinkovitost izdvajanja ugljikova tetraklorida od 95% očekivane ulazne koncentracije.

3.3 METEOROLOŠKI UVJETI

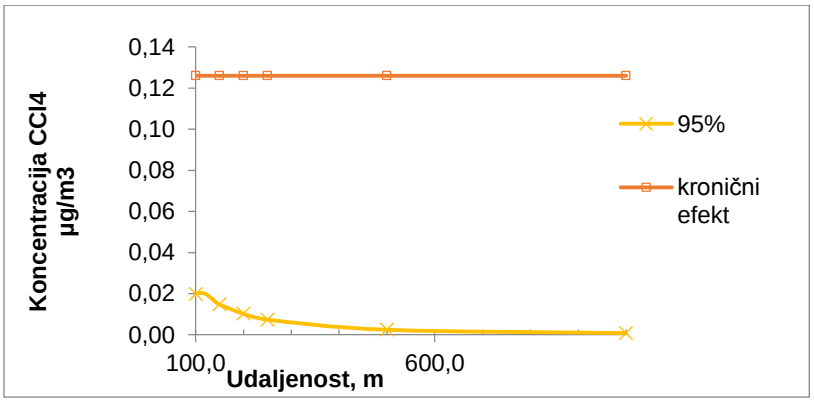
Za utjecaj na okoliš od meteoroloških uvjeta uzima se najnepovoljniji slučaj a to je učestalost tišina. U analiziranom slučaku broj tišina je na godišnjem nivou 17% .Utjecaj vremenskih uvjeta na područje utjecaja je prikazano na sljedećoj slici.



Zona utjecaja u periodu tišine je 120m dok je kod drugih vremenskih uvjeta ovisno o brzini vjetra ova zona dosta manja.

3.4 POTREBAN STUPANJ PROČIŠĆAVANJA

Potreban stupanj pročišćavanja iugljikovog tetraklorida i njegov kronični utjecaj na zdravlje je prikazan na sljedećoj slici



U izračunu modela koristili smo srednju očekivanu koncentraciju CCl_4 = 60 µg/m^3. Izračuni su provedeni za djelovanje izvora 8 h/dan (8 ciklusa x 1 h).

Proračun pokazuje da je neophodno postići 95% uklanjanja ugljikova tetraklorida da bi se u okolišu postigla koncentracija niža od graničnih vrijednosti koje, prema literaturi, mogu izazvati dugoročan učinak na zdravlje ljudi.

Koristeći podatke Agencije za zaštitu okoliša EPA (Environmental Protection Agency) (2, 3), za ocjenu utjecaja ugljikova tetraklorida na zdravlje ljudi izračunali smo faktore rizika za zdravlje HR (Health risk) i rizika pojave malignih oboljenja CR (Cancer risk). Vrijednosti HR < 0,5 i CR $<10^{-4}$ se, prema EPA, smatraju malim rizikom za zdravlje ljudi.

	HR<0.5	CR<10^{-4}
Ulaz u uređaj za pročišćavanje zraka	0,58	$1,5 * 10^{-4}$
Izlaz iz uređaja (efikasnost 95%)	$9,7 * 10^{-3}$	$2,5 * 10^{-6}$
Na udaljenosti 700 m od uređaja	$8,3 * 10^{-6}$	$3,0 * 10^{-8}$

Iz tablice se vidi da ne pročišeni zrak može imati utjecaj na zdravlje ljudi i pojavu malignih oboljenja.

3.5 USPORDBA REZULTATA

Prema našoj analizi minimalna udaljenost od prvih kuća treba da je veća od 120 m i najbolja raspoloživa tehnologija (NRT) je dvo stupanjsko pročišćavanje (kemijska predobrada – biofilter)

4.0 ZAKLJUČCI

1. Za rješavanje alarmantnog stanja ugroženosti čovjeka štetnim tvarima u zraku po našem mišljenju potrebno je

- Zaštitu ljudskog zdravlja postaviti kao primarni cilj kod planiranja, odlučivanja, izbora najboljeg rješenja i projektiranja.
- Definirati kvantificirane faktora rizika za zdravlje ljudi koji bi pravovremeno ukazao na hitnost rješavanja problema opasnosti na zdravlje

2. Primjenom MFA sa pronalaženjem ključnih štetnih tvari na zdravlje ljudi može se umanjiti „sukob“

- ekonomije i ekologije (zdravlje ljudi),
- u realnosti prisutne inženjerske etike - zasnovane na osobnom interesu,
- interesu poslodavca

3. Na primjeru projektiranja uređaja za obradu onečišćenog zraka iz procesa kompostiranja je pokazana mogućnost kvantificiranja utjecaja štetnih tvari, koje se ispuštaju u okoliš, na zdravlje ljudi.

4. Kvantificinjem utjecaja štetnih tvari na zdravlje ljudi otvara se mogućnost njihovog monitoringa, on line praćenja u cilju pravovremene zaštite zdravlja ljudi.

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STATUS AND TRENDS OF KEY AIR POLLUTANTS IN ZENICA VALLEY FOR THE PERIOD 2006 - 2017

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ABSTRACT

This paper presents results of measurements of sulfur dioxide (SO_2), total suspended particles (TSP), sediment dust (SD) and concentration of lead cadmium and zinc in total suspended particles and sediment dust. Sulfur dioxide was measured in three places, total suspended particles was measured in two places and sediment dust was measured in 13 places. On the basis of long-term measurements, the growing trend of air quality parameters in the Zenica city has been determined. Beside growing trend of stated air quality parameters, data clearly show that after 2012 there was an increase of concentrations of SO_2 and TSP in warm part of the year.

Keywords: air quality, sulfur dioxide, total suspended particles, sediment dust, trend

1. INTRODUCTION

In order to determine the air quality in the city of Zenica, Institute "Kemal Kapetanović" in Zenica performs continuous measurements of air pollution parameters. This paper shows the results for last eleven years. Bad air quality in this town is due to mining and metallurgic activities, great number of boilers, small house stoves and traffic. The worst situation is in winter because of the heating season and because of the formation of temperature inversion layers, which disrupts dispersion of pollutants in Zenica valley. How great is impact of inversion layer on air quality in deep valley, like this one, we can see through air quality records data from December 2007 when a period with temperature inversion lasted for about 7 days, and the daily average concentration of SO_2 reach the value of 900 μg/m3 [1].

2. MATERIALS AND METHODS

Sulfur dioxide was measured using the British standard number 1747 (24-hour samples). The measurement of the concentration of total suspended particles (24-hour samples) was performed according to guidelines VDI 2463, Blatt 4. Samples were collected in two locations using the sample device Lib Filter Gerat. Measurements of sediment dust (monthly samples) were performed according to Bergerhoff method. Samples were collected in 13 locations. Measurement locations are shown in Figure 1.). Among all measurement sites, "TETOVO", "INSTITUT" and "CRKVICE) are measurement sites characteristic for the Zenica valley. Measurement site "TETOVO" is located near the Steel Works about 350 m from basic oxygen furnace (BOF). The second location "INSTITUT" is measurement site located in urban part of the city. This measurement site was chosen because it is located north of the steel works and detects pollution that the north wind, which blows approximately 11.2% of the time, carries from the Steel Works to the city. Therefore, when it comes to pollution from the Steel Works, this measuring site is always considered as a representative for the city [2]. All three parameters were measured in these sites. The third measurement site "CRKVICE" is also an urban measurement site, located in east part of the city. Around of this measurement site there are numerous residential houses and a large boiler from the Cantonal hospital Zenica. In this measurement site, only SO_2 and SD were monitored.

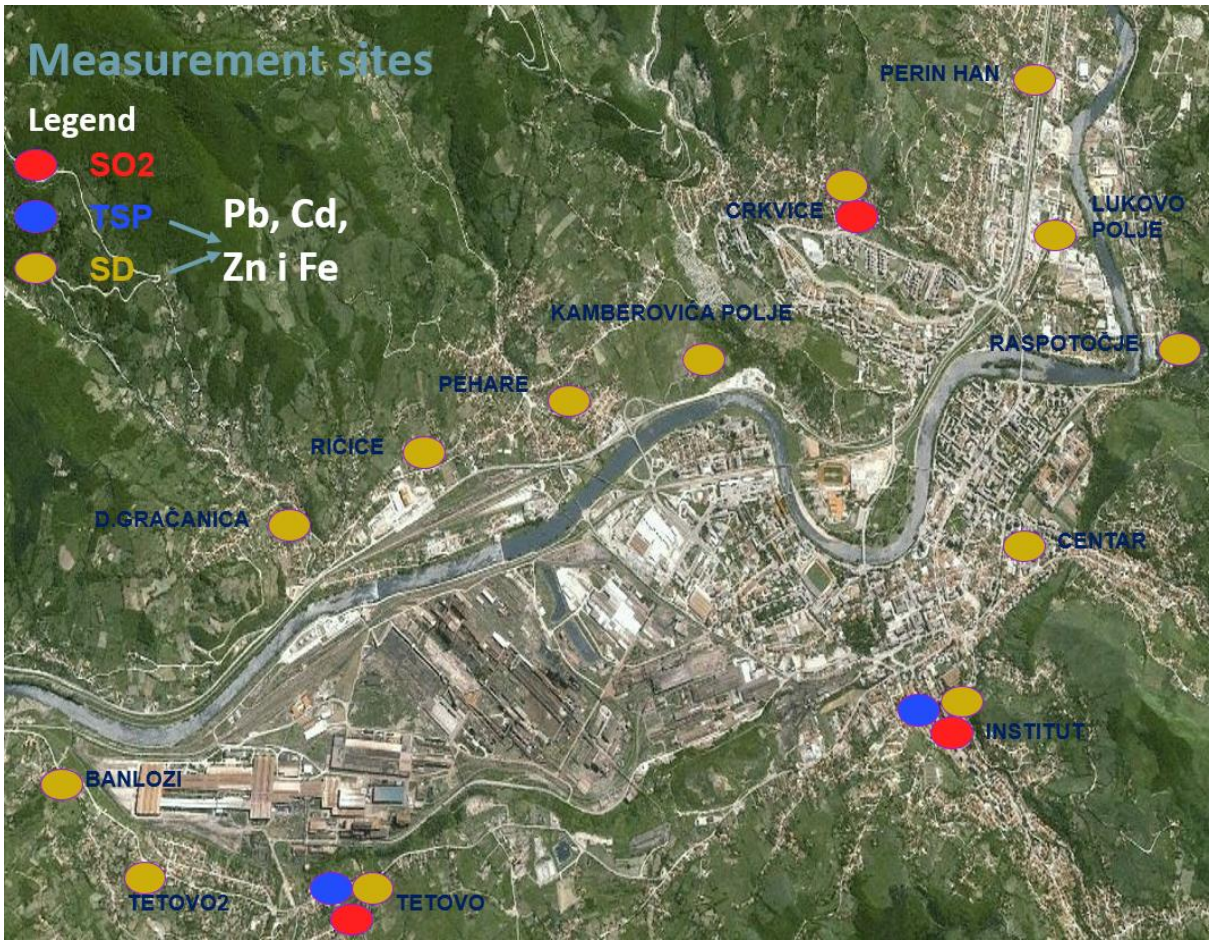


Figure 1. Measurement sites in Zenica city

All data concerning SO_2, TSPs, SD, and the content of toxic metals in the samples of total suspended particles and sediment dust are the outcome of measurements of the Institute "Kemal Kapetanović" in Zenica.

3.1 Meteorological conditions

Frequencies and average wind speed for particular direction observed on meteorological station Zenica for the period 2006-2016 are shown in Figure 2 [3]. As it can be seen from Figure 2 prevailing wind was south wind with average speed of 1,7 m/s. North wind which carries pollution from Steel

Works to the city had frequency of 8% with average wind speed of 2,1 m/s. The lowest air temperature is recorded in February 2012 with the daily average value of -13,5°C. The maximum rainfall was recorded in May and April of 2014 with total monthly amount of 204,5 l/m^2 in April and 184,8 l/m^2 in May.

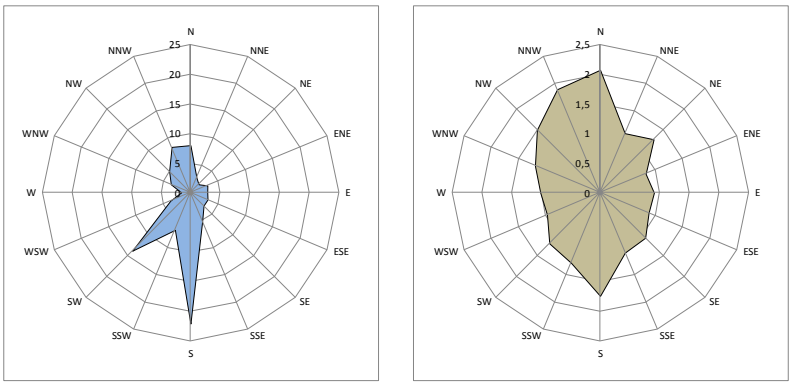


Figure 2. Frequencies (left) and average wind speed (right) for particular direction observed on meteorological station Zenica for the period 2006-2016[3]

3. RESULTS AND DISCUSSION

Annual averages of SO_2 and total suspended particles are shown in Figure 3.

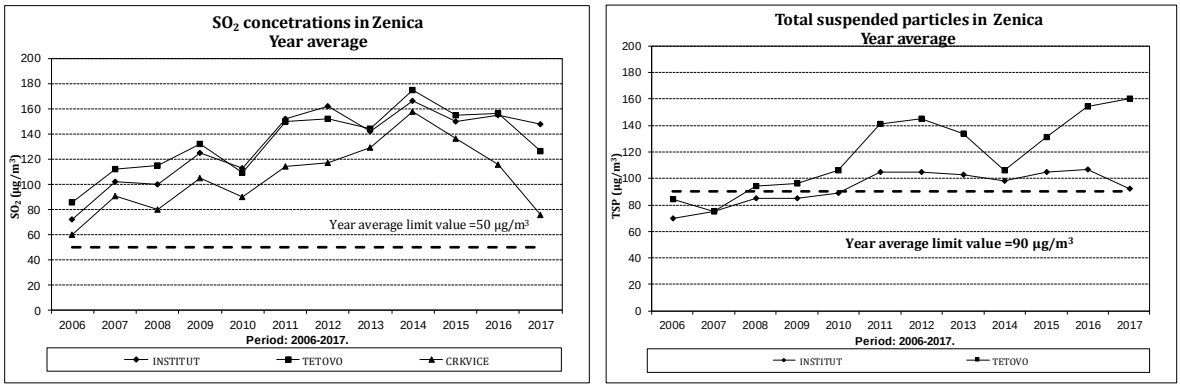
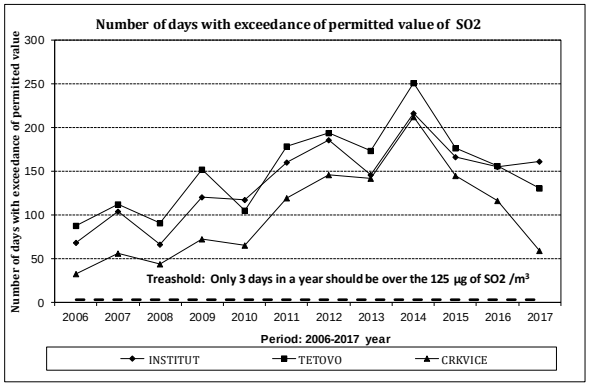


Figure 3. Annual averages of sulfur dioxide (left) and total suspended particles (right)

As it can be seen from the Figure 3, the concentrations of SO_2 in all three measurement places are over permitted value through entire examined period. The highest concentration of SO_2 in examined period was recorded in 2014 in measurement site "TETOVO" with year average concentration of 175 µg/m^3, which is more than 3 times higher than permitted value. After 2014 the trend of SO_2 concentration is declining. As it can be seen in the figure 3 trend of TSP concentrations in measurement site "TETOVO" does not follow trend of SO_2 concentrations. From the year 2014, trends of SO_2 and TSP concentrations are opposite. Since local community has no effective air quality management system (no pollutant release and transfer register, poor emission monitoring data, poor communication between operators and local community etc.) we can only speculate about reasons of this declining trend of SO_2, and opposite trends of SO_2 and TSP after 2014. Number of days with daily averages of SO_2 and TSP exceeding permitted daily average values is shown in Figure 4.



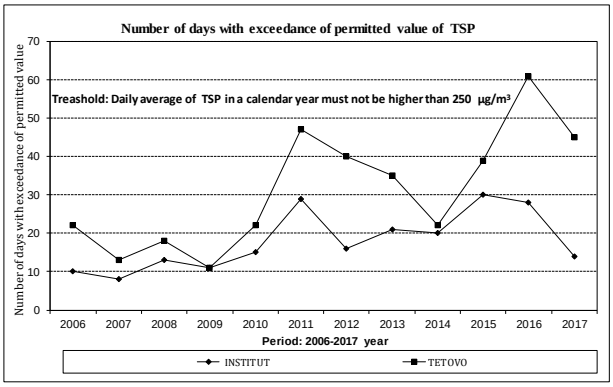
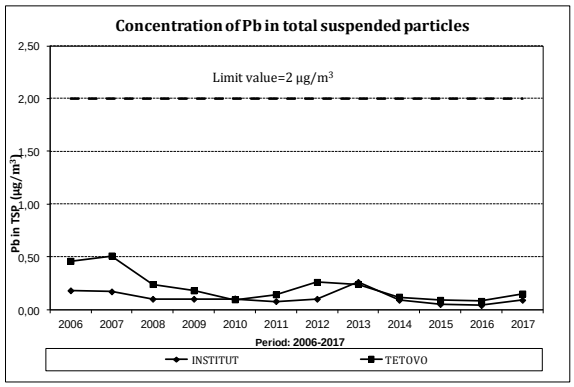
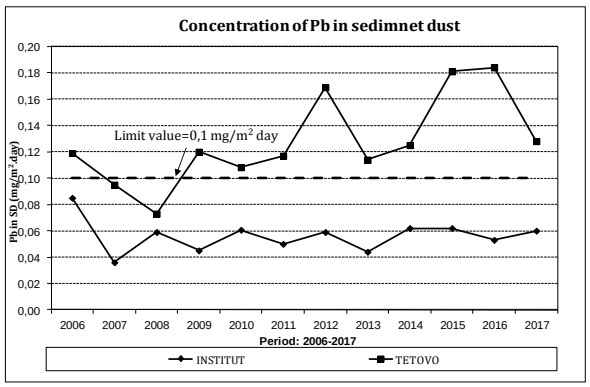


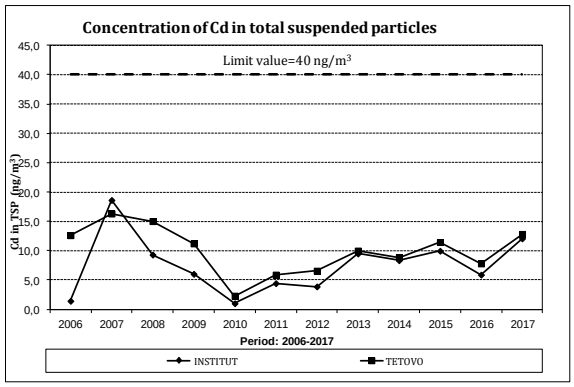
Figure 4. Number of days with exceedance of permitted value for daily average of sulfur dioxide (left) and total suspended particles (right)

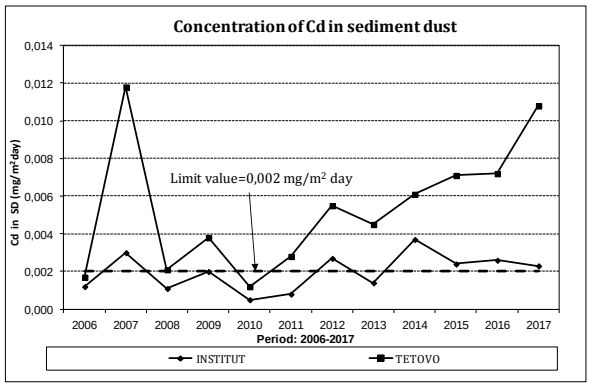
It is permitted that daily average concentration of SO_2 can be higher than 125 µg/m^3 only three days in a year, and that daily average concentration of TSP must not be higher than 250 µg/m^3[4].
From Figure 4 it can be seen that maximum number of days with exceedance of daily average values in measurement site "TETOVO", ant it is up to 60 times higher than permitted number of exceedance for SO_2. Maximum number of exceedance of permitted daily average value for TSP was recorded in 2016 with 61 days over 250 µg/m^3. Measurement records show that from 2012 there is substantial number of days with exceedance of permitted daily average values for SO_2 in the warm part of the year. Before 2012 there was no exceedance of permitted daily average value for SO_2. Mean value of SO_2 concentrations in warm part of the year were 2 to 3 times smaller before 2008 (e.g. in 2006 mean value of SO_2 in a warm part of the year was Mean±SD=52,23±20,77 and mean value of SO_2 in 2014 was Mean±SD=123,42±110,93) [5]. Furthermore, standard deviation of SO_2 concentrations in warm period of the 2006 was more than five times smaller than in 2014 which indicate existence of emission source that is not emitting continuously. Quarterly variations analysis of TSP showed increase of TSP during the cold part of the year.

Concentrations of lead, cadmium and iron in samples of TSP and SD are shown in Figure 4.









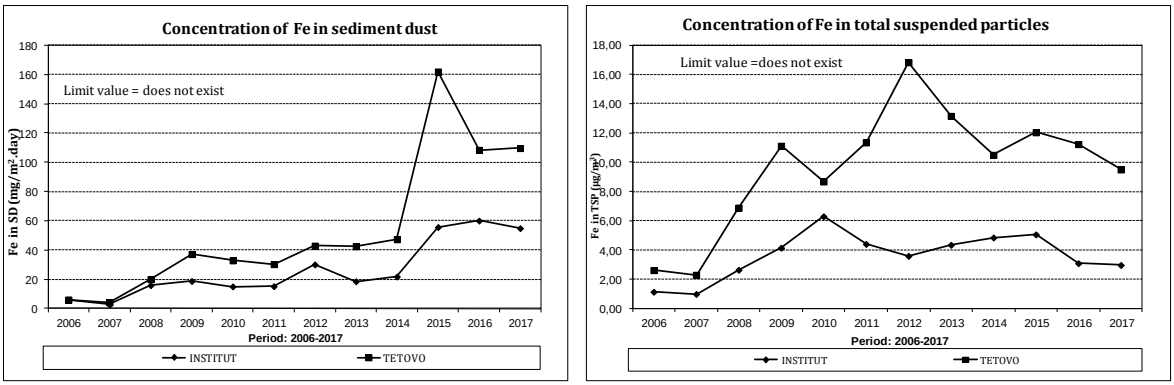


Figure 5. Annual averages of lead, cadmium and iron in total suspended particles (left) and sediment dust (right)

Concentrations of lead and cadmium in total suspended particles were below permitted value in both measurement sites through entire examined period. Concentration of lead and cadmium in sediment dust was over the permitted value in measurement site "TETOVO" through entire examined period. Maximum amount of cadmium is recorded in 2007 in the measurement site "INSTITUT" in TSP samples and in measurement site "TETOVO" in SD samples. It is speculated that this extra amount of cadmium could have come from two foundries located in the city and from electric arc furnace 100 tons located in Steel Works Zenica. Iron is not considered as pollutant, but iron has been monitored in Zenica for the past 30 years because of the presence of steel works. Increase of the concentration of iron in TSP and SD after 2008 has been recorded on all measurement sites, especially on measurement sites around Steel Works. Growing trend of concentrations of lead and cadmium in SD is obvious.

Content of sediment dust and number of exceedance of permitted value for sediment dust is shown in Figure 5. Growing trend of amount of SD and number of exceedance of permitted monthly value is obvious, and as shown in figure 5 the beginning of growth was in 2008 (when integral production in the steel work plant re-launched).

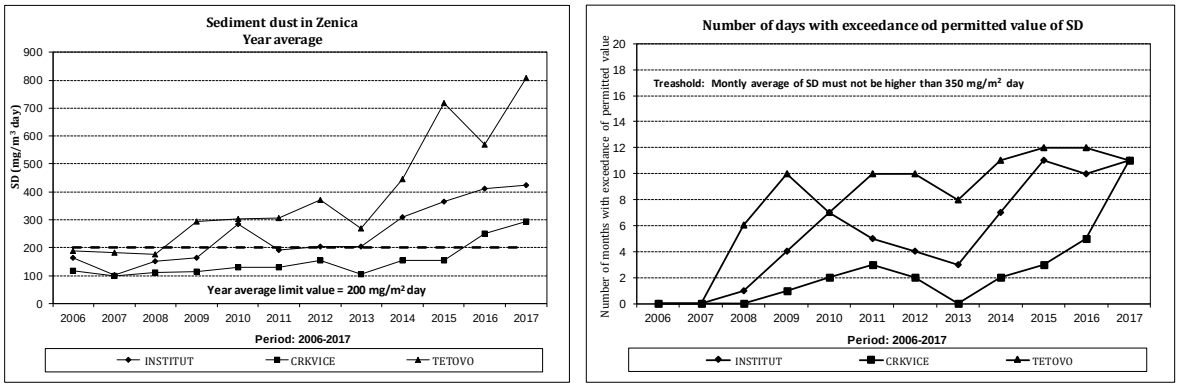


Figure 5. Annual averages of sediment dust (left) and number of months with exceedance of permitted monthly amount of sediment dust

Amount of sediment dust is highest at measurement site "TETOVO" which is normal concerning the position of the measurement site. The number of exceedance of permitted value for monthly amount of sediment dust is also highest at the measurement site "TETOVO". Season-specific patterns for SD are not very clear. Sometimes it is higher in the warm part of the year and sometimes is higher in cold part of the year. This random behavior of amount of SD could be connected with frequent still conditions in Zenica valley[6]. Variation analysis of SD and heavy metal concentrations was found to be inconclusive, and does not produce clear evidence on the association of heating season with amount of SD and heavy metal concentration in SD.

4. CONCLUSION

Annual averages of SO_2, total suspended particles and sediment dust was over permitted value through entire examined period. Growing trend of concentrations of all pollutants in all measurement sites is recorded in all measurement sites. Quarterly variations analysis of TSP and SD showed increase of TSP during the cold part of the year. On the other hand quarterly variation analysis of SD and heavy metal concentrations was found to be inconclusive, and does not produce clear evidence on the association of heating season with heavy metals and SD. Domestic legislated limit values for metals in TSP were not violated. On the other hand limit values for annual average of TSP, SD and heavy metals in SD were violated multiple times. Measurement data clearly indicate that air in Zenica valley contains enormous amounts of SO_2, TSP, SD and heavy metals in SD, which means that the capacity of Zenica valley to receive air pollution has been exhausted a long time ago. Authorities should consider whether to allow construction of any additional source of SO_2 and TSP in Zenica valley. Pollution source apportionment study should be made as soon as possible.

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ALIGNING STRATEGIES: S3 AND A POTENTIAL ORIENTING OF BIH'S ENVIRONMENTAL ISSUES

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ABSTRACT

The paper elaborates on the concept of smart specialization (S3), recently strongly promoted by the Joint Research Centre of the EU. Taking into consideration workshops held on this topic and the whole range of printed materials (handbooks and reports), the paper will, in its first part, present S3 services, the role of higher education, needs of organizational development, the EU's help provided to our region and the platform for industry.
After gaining an insight into drivers of change and focuses of smart specialization, the paper will examine the current status of environmental issues in BiH and their compliance with the mentioned specialization, with a main focus put on the question if they could present a basis for developing, in analogy with S3P on Agri-Food, a S3P on environmental issues.

Keywords: smart specialization, higher education, environmental issues.

1. INTRODUCTION

In order to support its economic development, Europe turned to a new concept of cooperation and learning and denoted it Smart Specialization or S3. This concept has been strongly supported in the recent period, i.e. from 2011 onwards, and many workshops and training were held for the purpose of awareness-rising. S3 as a new concept focuses on research and innovation strategies.

2. S3

As Practical Handbook (2017) explains the role of the S3 Platform is to provide information, methodologies, expertise, peer-reviews and advice to national and regional policy makers. Support includes technical assistance (e.g. linking regions), training, joint reports, analysis, study visits/mutual learning, modelling, use of interactive platforms, etc. Therefore, it can be also said this S3 platform

strengthens triple-helix (or quadruple), i.e. it provides support to the authorities so they could employ their HEIs on development of S3.
Therefore, higher education continues to have an important place within S3, as within triple helix model, and it is seen and understood as HE's part in the regional development. Also, the EU allocated funds for the HE's engagement. The most important asset of higher education institutions (HEIs) is highly skilled human capital. It is a driver of knowledge-based development. As was envisioned, HEIs contribute to S3 as places of teaching, researching and externally engaged in 'knowledge triangle'. Their close cooperation with regional authorities is strongly supported.
Participation of industry is inevitably important in the aspect of fostering industrial modernisation. This modernisation bases upon innovations, produced in cooperation of the regions and their HEIs.
S3 states these as drivers of change: deindustrialization, innovation system inefficiency, entrepreneurial discoveries, new paradigm creation and transnational inter-regional co-specialisation.
Focuses of S3 are placed on areas: 1. Smart Specialisation, 2. Research and Innovation, 3. Energy and Transport, 4. Environment, 5. Multi-territorial dimension and 6. Crisis management and resilience.
In order to achieve S3 goals, i.e. to enable trans-regional and transnational learning, many tools were introduced. The Practical Handbook (2017) as tools states peer reviews, which should serve not only for knowledge transfer and learning, but discovering good practices of various regions for issues they were, or are, facing.
Use of peer reviews, and this whole approach, was designed out of a current development: many EU regions transitioning from "traditional to knowledge-intensive domains and from top-down policy-making to more participatory approaches" (Handbook, 2017). There are nine lagging regions in eight EU Member States. This platform is designed for them. It tries to help them understand the overall conditions they are facing and, also, to help them overcome them by transferring practical experiences of other regions. In case of developed countries, this platform most often serves to address the innovation gap. It fosters synergies and complementarities between diverse funding sources, with the objective to accelerate the development of joint investment projects supported by possible synergies between European Regional Development Fund (ERDF), the EU program for the Competitiveness of Enterprises and Small and Medium-sized Enterprises (COSME), Horizon 2020 and other funding sources (Handbook, 2017).
Given the all above mentioned relates to the EU Member States, it is important to find the policy for the non-EU states. This was discussed in the Trieste Summit, where Western Balkan countries agreed on making and implementing smart specialization strategies. Bosnia and Herzegovina is included in two EU strategies: The EU Strategy for the Danube Region (EUDR) and the EU Strategy for the Adriatic and Ionian Region (EUSAIR). The first one deals with S3 and identifies it as important for creating a knowledge society.

3. S3P AGRI-FOOD

S3P Agri-Food is meant for joint investment projects in the field of agriculture and food at EU level. It supports interregional cooperation in thematic areas based on smart specialisation priorities defined by regional and national governments. Through this thematic platform, EU regions and member states are able to implement more efficiently their smart specialisation strategies, and regional stakeholders benefit from the new cooperation opportunities with partners from other regions (Handbook, 2017).

4. A S3P FOR ENVIRONMENT?

Given the shortcomings of the Energy Strategy of BiH, which were analysed and presented in 2017 by the Green Council, serving as a civil society stakeholder, on the one side, and having the example of S3P Agri-Food, on the other, and in addition, the EU Strategy for the Danube Regions, where also belongs Bosnia and Herzegovina, a proposal on potential S3P Environment emerges, aiming to encompass the environmental possibilities (i.e. significant potential of renewable energy sources, green jobs, green public procurement, NZEB, overall regional cooperation, biomass potential etc.) in this region. Regarding open issues, as the mentioned Green Council's Analysis pointed out, there is:

- a need for developing new models of collective and individual electricity production and new models of funding through energy co-operatives and public-private partnerships. In order to exploit the significant potential of renewable energy sources (RESs), it is necessary to harmonize the existing solutions in BiH regarding support to developing RES with current EU solutions, which have yielded good results (e.g. introducing feed-premium tariffs instead of feed-in tariffs; also, mechanisms for funding projects on the basis of public tenders without preferring RES technology).
- a need for environmental protection through EE, green jobs, green public procurement, the latest EU demand for the so-called "nearly zero-energy buildings" (NZEB), education that brings developments of new technologies, etc.
- a need for regional networking. Energy strategies should not be seen as isolated islands without influencing regional events and vice versa. In the same way, BiH cannot create a strategy without taking into account the development trends in neighbouring countries.
- a need for regional cooperation between the Energy Community and the neighbourhood will help Bosnia and Herzegovina meet energy and climate objectives in an efficient and cost-effective way.
- a potential of biomass (existing forest waste, biomass from urban garbage, organic industry, agriculture, strategic re-cultivation of wild forests, as well as plantation production) should be further explored.
- an initiative for planning afforestation in BiH (Green Council, Politike okoliša koje nose ekonomski razvoj BiH, 2017).

Here are singled out only a few potential open issues. All the mentioned could be addressed by identifying and nominating Environment (including above aspects) for Smart Specialization Platform (as a thematic area for interregional cooperation). In this way, technical assistance, provided for S3P, would be available. This assistance for current S3Ps:

- Supports development and enhancement of European eco-systems for interregional collaboration based on areas of smart specialisation
- Facilitates the exchange of experience, mutual learning and cooperation to achieve better matching of business entities with research, as well as innovation actors with their business counterparts
- Prepares guidance material on the role of regional authorities in co-creating and developing European value chains in key smart specialisation niches. The S3P Platform provides methodological support, expertise, advice and networking opportunities through workshops and seminars. In addition, partnerships are provided with support in identifying strong and missing competences among the participating regions, by combining existing EU analytical tools.

5. CONCLUDING REMARKS

Smart Specialization Platform is meant for trans-regional cooperation and aims to help regions, primarily those in the EU Member States, to overcome current, open issues they are dealing with. This help consists of transferring examples of successful practices from other regions. There are funds allocated for this assistance. Our country could also try to overcome its open issues by nominating the relevant areas, in which it faces challenges, for its Smart Specialization. Although, it is not an EU member state, it is encompassed by the EU Strategy for Danube Region, which also supports S3P, and could serve for this purpose. For example, issues of energy and environment are common for neighboring regions; the need for the EU support has been already stated in some analyses; further, these issues affect economic growth and bring to the overall prosperity; and, inevitably connect all stakeholders: regional authorities, industry and higher education. Therefore, it might be a solution for obstacles, which are persistent in the mentioned areas of energy and environment, and cannot be resolved at the national level, to incorporate them into a trans-regional and transnational frame, and to resolve them at that, higher level.

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CARBON FOOTPRINT OF HOUSEHOLD – ANALYSIS OF AVAILABLE CALCULATORS AND COMPARATIVE ANALYSIS OF TWO MODELS OF HOUSEHOLD

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ABSTRACT
This paper deals with the carbon footprint of products, as a way of measuring and managing greenhouse gases related to products and services. The carbon footprint is based on a life cycle assessment, but focuses on one thing, which is climate change. Lately, there is a strong emphasis on tools and studies associated with determining the carbon footprint of households, given that consumer activities generate a significant part of global greenhouse gas emissions. One of the most famous tool for calculating the carbon footprint of the household is the so-called. carbon print calculator. As there is a wide range of variations in the utility, capacity, and comprehensibility of these calculators, this paper provides an overview and analysis of the most widely available online carbon footprint calculators and their comparison. After the analysis, one calculator was selected, most suitable for the territory of BiH, and on the basis of it, the total carbon footprint of the two models of households was determined, one with above average earnings and consumption, and the other with modest income in order to analyze and confirm the results of several research of the carbon footprint of households in the world.
Keywords: carbon footprint, household, greenhouse gases, carbon calculators, LCA.

1. INTRODUCTION
In response to climate change as a result of anthropogenic activities, numerous international, regional and local national initiatives are emerging to reduce greenhouse gas emissions. Applying voluntary environmental management tools contributes to raising awareness among citizens, as customers of products and services, with the aim of reducing environmental pollution. The method developed on the basis of contemporary approaches, which primarily encompasses the entire product life cycle, is the carbon footprint of the product, a part of the "fingerprint" family that consists of a water mark and a fingerprint.
The carbon footprint is based on a lifecycle assessment, but focuses on one thing, which is climate change. An increasing number of companies quantify the carbon footprint of the product, increasing market reputation, cooperating with customers and other interested parties, and making the first step towards better environmental printing. It is clear that a large reduction of greenhouse gas emissions can not only happen to changes in the technical sector, and that changes in consumer behavior and lifestyle play a big role here. Each of us, me, writing this paper or you reading it contributes to our carbon footprint. Any decision about how we will go to work, which product we choose in the store, will we turn off the light after leaving the room, whether we will shut down the computer when we do not use it, what kind of food to eat everyday, and a host of other decisions affect our carbon footprint.
Recently, great emphasis has been placed on tools and studies associated with determining the carbon footprint of households, given that consumer activities generate a significant part of global

greenhouse gas emissions. [1] One of the most popular household carbon footprint tool is so-called carbon calculator. There are plenty of this calculators, only if the word is in English typed in the search on the internet.[2] As there is a wide range of variations in the usefulness, capacity and comprehensibility of these calculators, this paper gives an overview and analysis of the most widely available online carbon footprint calculators and their comparison. After the analysis, one calculator was chosen, most suitable for the BiH area, and based on it, the total carbon footprint of two household models, one with above average income and consumption, and the other with modest income was calculated in order to analyze and confirm the results of several carbon survey of households in the world.

2. TERM "CARBON FOOTPRINT" AND METHODOLOGY OF ISO 14067

The term carbon footprint is often termed as "the total amount of greenhouse gas emissions caused by an individual, event, organization or product, expressed as CO2e". [4] The total carbon footprint can not be calculated due to the large amount of data needed and the fact that carbon dioxide can also produce natural phenomena. For this reason, Wright, Kemp and Williams proposed a more practical definition in the Carbon Management magazine: "Carbon imprint is the measure of the total amount of carbon dioxide and methane produced by a defined population, system or activity, taking into account all relevant sources, outputs and supplies within the spatial and temporal boundaries of the population, system or activity of interest, calculated as CO2 equivalents, using the relevant 100-year global warming potential (GWP100). "[5]

The carbon footprint is used to establish the link between climate change and production and consumption of certain products and services. This analysis seeks to quantify all direct and indirect (included) greenhouse gas emissions caused by final demand / demand. This requires the inclusion of all the emissions that have taken place anywhere in the world to enable the production of end-use goods and services. The time limit for carbon-based analysis depends on the subject of the analysis: the product is a lifetime, while for other estimates, the time frame is usually a year, as this is a standard framework for national and corporative conclusion of financial analyzes. [1]

The carbon footprint methodology is based on international standard ISO 14 067, which specifies the principles, conditions and guidelines for quantification and communication of carbon product labels. The term product by this standard implies any good or service.

CFP (Carbon Footprint of Product) study, according to ISO 14 067 consists of five stages:

- Definition of goal of CFP study,
- Definition of scope of CFP study,
- Calculation of carbon footprint of product,
- Interpretation of CFP study results. [6]

The carbon footprint calculation is used to calculate the product's impact on climate change through the production of greenhouse gas gases in all significant phases of the product life-cycle of the analyzed product. Steps in the budget of the CFP study are:

- classification of CFP flows;
- characterization of CFP flows;
- normalisation of CFP results and
- weighting of results of CFP. [6]

CFP marks present information about the results of the CFP study, identifies products with CFP that meet certain criteria of the quantification program CFP. The most important labels in this area are shown in Figure 1.

Figure 1. The most used marks as a part of CFP

3. CARBON FOOTPRINT OF HOUSEHOLDS

Determining the carbon footprint of households is the most complex carbon footprint determination. "Lifestyle" is defined as a "consumer pattern of a group of people or households with a well-defined set of socio-demographic characteristics" when analyzing the carbon footprint. [8] Consumption of various socio-economic groups around the world causes various greenhouse gas emissions. [9] That is why determining the carbon footprint of households is a big challenge.

Most greenhouse gas emissions from households come from indirect sources, eg. fuels burned to make the raw material, far from the end consumer. [8] These sources differ from direct sources, which come from fuel combustion in a car or an individual's furnace. For activities related to products such as food, cars, electronic devices, carbon footprint includes greenhouse gas emissions from raw materials, production, distribution, use of the product and its disposal / recycling. For services such as banking, health care, hairdressing salons, etc., carbon footprint includes emissions associated with the construction and maintenance of the infrastructure necessary for providing such consumer services (eg business premises, communication systems, furniture, paper and other equipment). [10]

The average carbon footprint per capita, when it comes to households, varies from just over 1 ton per year to several African countries and Bangladesh, up to 28 per person per year for the United States and 33 per person per year for Luxembourg. [11]

Research [11] has shown that carbon footprint strongly correlates with cost per capita (Figure 2). As nations become richer, the CF increases by 57% for each spending cycle. Though it is possible for households with higher income to buy energy-efficient appliances and live in better isolated homes, large houses, cars, fridges, etc. "raise" their carbon footprint.

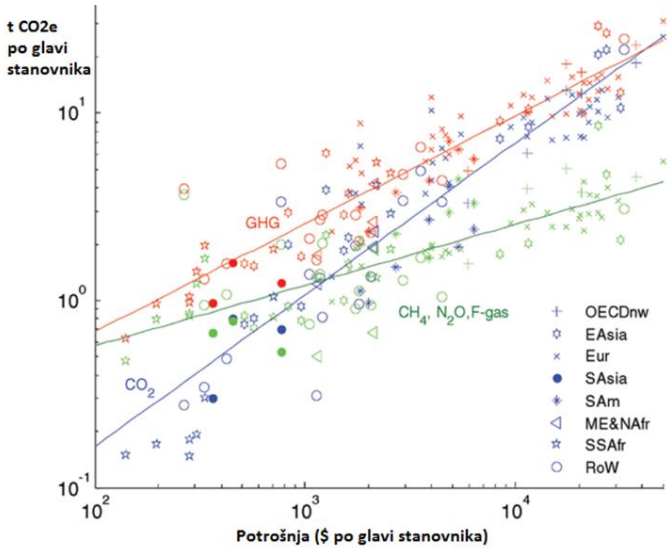

Figure 2. Connection of consumption with GHG emission from households

4. ANALYSIS OF AVAILABLE CALCULATORS OF CARBON FOOTPRINT

There is a growing interest in developing tools and methods for calculating the carbon footprint of an individual or household. [2] One of the most widely used tools is a carbon footprint calculator, wich there is dozens developed by different institutions and organizations. These calculators are based on individual / household consumer activities and serve to raise awareness of linkage between personal consumption and global climate change. [8] It is true that carbon footprint calculators take into account a limited amount of the total carbon footprint of the household, most often the direct emission. To determine the exact carbon footprints of each household, each household should be analyzed individually, so carbon footprint calculators, though not completely accurate, are certainly a good tool to raise awareness of the individual's emissions of greenhouse gases by generating their own consumption and consumption of their household.

This paper analyzes the 10 most popular online carbon calculators and is presented in Table 1, where "x" is a feature labeled by the calculator.

Table 1. Display and analysis of available online calculators of carbon footprint

Calculator (institution, web location)	Is it specialised?	Type of dwelling	Electric energy	Green energy inculded	Heating of home	Car	Public transport	Plane transport	Waste	Food	Services	Solutions for lowering of CF are included	It is possible to compare results with average	Additional comment
http://www.carbonindependent.org/ [12]		x	x	x	x	x	x	x	x	x	x		x	The only calculator for regular data refresh.
US EPA [13]	USA		x		x	x			x			x	x	Clear review and budget how much CF reduces by applying some measure.
http://www.carbonfootprint.com/ [14]			x		x	x	x	x		x	x		x	Detailed analysis including year of vehicle, model, motorcycles, taxi, detailed services are processed
University of Berkeley [15]	USA	x	x		x	x	x	x		x	x		x	Includes water consumption, the only calculator, possible to elaborate in detail the savings plan.
The Nature Conservancy [16]	USA	x		x		x		x		x			x	It does not contain key elements, too little information.
Global Footprint Network [17]	Neke zemlje	x		x		x	x	x		x	x	x	x	Uključeno i pitanje koliko se domaće hrane konzumira, ukucava se cijena a ne kWh el. energije, slikovito dat rezultat.
co2.myclimate.org [18]			x	x	x	x		x		x	x			The only one has a budget for maritime traffic.
C2ES- Center for Climate and Energy Solutions [19]	USA	x			x	x	x	x						The only question is whether the home is air-conditioned.
UN-Climate Neutral Now [20]			x		x	x	x		x					
http://www.conservation.org/ [21]		x	x			x		x		x				

Some of these calculators have more detailed analysis and more specific questions, as can be inferred from Table 1, while some have multiple forms of short quiz that can give some guidance or influence the awareness of citizens who are not addressed in environmental issues. It should be noted that during the analysis of the above mentioned weights, it should be borne in mind that some of the calculators have questions about a segment, but may not be as expert as others. More detailed calculators require much more information and are more difficult to fill, while they have less data processing to make the results as close as possible to the real carbon footprint, so the challenge in making calculators of this kind is to balance between the amount of data and filling potency.

From the analysis conducted in this paper, the best and most desirable calculator for the carbon footprint of the household is the Carbon Independent calculator, which regularly updates its data, but there are also many questions that are subjective and involve more opinion of the person who fills the

calculator than they are specific data, and the Carbon Footprint Officer's calculator, which gives the most objective results because it uses accurate data. The US EPA calculator is best placed to set up a specific carbon reduction plan for the household and raise awareness of how much it can actually save money with a lifestyle in accordance with ecological principles.
The Carbon Footprint Officer's Web Site Calculator was selected for a comparative analysis of two models of households in this paper. The only one in which Bosnia and Herzegovina can choose for homeland and, as it has already been said, uses accurate numerical data, not subjective opinion of the user. It is possible to choose the exact model of the car, the year of the car, the exact takeoff and landing aerodrome, all types of public transport, and take into account all segments of the service sector as well as the quality of electronic equipment. It does not include waste, whose recycling would potentially reduce the carbon footprint of households, or so-called. green energy, but since neither one is so much represented in Bosnia and Herzegovina, this analysis is not a problem. The problem of unhealthy nutrition analysis remains, but it only determines the carbon footprint of spending money in that sector.

6. ANALYSIS OF CARBON FOOTPRINT OF TWO MODELS OF HOUSEHOULD ACCORDING TO CALCULATOR CARBON FOOTPRINT

The model of two households in Bosnia and Herzegovina for the carbon footprint analysis according to the carbon footprint calculator was made based on research on life-style segments that most influence carbon footprint and on the basis of statistical data on average consumption in BiH. A model of two households has been created, one with high salaries that travels a lot and consumes a lot in the service sector, and one below the average, which is also more environmentally conscious. The model features are given in a sequence that calculates the Carbon Footprint Officer's page and offers questions. For both models, the period of 1.1 is set. until 31.12.2015. year, and the homeland of Bosnia and Herzegovina.
Household Model A is a family of four families heated using electricity, the average household consumption is 960 kWh, which, according to the mentioned calculator, generates 0.69 metric tons of CO2e per year. Family A traveled three times by airplane on holiday in Antalya, Turkey, winter in Switzerland, landing at the airport in Zurich, and a family visit to Aarhus, Denmark. These 3 trips generated 0.19, 0.13, and 0, 22 metric tones of CO2e respectively, giving a total of 0, 53 t CO2e in total. The family car A, whose one member is often used by this car, has moved 20,000 km in 2015. The vehicle was the BMW X5 E70 X5 3. 0d series made in 2007 and participates with the mentioned mileage in a carbon print of 5.031 t CO2e. Family A does not own a motorcycle or is used by public transport. The average consumer basket in BiH is 200 euros (€) [22], while family A provides 350 € monthly, 150 medicines, 200 € clothing and footwear, 50 € prints and books. In 2015, Family A bought a new computer of 400 €, a television and cell phone for a total price of € 1000, furniture in the amount of € 10,000, spending € 2,000 on hotels and restaurants, and € 2,500 for private schooling of one household member . Monthly account for household telephone A is 100 €, for insurance 30 €, and for recreation and sports it costs 50 €. All this from the service sector generates a total of 15.90 t CO2e. The life of A family in 2015, according to the selected calculator, has a carbon footprint of 22, 43 t CO2e, which is far greater than the average in BiH (4 t) and the world target (2 t), which is illustrated in Figure 6, which is given by the calculator by going to the "results" option.

Figure 3. Display of results of calculator for household A

Household Model B is a four-member household which heats on coal, 5 t for the heating season, 0.83 tons per month, and consumes an average of 200 kWh of electricity per month, which generates 0.83 and 0.14 t CO2e, respectively. Family B did not travel by plane, and the car of the Golf 3 1.9 TD has exceeded 1500 km, which participates in the total carbon footprint with 0.35 t CO2e. Household B does not have a motorcycle and in the total sum of greenhouse gas emissions by public transport (busem) in the amount of 2000km contributes with 0.20 t CO2e. Family B provides 200 € per month, medicines 50, clothes and footwear 20 €, printing and books 10 €. In 2015, family B spent 100 € on electronic equipment, 20 € for car maintenance, 50 € for restaurants, and 30 € for education. Monthly account for household telephone B is 20 €, war loan 80 €, and on recreation and sports costs 5 €. All this from the service sector generates a total of 3.34 t CO2e. The life of the B family in 2015, according to the selected calculator, has a carbon footprint of 6.04 t CO2e, which is higher than the average in BiH and the world target (2t) - shown in Figure 4.

Figure 4. Display of results of calculator for household B

7. CONCLUSION

As the first conclusion of the analysis, the impression is that the CFP method has been significantly developed and regulated. This was certainly contributed by the fact that this method largely relies on the method of assessing the life cycle, as well as the type III environmental protection label.

Two calculators have been labeled as the best and most expensive Carbon Independent calculator and the Carbon Footprint Officer's calculator, which gives the most objective results because it uses accurate data. The US EPA calculator is best placed to set up a specific carbon reduction plan for the household and raise awareness of how much it can actually save money with a lifestyle in accordance with ecological principles.

The Carbon Footprint calculator has been selected for a comparative analysis of two models of households. This calculator determines the total carbon footprints of two household models, one with above-average income and consumption, and the other with modest income of 22.43 t CO2e and 6.03 t CO2e. Indirect emissions from the household sector's A service sector are most affected by the high carbon footprint, in addition to the large use of cars. Domestic fuel heating B most influences the carbon footprints of this home, as well as a car that, though far fewer kilometers, has a much lower efficiency and poor exhaust system. These results confirm the results obtained in household surveys showing a direct link between consumption and greenhouse gas emissions.

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APPLICATION OF GEODETIC TECHNOLOGIES IN WATER MANAGEMENT

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ABSTRACT
The rapid advancement of the technologies used in geodesy and geomatics has opened up many possibilities in various scientific spheres. Modern technologies of data collection and the obvious development of geoinformation technologies provide a wide range of information. This indicates that the moment of transition from conventional methods to introducing new technologies for making digital topographic maps has come. This paper deals with the purpose of these modern technologies in water management, that can be used for managing and making decisions related to natural disasters such as floods, where collected data before flooding and the future estimated water levels are used for prediction of the flood zone and areas that should be evacuated. In that way, many damages are prevented on time. While previously manual maps were drawn and used, nowadays everything is digitized, and with very simple tools many calculations can be made and different polygons of interest can be created in a very short period of time - sufficient to react in some situations. In this paper, examples of water management are highlighted, with an emphasis on floods by using different software and hardware technologies. Point cloud (based on data obtained by mobile or terrestrial laser scanning, LiDAR (Light Detection and Ranging) technologies or aerophotogrammetry) and radar remote sensing techniques (SAR) are used for acquiring terrain information and modeling it. By using collected data and the possibilities of geoinformation systems, water and flood state can be modeled and predicted in order to define possibly endangered areas around flood and take reactions on time in order to save lives and cut losses.
Keywords: LIDAR, InSAR, GIS, water management

1. INTRODUCTION
Geoinformation technologies are a new group of tools, methods, instruments and systems developed in recent decade to improve acquisition, processing, use and display of the terrain data. Examples of such tools are GPS (Global Positioning System) receivers, GIS (Geographical Information System) tools, algorithms for spatial data modelling, remote sensing techniques, geostatistical tools etc. Those technologies have been widely applied in all scientific fields and practical activities [1]. In this paper, GIS tools are used to vizualize certain data and manipulate with them. Through the paper, examples of water management are given, with an emphasis on floods, where collected data before flooding are

used for prediction of the flood zone and areas that should be evacuated. Those data refering to water areas are obtained by using modern surveying technoliges - LiDAR and Radar, described below.

2. LIDAR

Light Detection and Ranging (LIDAR) is an accepted method for generating precise and directly georeferenced spatial data about the characteristics of the Earth's surface. This method enables data that are more accurate, precise and dense. What makes LIDAR particularly attractive is the high spatial and temporal data resolution, as well as the ability to observe the atmosphere and cover the altitude from the ground to more than 100 km. LIDAR instruments collect land surface data at frequency of about 150 kHz. The resulting product is a dense network of georeferenced points, called the point cloud [2]. Also, by surveying with UAV technologies (Unmanned Aerial Vehicles), the product is the same-point cloud. The LIDAR method can be classified as active data collection method, since it does not use solar light, but the LIDAR system itself is the source of the laser light pulse. This feature allows data to be collected at night, when air is cleaner and less polluted by traffic than during the day. One of the main advantages of the LIDAR system is the ability to register multiple reflections of the emitted laser beams [3].

The basic working principle of LIDAR (as shown on Figure 1) is based on determining the distance from the sensor to the object in space by means of laser light. The technology is based on the collection of three different sets of data. Position of sensor is determined using a GPS phase measurements in a regime of relative kinematics, while the use of an inertial measurement unit (IMU) provides known orientation. The last component is a laser scanner. Laser sends an infrared beam to the ground and it is reflected back to the sensor. After the field work operation, the data are processed, after which the polar coordinates for each point on the surface from which the laser beam had reflected are obtained. It is essential to focus the laser beam in a certain direction, which is done in most LIDAR systems by using a mirror that oscillates or rotates. This system is the most flexible in terms of layout and density of points on the ground. This results in a range of laser pulses, which scans the surface of the field by one line. The mirror oscillates perpendicularly to the direction of flight, and as a result of movement of the aircraft, scan lines that are not perpendicular to the direction of flight, but a little slanting, are obtained [4].

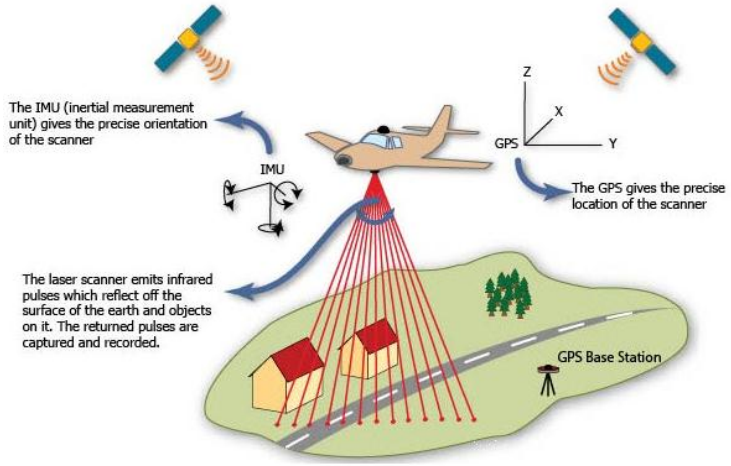

Figure 1: Basic principle of LiDAR system [URL 1]

3. RADAR

Radar is a device that collects information about the terrain surface by using photographs that contain information on the intensity of reflection of the emitted microwaves from the terrain surface. The great advantage of these sensing systems in comparison with some other modern surveying technologies is their ability to break clouds and fog and the ability to take photographs under any weather conditions, during day or night [5].

Currently, the following radar data collection technologies are the mostly present [6]:

- SAR (Synthetic Aperture Radar) - radar with synthetic aperture;

- InSAR (Interferometric Synthetic Aperture Radar) - SAR interferometry, i.e. interferometric radar with synthetic aperture;
- PS-InSAR - an advanced version of conventional InSAR technology that addresses the problems of weather and geometric decoration.

When scanning with a radar system, the platform moves in the direction of the azimuth, or the direction along the surface that is being scanned (*Figure 2*). The radar sensor implemented on the platform illuminates the Earth's surface laterally in relation to the direction of the platform movement. The swath width defines the width of the radar scene on the terrain surface, while the length of the scan line is defined by the time of data collection, i.e. whether the radar is on or off. While the sensor moves along its assumed straight path at altitude H above the reference plane, it emits microwave pulses through the antenna towards the Earth's surface with the pulse repetition frequency. Microwaves are reflected from the Earth's surface and they travel back to the radar sensor in the form of a series of echoes corresponding to pulses. In order to process, ehoes are arranged in the form of a 2D matrix with two coordinates. One dimension refers to the azimuth (direction of the trajectory of the sensor) and the other to the distance (the direction perpendicular to the sensor trajectory) [7].

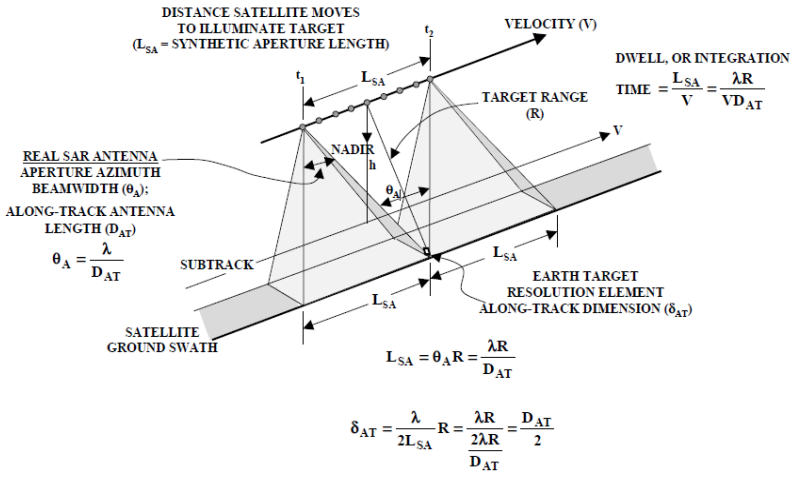

Figure 2. Basic principle of radar synthesis [8]

4. APPLICATIONS OF LIDAR AND RADAR TECHOLOGIES IN WATER MANAGEMENT

Modern geodetic technologies of data collection, such as LiDAR and RADAR, and the obvious development of GIS provide wide utilization in very different areas, as it is already mentioned. In this chapter, the use of above mentioned systems in water management is presented.

4.1. Water management using LIDAR technologies

LiDAR systems enable high resolution data with the ability to quickly and accurately detect flooded areas. In central Japan in September 2015, on the river *Kinu*, a catastrophic ice crack was formed. That crack, its spreading and accompanying modifications are documented using multi-temporal digital surface models (DSM). DSM were created based on LIDAR data pre-flood (resolution 2 m) and post-flood (resolution 1 m) from January 2007 to September 2015. The photogrammetric data of the moving structure – SFM of the 3.8 cm resolution are derived from the UAV (Unmanned Aerial Vehicles) surveyings in December 2015. After the elimination of systemic errors, the differential DSM was created by subtracting the previous surface models, where topographic changes are detected with 0.1 m accuracy. The changes included the vegetation growth, the disappearance of flood waters, restoration and reconstruction works derived from the people. The results (*Figure 3*) have shown that DSMs of different resolutions created using the combination of UAV-SFM and LIDAR data can be used for quick and detailed topographic changes classification due to floods [3].

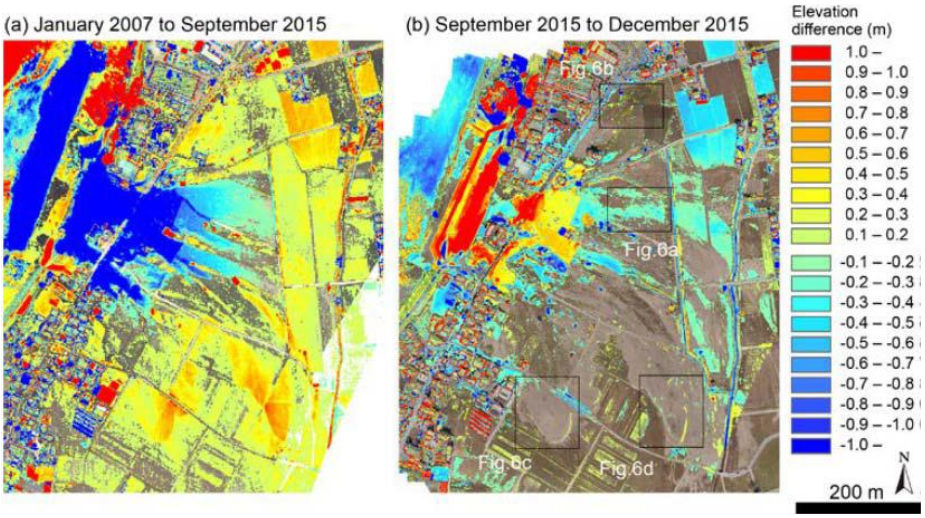

Figure 3: Differential raster showing the difference in height of two successive data sets [3]

According to paper [1], the predicted water levels and floods can be displayed via dynamic web pages, and overlaid with maps of the transportation network, property boundaries, municipal infrastructure and water depth contour lines. The combination of technology and software can provide good flood prediction precision and strong support to the public evacuation if flood events happen. The basic inputs for automated floodplain delineation are the DTM and the water levels at the cross sections obtained from the water gauges. The floodplain depth data sets are generated by computing the elevation difference between the water surface TIN and the ground surface DTM data. Based on flood depth data, the floodplain extent and flood depth contour maps can be generated. The Web-GIS interface is designed to calculate and display the spatial extent of predicted flood plain (see *Figure 4*), enabling the visualization of the transportation network, property boundaries, municipal infrastructure, flood polygons and water depth contour.

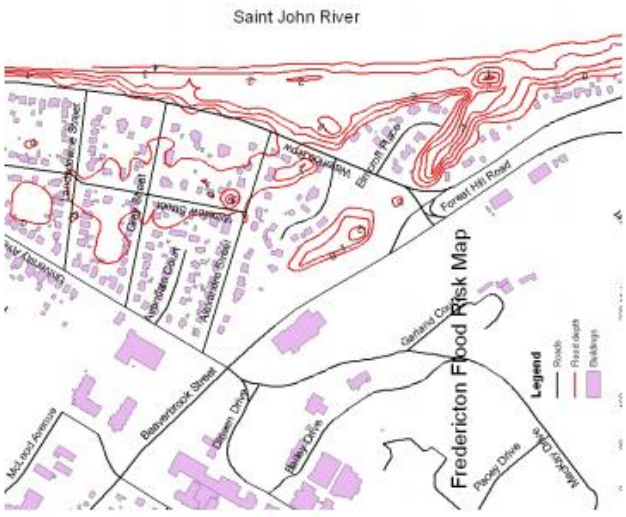

Figure 4: Flood risk map [1]

4.2. Water management using RADAR technologies

In paper [9], the high-resolution, X-band, stripmap COSMO/SkyMed data for the monitoring of a flood events occurred in the Bradano river are used. The Bradano is located in the Basilicata region, Southern Italy, and it inundated a large part of the relative floodplains, for which some limited information were available from inspections and interviews with local inhabitant. The multi-temporal data set was available, allowing interferometric processing. It is shown how the use of the interferometric phase information can actually help to detect precisely the areas affected by the flood, using e.g. RGB composites of various information layers derived from the data. SAR images were

available over the area, with a ground pixel size of approximately 3×3 m², acquired in the same geometry, polarization (VV), and incidence angle (38°), so that InSAR processing could be performed. The acquisition dates are 2, 3, and 10 October, 3, 4, and 11 November, 2010. Data were co-registered to a single master scene, then interferometric processing was performed. SAR intensity images were calibrated and converted to logarithmic scale. Final products were geocoded to a common reference frame. As an example, in *Figure 5*, the series of RGB composites derived from various arrangements of the information layers available for this study are shown. The image indicated as "1" has the two intensity images of Nov. 3 and 4 in the R and G channels, respectively, and the Nov. 3-4 coherence in the B channel. The other two images both have the Oct. 2-3 and the Nov. 3-4 coherences in the G and the B channels, respectively. The R channel is assigned to the Nov. 3 intensity in image "2", and to the Nov. 4 intensity in image "3.

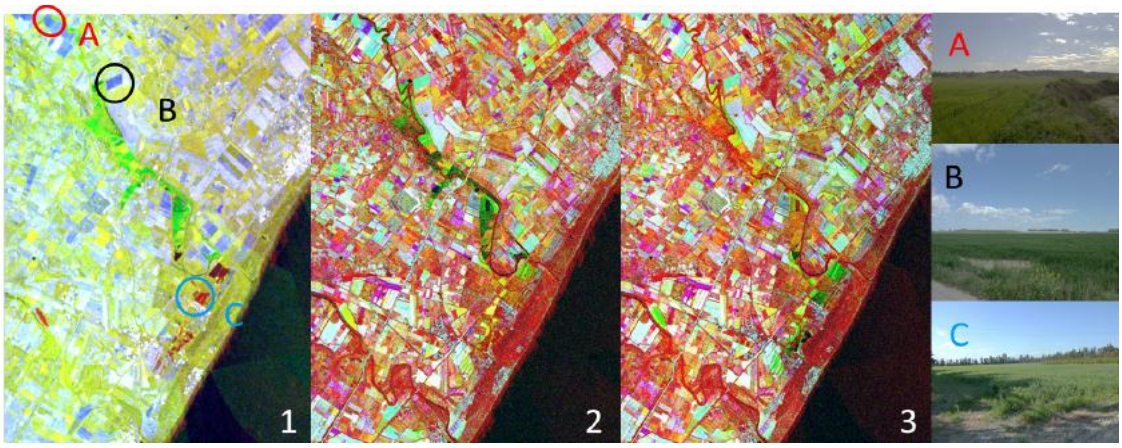

Figure 5: RGB composites of intensity and coherence images relevant to the area highlighted

The paper [10] deals with the improvement of the exploitation of SAR images in hydraulic modelling and near real-time crisis management by means of developing image processing methodologies that allow the extraction of water levels at any point of the floodplain. Also, methods can be exploited that combine SAR-derived flood extent maps and precise topographic data for retrieving water depth maps. In a case study of a well-documented flood event in January 2003 on the River Alzette, Luxembourg, a root mean squared error of 41 cm was obtained by comparing the SAR-derived water heights with surveyed high water marks that were collected during image acquisition. Water levels computed by the calibrated hydraulic model also suggest that the water surface profiles provided by the combined use of topographic data and SAR accurately reflect the true water line. The extraction of flooded areas within vegetated areas demonstrates the usefulness of the proposed methodology.

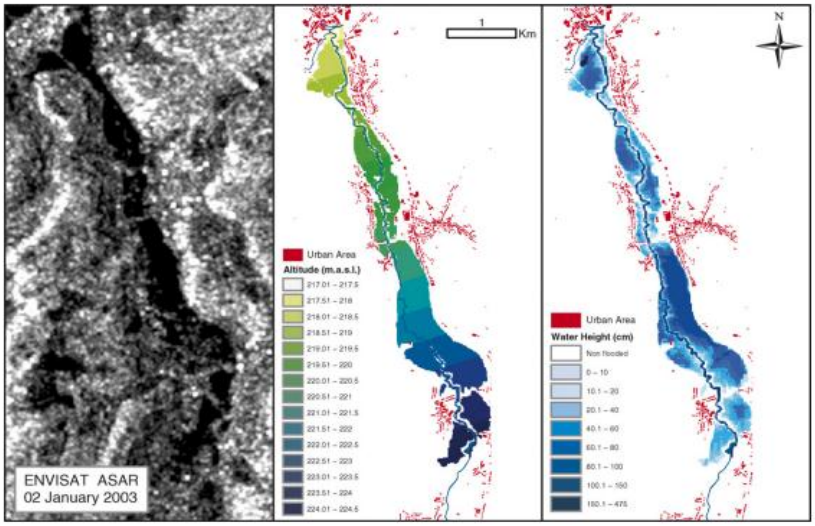

Figure 6: Water surface and flood depth mapping for the January 2003 flood

5. CONCLUSION

Most of the human casualties in the last few decades have been caused by floods. In addition, material damages that result from this natural disaster reach great intensities. This is due to climate change, urbanization and other natural and anthropogenic factors. It is highlighted here that geodetic systems play an important role in the analysis and forecasting of potential risks from the occurrence of floods, as well as their mapping and analysis of vulnerable areas. It is important to create a system that will provide early warning and allow evacuation of the population before the flood waters reach the houses [1]. In water management applications, flood depth maps can be useful at very different stages and thus the accuracy requirements of the inundation depth product vary considerably with the intended applications. The accuracy requirements are most important in flat areas as well as in heavily urbanized areas where small differences in water elevation may cause large changes in the flooded area. This is also a reason why more emphasis needs to be put on the integration of the surveying methods [10] and tools for obtained data manipulation, referring to on-time reaction in vulnerable areas.

Flood risk mapping involves hydrologic and hydraulic analysis, damage and risk calculations, and mapping of the floodplain, and all these can be provided by laser scanning and radar remote sensing techniques, as it is shown in this paper. Also, geoinformation technologies are shown as very important to improve acquisition, processing, display and the use of the data.

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MANAGEMENT OF *AMBROSIA ARTEMISIFOLIA* IN CROATIAN AGRICULTURAL PRACTICE

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ABSTRACT

Common ragweed (Ambrosia artemisiifolia) is an invasive weed species with a negative impact on agricultural production, human health and biodiversity. The negative allelopathic effect on surrounding flora contributes to the increased spread of common ragweed. Common ragweed suppresses flora of both ruderal habitats and agricultural crops such as arable farming and vegetable crops. This reduces biodiversity of different habitats. Thanks to its adaptation to various agroecological conditions and ability to keep germination of its seed for about 40 years, common ragweed causes significant damage in agricultural production. The exuberant growth of above ground mass and roots in common ragweed also impoverishes agricultural soil of nutrients. Due to the stated facts, on agricultural land in Croatia, according to the principles of cross compliance from 2015, removal of common ragweed is mandatory for all farmers who are direct payments users, users of IACS measures for rural development (M 10 - Agri-environment-climate, M 11 - Organic farming , M 13 - Payments to areas facing natural or other specific constraints) and users of Wine support program: reconstruction and conversion of vineyards and green harvesting. Although it is mandatory for the above-mentioned farmers to remove common ragweed from their agricultural land, it is still present to a certain extent on both agricultural land and on its edges. Therefore, the aim of these research is to determine the acknowledgment by farmers in Croatia about the problem of appearance and spread of common ragweed and the measures they take to prevent its occurrence. This research will provide the basis for further education and informing of farmers in order to intensify the prevention of this invasive plant with an allergenic, negative effect on human health and to reduce its unfavorable effects on agricultural production.

Keywords: common ragweed, alien species, Croatian agriculture

1. INTRODUCTION

Common ragweed (*Ambrosia artemisiifolia*) is a plant species of the sunflower family (Asteraceae). It is annual weed species which can grow up to 150 cm. It's stem is much-branched, square in cross-section and covered with hair. The leaves are opposite along the stem, deeply pinnatifid, 4-10 cm long, dark green on the upper surface of the leaf and greyish and hairy on the underside. The plant is

monoecious. Plant produce a large amount of pollen grains. Common ragweed pollen grains are the strongest known allergen that causes health problems in humans. Common ragweed can produce from 60,000 to 150,000 pollen grains per plant annually. The invasiveness of the common ragweed is manifested in allergic reactions it causes with a concentration of only 20 to 30 pollen grains per m^3 of air, where it can stay for days and exceed distances up to 500 km. The plant blooms from June to October. One plant produces up to 3,000 achenes that can keep germination up to 40 years. Due to the mentioned characteristics, common ragweed is a very widespread invasive weed species in North America, Europe, parts of Asia and Australia which are characterized by a moderately warm climate. In these areas it represents an extremely aggressive weed in almost all crops on fields, in gardens, orchards and vineyards. It is most commonly found in ruderal habitats and uncultivated fields in sunny and dry areas along urban settlements or along roads and railroad tracks. The name derives from the Greek word (*ambrosia*), which in Greek mythology meant food for gods that brings immortality. Common ragweed starts to spread across Europe in 19th century. It arrived in Europe in shipments of agricultural seeds from North America. Today in Europe, common ragweed is a major problem in following areas: Pannonian plain in Central Europe, Po river valley in Italy, french Rhone-Alpes region, Ukraine and southern European Russia [1]. Significant occurrence of common ragweed is also found in the areas of Spain [2] and Sweden [3]. Occurrence of common ragweed was recorded for the first time in Croatia in 1941 in Slavonia, Posavina and Podravina regions [4]. Today, common ragweed is present in most parts of the continental Croatia and in the Mediterranean part of Croatia such as in the central and southern parts of Istria, Primorje-Gorski Kotar county, Zadar county and Šibenik-Knin county [5]. The areas in which common ragweed is largely represented are areas between Sava and Drava rivers [6]. Common ragweed has a good adaptive ability that, along with mentioned characteristics, enables invasion of new habitats. Thanks to its ability to adapt to different habitat conditions, common ragweed has spread from its native lands to many new areas where it has found favorable conditions for its development. To this also contributes negative allelopathic effect of common ragweed on other plant populations that grow in its surrounding. Common ragweed thus suppresses existing flora of the surrounding habitat both on ruderal surfaces and on surfaces with agricultural production. In this way, growth of common ragweed decreases the biological diversity of its habitat. In the agricultural practice, negative effect of common ragweed on germination and growth was determined in: alfalfa, barley, salads, tomatoes and wheat [7]. Similar studies on maize, soybean and sunflower also confirmed negative allelopathic effect of common ragweed on the cultivation of mentioned agricultural crops [8]. Although farmers awareness for many years presented the basis for removal of this invasive species from agricultural areas, activities to prevent its spread formally intensified lately. That is why removing of common ragweed is mandatory since 2015 for all farmers who are receiving subsidies in Croatia. These obligations are governed by the principles of cross compliance. Cross compliance represents a series of prescribed mandatory requirements and conditions that farmers have to comply when carrying out their agricultural activities in order to receive subsidies for agriculture. Cross compliance is a requirement when applying for: direct payments program, IACS measures for rural development involving beneficiaries of measure M 10 - Agri-environment-climate, measure M 11 - Organic farming and measure, M 13 - Payments to areas facing natural or other specific constraints. Cross compliance is also required when applying for market support measures from wine sector support programs related to reconstruction and conversion of vineyards and green harvesting. If farmer doesn't comply with the rules of cross compliance, administrative penalties are imposed. The mentioned penalties can be imposed for disregarding the rules of cross compliance at any time in calendar year in which farmer has applied for subsidies. Due to the importance of removing common ragweed from agricultural land, a survey was carried out on farmers activities related to the removal of common ragweed. This research would determine and improve existing knowledge and activities of farmers with the aim of preventing the emergence of this invasive weed species.

2. MATERIAL AND METHODS

Data collection related to the research on agricultural practices of detection and removal of common ragweed was conducted by surveying farmers. Due to the differences in biogeographical regions of Croatia, which have direct impact on the agricultural production, farmers within entire territory of the Republic of Croatia were involved in survey with the aim of obtaining more complete results. The sample involved 99 farmers from different fields of agricultural production (olericulture, arable farming, pomology, viticulture, animal husbandry). The questionnaire for farmers included simple and numerical questions and questions on Likert scale. Based on the series of proposed assertions, insight on farmers opinions about research topics were obtained. The questionnaire was thematically structured for the users of green payments program and for the users of measures M10 and M11 of the Rural development programme. The goal of the questionnaire was acquiring informations on the level of knowledge and awareness of farmers on the topic of importance of removing common ragweed from their agricultural lands. Survey research has provided data on how farmers are acquiring knowledge and informations about common ragweed as an invasive weed species and in what case would farmers engage more actively in suppression of common ragweed spread. The collected data are further subjected to statistical data analysis in order to obtain the necessary research result.

3. RESULTS AND DISCUSSION

According to the principles of cross compliance, maintaining all agricultural areas without common ragweed (*Ambrosia artemisiifolia*) is the obligation of all farmers who are users of direct payments program and users of measures M10 and M11 of the Rural development programme. Farmers who are users of basic payments program, other than those participating in the program for small farmers, are obliged to abide agricultural practices that are beneficial to climate and environment on the areas for which they receive direct payments. Agricultural practices beneficial to climate and environment for which green payments are made are: variety of crops, conservation of permanent grasslands and ecologically significant areas. Research has shown that out of the total number of farmers participating in the survey, 59,6% of them receive subsidies from green payments program, most of which are subsidies for ecologically significant areas (74,6%), followed by variety of crops (59,3%) and conservation of permanent grasslands (8,5%). The study also included 25,3% of farmers involved in measure M10 - Agri-environment-climate and 26,9% of farmers involved in measure M11 - Organic farming. Farmers involved in some types of operations in measure M10 can also be in the organic farming system and use green payments program. However, in order to avoid double funding, farmers involved in organic farming cannot receive green payments subsidies because their production method implies the activities they encompass. Research showed that, although only 6,1% of farmers fully understand the issue of invasive plant species, 79% of them, due to the obligations prescribed by the principles of cross compliance, remove common ragweed from their agricultural lands (Figure 1).

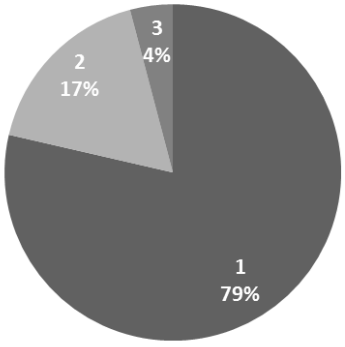
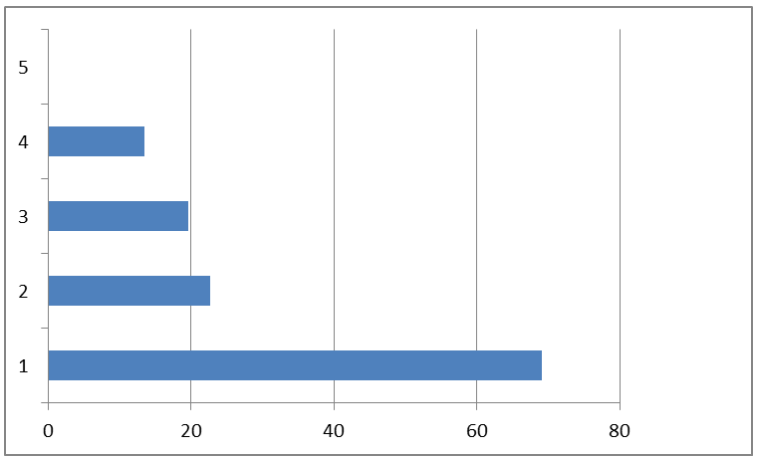


Figure 1. Representation of common ragweed removal from agricultural lands
Legend: 1- removal. 2 - common ragweed not present, 3- non removal

The obtained results show that 92,7% of farmers recognize common ragweed by morphological characteristics. When removing common ragweed, 82,1% of farmers also remove other invasive species from their agricultural lands. That is why most farmers (69%) think that common ragweed along with other invasive species needs to be removed from agricultural lands when it is noticed. (Figure 2).



Legend:

1. Removing when seen (%)
2. Removal depends on current situation on farm (%)
3. Removing when it represents threat to livestock (%)
4. Removing only when it represents threat to economy (%)
5. Never removing (%)

Figure 2. Time of removal of common ragweed and other invasive species from agricultural lands

Farmers knowledge about morphological characteristics of common ragweed and the importance of removing this invasive allergen species is largely due to the information they can find online or by various expert services. Farmers mostly need additional expert theoretical and practical knowledge about removing common ragweed from agricultural lands (Figure 3).

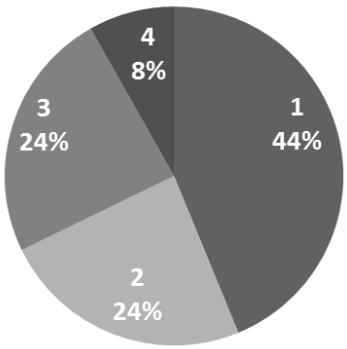


Figure 3. Farmers need for new knowledge on common ragweed removal

Legend: 1- no need for new knowledge. 2 - need for theoretical knowledge, 3- need for practical knowledge, 4 - need for theoretical and practical knowledge

In addition to the informations that most farmers remove common ragweed in order to receive subsidies and very few farmers are fully aware of invasive species issue, it is confirmed that 53,8% of farmers are willing to participate more actively in suppression of other invasive species alongside common ragweed if additional subsidies could be obtained for these activities.

4. CONCLUSIONS

Most farmers remove common ragweed from their agricultural lands in order to receive various forms of support programs in agriculture, although only a small number of farmers are fully aware of the problem of invasive plant species.
Removal of common ragweed from agricultural lands in Croatia is done when it is noticed on them. Farmers knowledge on common ragweed morphological characteristics contribute to its removal.
Common ragweed is removed from agricultural lands thanks to knowledge acquired by farmers through information found on internet and through education and advices given by expert services for agriculture.
Most farmers are also willing to remove other invasive species from their lands if they could receive additional subsidies for these activities.
From conducted research it is visible that in the recent time activities regarding identification and removal of common ragweed from agricultural lands have intensified. The motivation for these activities is in correlation with agricultural support programs and it is therefore important to raise awareness among farmers about negative impact of common ragweed on the environment. Education of farmers related to the negative impact of common ragweed on agricultural production, human health and biodiversity will contribute to the long-term prevention of the occurrence and spread of this invasive species both locally and globally.

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APPENDIX TO LOGISTICS OF MUNICIPAL WASTE DISPOSAL

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ABSTRACT
Reverse logistics is a system of return of products, or the rest of the product, back through the supply chain and it is a part of the integral logistic system. In order to reduce and solve the problem of waste generation, reverse logistics relies on logistics activities and managerial abilities. The recycle-supply chain can be displayed as a four-step process. This paper deals with the logistics of municipal waste management with a review of the factors affecting its organization. By showing the indicators of the applied waste management system, it was intended to show operational indicators that could be used to evaluate quality and ability of collecting, usable or unusable, municipal waste.
Keywords: municipal waste, waste disposal, waste collection,

1. GENERAL CHARACTERISTICS OF DISPOSAL LOGISTICS

Logistics is generaly defined as: forming, managing, regulating and controlling total flows of energy, information, personnel, materials (raw materials and products) within and between the system [2]. Logistic processes, through the process of transformation, lead to changes in state of objects in the system in terms of time, place and order [3]. Typical logistic processes are storage, transport, relocation, sorting, related mediation with information and forming processes [4]. During the production of economic goods, as well as the consumption of the same, unwanted material and energy compounds [5], which we call the remnants of production and consumption, are formed. These residues, in the form of waste, waste water, waste gases and waste heat, are partly ecologically harmful [6].

The resulting emissions, in accordance with the known laws of thermodynamics, do not contribute to the reduction of the total quantity, but make diffusion of used materials and energy into the environment, air, soil and water [7]. The resulting compounds (materials and emissions), not considering their potential negative impacts on human health, biodiversity and environment, are in the forms that are not suitable for further reuse. Therefore, their preparation for re-use requires a large amount of energy and materials, and overall, the increase in entropy in this process is much greater than the desired entropy reduction [9].

Understanding the inability to remove residues, induced increase in entropy, and associated increased environmental burden, indicate the necessity of avoiding residues (waste) and if it is not possible to avoid than to handle it in accordance with environmental protection and conservation of raw material resources.

In the hierarchy of waste management, the principles that should be adhered to are listed [10]:

a) Avoiding waste generation
b) Preparation for reuse
c) Recycling
d) Other exploitation; eg energy utilization
e) Responsible disposal

From the stated principles of waste disposal, that is, the impact that waste may have, disposal can be included beside production and consumption as the third logistical sector of economic processes [11].

Following the hierarchy of waste management, the activities of obtaining (secondary) materials and energy from waste and responsible disposal require collection, transportation, handling and disposal, which are logistical processes because using them space, time and order (sequence) of the processes in question is managed. Logistical approach to transfer tasks of residues generated from production and consumption is more necessary because overall waste management should be technically and economically feasible, as outlined in the FBIH Waste management act, which among other states: „Waste is only disposed of if it is not possible to use its material and/or energy in the existing technical and economic conditions and if the reuse costs are unreasonably high compared to the expense of disposal“ [12]. Disposal logistics can also affect waste avoidance, eg by selecting an adequate containers system for collecting waste in the area of municipal waste disposal.

2. THE FEATURES OF DISPOSAL LOGISTICS IN PART OF HOUSEHOLD WASTE

The object of disposal in households is a usable and unusable household waste, a compact material that is not filled with liquid or air in a clearly visible and tangible form, predominantly generated in consumption. These materials represent the mentioned municipal (household) waste in the existing Waste management act and the Waste catalog in the FBiH [12, 13].

Definitions for waste are:

- "waste" means any substance or object that the holder disposes of, or intends to dispose of or is required to be disposed of in accordance with one of the categories of waste specified in the waste list set out in the implementing regulation;
- "municipal waste" means household waste as well as other wastes which, by reason of their nature or composition, are similar to household waste;

The term household waste used here refers to the origin and type of material and not to the economic (statutory) status that may have a waste or usable material. When separating waste into households on usable and non-usable part of the waste, usable quantities that end in other collection systems, such as collecting for charitable purposes or handing over to collectors of recoverable households waste should be excluded. Collected quantities of usable part of waste from households, after recycling, are no longer in the category of waste but are becoming commodities or raw materials. When usable part of the waste is handed over to communal companies, its switch to commodity, raw material or energy is not warranted, as this will depend on stocks on the stock of recoverable materials where the value of the recoverable materials varies continuously. Will the usable part of the waste be going to the commodity or raw material depends on the existing technical possibilities and the acceptable costs of exploiting them, ie the market value of the ready-to-use materials in relation to the disposal price.

The aforementioned possibilities of dealing with household waste products as secondary raw materials have a significant impact on the organization's appearance in the municipal waste collection system. Today, the issue of collecting part of waste, which is regulated by the Ordinance on collecting certain streams of materials (packaging, electrical and electronic waste, medical waste etc.), is better regulated by the statutory obligation to pay compensation for pollutants, thus creating a prerequisite for better functioning of the collection system and ultimately the exploitation or disposal of such waste.

3. IMPACT FACTORS ON THE SELECTION OF ORGANIZED WASTE MANAGEMENT SYSTEMS

For the establishment of a system of organized waste disposal of municipal waste, data on expected waste are needed, as well as waste generators, ie the population and the area in which waste will be collected. The most important parameters for the analysis are:

a) quantity of produced waste on a daily, weekly and monthly basis,
b) composition of municipal waste,
c) number and arrangement of users of the municipal waste collection system,
d) location, distance and capacity of the facility for processing / receiving municipal waste,
e) settlement structure (rural / urban, density, type of construction),

f) network and traffic conditions,
g) climatic conditions (hygiene requirements),
h) collection budgets

According to the (input) data, methods and operational organization of the collection system and the type of vessels is selected :

a) individual - collective collection,
b) collecting a usable part (separately, mixed)
c) criteria for selecting the vessel system:
- Economics (vessel size, loading time, performance)
- Physical activity of employees (transport, containers, noise, dust)Sigurnost na radu
- Hygiene - cleanliness (containers, vessels)Građevinski aspekti
- User requirements,

d) type of vessel:
- bucket (60-360 lit.) /2 wheels/
- container (500-1100 lit.) /4 wheels/
- container (1,1-8 m^3) /Hinter und Frontlader/
- multi-storey container
- depot containers (1,5-5 m^3) / igloo or bell /
- underground containers
- removable containers (2,5-7 m^3) / lifts /
- roller containers (12-40 m^3),

e) other.

Housing structure and the existing traffic and urban conditions have the great impact on the final appearance of the municipal waste collection system. Waste collection is done by parts (regions) in the urban and suburban areas, and standardized containers are used for collection.

4. INDICATORS OF THE APPLIED WASTE DISPOSAL SYSTEM

Performance indicators, performance of a particular system, are based on individual indicators, values that in a certain relationship affect one another. When we talk about logistics logistics in the part of the collection process, and the primary transport, there are many interconnected relationships that are based on common elements.

Primary transport is the driving of a pick-up vehicle from the starting point (company or garage) to the collection area, and driving from the collection area to the place of unloading or starting place ie garage. Collecting is the dumping of collected waste from the waste collection vessel into the waste collection vehicle (waste container).

Performance indicators in order to evaluate the effectiveness and efficiency of the observed waste removal process (collection and primary transport) are [14]:

V_{ras}^{podr} - the available volume of waste collection containers in the observed area,
S^{podr} - route length (road) of waste collection in the observed area,
T^{podr} - time of collection of waste in the observed area,
$G^{podr.}$ - the amount of collected waste in the observed area
St – number of inhabitants on the route of collection (population in the observed area)
K_{nos} - the capacity of the vehicle for waste collection
S_{tr} – route (road) of transport
T_{tr} - transport time
$T_{praž}$ – vehicle unloading time
G^{podr} - quantity of waste collected in the collection area
St – number of inhabitants in the area of collection
$n_{praž}$ – number of discharges in the observed area
S_{stv}^{tr} – the actual transport route in a particular area
T_{uk}^{rasp} – total available time

T_{sak}^{podr} – available time for collection

By putting the above indicators into a certain relationship, a system of indicators is provided which can serve to analyze the possibility of executing the given service.

The available volume of the waste collection vessel is calculated as the multiplication of the number of placed vessels of the selected type in a particular area and the volume of the type vessel

$$V_{ras}^{podr} = \sum_{n} V_{pos}\,, \quad n = (1, 2, 3 \ldots . k)$$

V_{pos} – volume of the waste container
n – number of waste containers

The length of the collection route consists of sum of the collection routes, referring to the usual distances between individual vessels (up to 100 m) and the route of the bypass, which refers to the longer driving required in the collection area without discharging the vessel due to the shape of the road, the group visits buildings and similar.

$$S^{podr} = S_{sak} + S_{zaob}$$

S_{sak} – collecting route
S_{zaob} – route bypass

The ratio of the available container volume and the length of the collection route indicates how many m3 of the disposed waste trash on the collection route.

$$\frac{V_{ras}^{podr}}{S^{podr}}$$

The waste collection time in the observed area can be presented as a sum of waste collection time, passing bypasses and loading the contents of vessels in the collection vehicles.

$$T^{podr} = t_{sak} + t_{zaob} + t_{uto}$$

t_{sak} – collecting time
t_{zaob} – time of passage of the bypass
t_{uto} – time of loading

The ratio of the collecting time and the available volume of the collection vessel indicates the time required for collecting waste per unit vessel volume

$$\frac{T^{podr}}{V_{ras}^{podr}}$$

The regional velocity tells us what distance (part of the area) per time unit in process of collection exceeds the observed scavenger. The value of the regional speed is essentially influenced by vehicle used, type of vessels, established collection route and other operational factors.

$$\frac{S^{podr}}{T^{podr}} = \frac{1}{\frac{V_{ras}^{podr}}{S^{podr}} \cdot \frac{T^{podr}}{V_{ras}^{podr}}}$$

The amount of waste per inhabitant (user) is the subject of experienced research activities. All research indicates the fluctuation in quantity and type of waste per capita. Often the mean value is measured during all seasons.

$$\frac{G^{podr}}{St}$$

G^{podr} – collection of waste collected in the collection area
St – number of inhabitants in the area of collection

The population density shown as the number of inhabitants on the route (area) of collection directly affects the amount of waste.

$$\frac{St}{S^{podr}}$$

We can present the density of the produced waste from the previous term as:

$$\frac{G^{podr}}{S^{podr}} = \frac{G^{podr}}{St} \cdot \frac{St}{S^{podr}}$$

The average collection rate in the area with the presented density of produced waste from the given ratio can be shown as:

$$\frac{\phi G^{podr}}{\phi T^{podr}} = \frac{S^{podr}}{T^{podr}} \cdot \frac{G^{podr}}{S^{podr}}$$

The average collection speed indicates the possible amount of the collected waste in the unit of time. It is evident that with the increase in collection time, the possible amount of collected waste is directly increased. Sizes that influence the calculation of the available time for collection can be presented in the following relationships.

The discharge route of the vessel in a certain area and the associated transport time is determined by the number of runs (discharges), which depends on the volume of the upgrade, the degree of compression and the carrying capacity of the vehicle for collection and primary transport, and can be presented as:

$n_{praž} = \frac{G^{podr}}{N_{smeć}}$ (rounded to an integer)

The actual transport route for a specific area can be presented as:

$$S_{stv}^{tr} = S^{gar-podr} + \left(2n_{praž} - 1\right) \cdot S^{podr-pret} + S^{pret-gar}$$

S_{stv}^{tr} – the length of the actual transport route

$S^{gar-podr}$ – distance from the starting point (garage) to the discharge area

$S^{podr-pret\cdot}$ – distance from the discharge area to the discharge point (transhipment)

$S^{pret-gar\cdot}$ – distance from the loading area to the garage

Different indicators, such as the acceleration, decelerating and rotating ability of the vehicle, ie the dimensions of the roads and the traffic conditions, have a great impact on the value of the transport speed in some area.

The average transport speed is

$$\frac{\phi S_{stv}^{tr}}{\phi T_{stv}^{tr}}$$

The total available time can be represented by the following equation:

$$T_{uk}^{rasp} = T_{reg} + T_{prek}$$

T_{uk}^{rasp} – total available time

T_{reg} – normal contractual working hours

T_{prek} – overtime due to work needs

The real time of transport refers to the time spent at collection, rounding, and loading which is not earlier taken into account.

$$T_{stv}^{tr} = \frac{1}{\frac{\phi S_{stv}^{tr}}{\phi T_{stv}^{tr}}} \cdot S_{stv}^{tr}$$

Time of unloading at the place of discharge (transhipment) participates in the total time of execution of the service of primary transport and collection of waste.

T^{ist} – unloading time

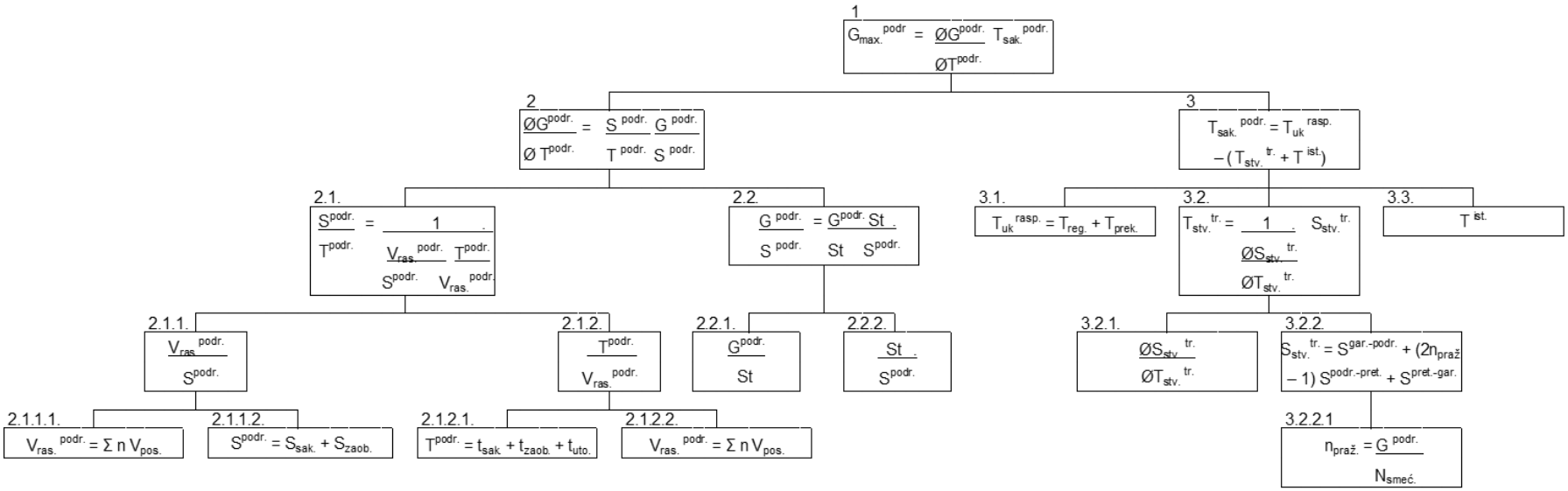
The available time for collection (and primary transport), observing the previously mentioned time relationships, can be presented as

$$T_{sak}^{podr} = T_{uk}^{rasp} - (T_{stv}^{tr} + T^{ist})$$

At the end of this consideration of relationships and values that affect the average collection speed and the time available for collection in a particular area, the (maximum) amount of waste for disposal as:

$$G_{max}^{podr} = \frac{\phi G^{podr}}{\phi\, T^{podr}} \cdot T_{sak}^{podr}$$

Indicators for the analysis of the efficiency of collection and primary transport can be presented in the form of the following scheme. (12*)



LEGENDA:

1. The largest quantity of waste for removal

2. Average collection speed in the area

2.1. Regional speed

2.1.1. The ratio of the available volume of vessels and the length of the collection route
2.1.1.1. Available volume of waste collection containers in the observed area
2.1.1.2. Length of route (road) of collection of waste in the observed area

2.1.2. The ratio of the collecting time and the available volume of collecting vessels
2.1.2.1. Time of collection of waste in the observed area
2.1.2.2. Available volume of waste collection containers in the observed area

2.2. The density of the produced waste
2.2.1. Quantity of waste per inhabitant (user)
2.2.2. Density of population

3. Time available for collection

3.1. Total available time

3.2. Real time of transport
3.2.1. Average transport speed
3.2.2. The real transport route
3.2.2.1. Number of runs (discharges)

3.3. Time unloading

Scheme of performance indicators for the collection system and primary transport

5. CONCLUSION

Waste collection service, collection and primary transport can be viewed as part of integral logistics. When determining appropriate systems for municipal waste management (treatment of municipal waste), it is necessary to take into account that in the logistics system next participants should be associated:

a) producer (generator) of waste
b) collector (utility company or collector of usable waste)
c) sorting plant - transfer station - landfill [12]
d) recyclers
e) processors (production plants)

The final result is a product that contains recycled material from waste, things or materials that is not needed by the owner. The extremely important result of this logistic chain is the reduction of the environmental burden due to the reduction in the amount of residual waste that ends at the landfill or as a fuel, and the reduction in the utilization of natural resources (raw materials) for the production of raw materials for production. The listed waste management activities are not subject to market relations because the starting conditions and expected products can not be competitive on the market. The achieved overall results in the mentioned waste treatment enable sustainable development and as such need to be further stimulated (co-financed) from the collected funds from the state budget.

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ANALYSIS AND EVALUATION OF AIR QUALITY IN THE CITY OF ZENICA ACCORDING TO MONITORING RESULTS OF SPM CONCENTRATIONS IN THE PERIOD 2006 - 2015

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ABSTRACT

In this paper, based on the results of monitoring of SPM , an analysis and assessment of air quality had been carried out under relevant legislation, as well as trend assessment by statistical tests: Mann-Kendall and Sen's method. According to the analysis, the air in Zenica is ranked as air of the third category with existing growth trend of concentration of SPM.

Keywords: air quality, SPM, contaminated/polluted air, Mann-Kendell, Sens Method

1. INTRODUCTION

The impact of air pollution is reflected in the health of people in many ways, air pollution also damages our environment and its constituents. Scientific studies have led to air pollution associated with various health problems, including: the appearance of respiratory and cardiovascular diseases, decreased lung function, increased frequency of severe breathing and cough, sensitivity to respiratory infections, affect on the nervous system, including the brain, such as loss of IQ and the impact on learning, memory and behavior, and the appearance of cancer and premature death.

The particles in the air that nebulized and absorb light reducing visibility. In order to avoid the impact of the polluted air it is necessary to make the public timely, and to continuously and efficiently monitoring the air quality. According to the European Environmental Agency (EEA), effective air quality monitoring in the area (inhabited or uninhabited) should be based on modern approaches and standard methodologies and the use of information and communication technologies to provide accurate results and obtain a clear insight into the current state . In order to meet these conditions and to achieve the set goals, an integrated concept of air quality management should be created. [1, 2]

Air quality management is based on regular air quality monitoring. The two basic aspects of air quality monitoring are: quality tracking and static analysis. Namely, proper monitoring of air quality with appropriate static analysis can provide a large range of data on pollution, trends, policy efficiency, and the like. However, for statistical analyzes to make sense and give a true picture of the condition, it is necessary that the data being processed be precise, high quality and reliable. In this paper analyzes are trends and trends in the series of air pollution in Zenica in the ten year period. Tracking trends is one of the most frequently used statistical methods when talking about the state of the environment. The goal of testing the trend is to see if the values of the random variable (in this case measured annual pollutant concentrations) are increased or decreased over a certain period of time. [3]

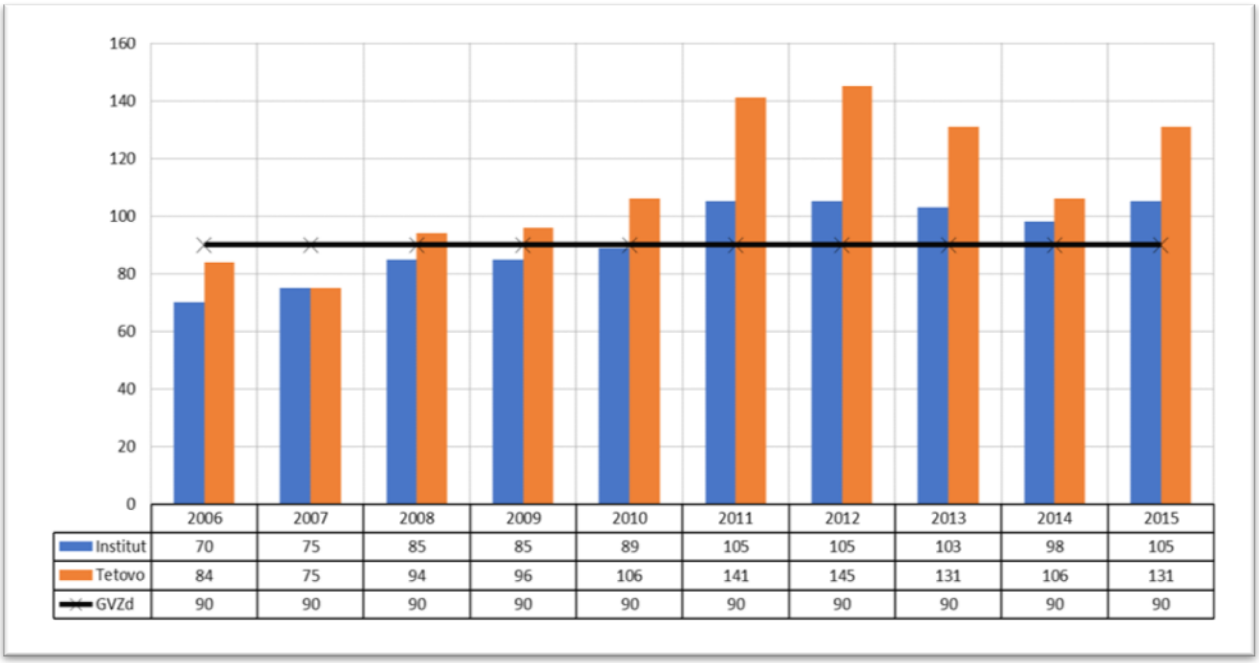
2. ANALYSIS AND EVALUATION OF THE MEASURED AVERAGE ANNUAL CONCENTRATION OF SPM IN THE CITY OF ZENICA IN THE PERIOD 2006 TO 2015

According to the Rulebook on the method of performing air quality monitoring and defining the types of pollutants, the categories of air quality are determined according to the pollution levels with regard to the limit and tolerance values, according to which three categories of air are defined. The limit and tolerance values for the air quality assessment are prescribed, according to which the average annual concentration of the SPM must not exceed the concentration of 90 μg /m^3, and the number of daily exceedances of the concentration of 250 μg /m^3 should not exceed 1 times during one calendar year.
Table 1. gives an overview of the measured average annual and maximum SPM concentrations, and the number on the day when the measured daily SPM concentration was greater than 250 μg / m^3. In the table, the categorization of the SPM air is also based on these data.

Table 25. Measured average annual concentration of SPM in the period 2006 to year 2015 with a maximum average daily concentrations and the total number of days exceeding

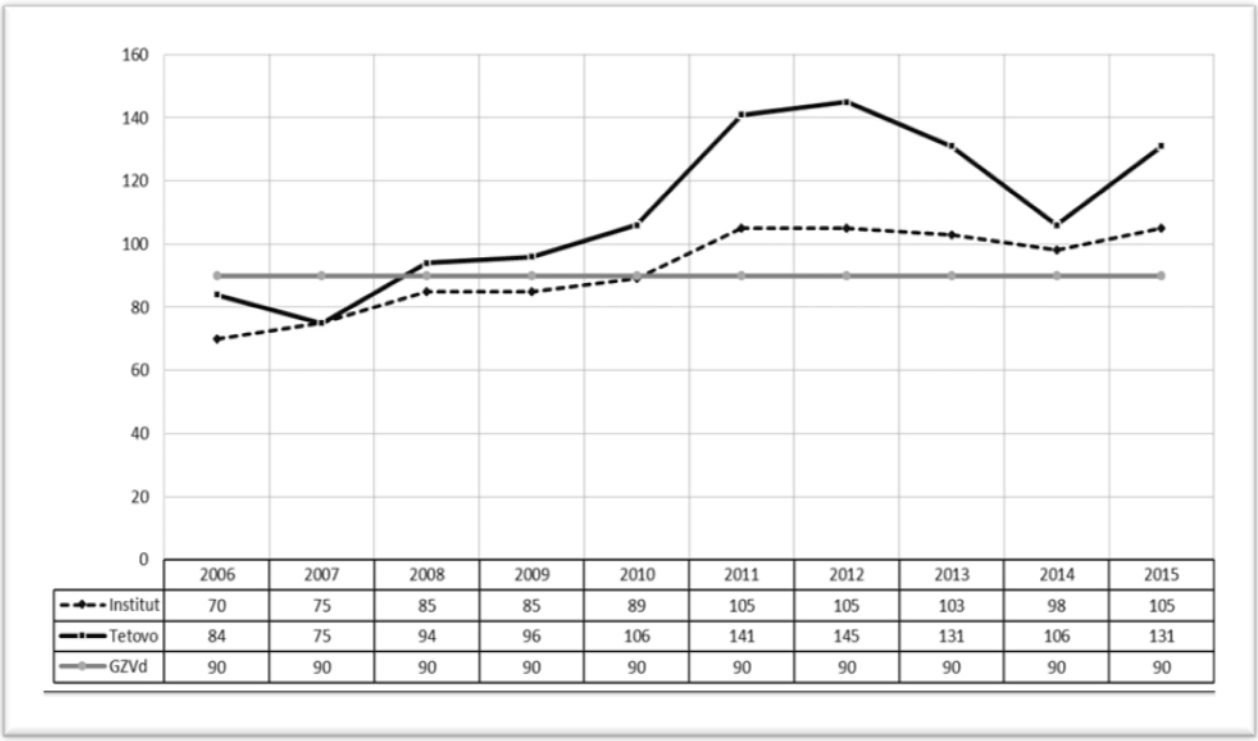
Year	The average annual concentration (μg/m^3)		Maximum daily concentration (μg/m^3)		Number of daily overruns (>250 μg/m^3)	
	Institut	***Tetovo***	***Institut***	***Tetovo***	***Institut***	***Tetovo***
2006.	**70**	**84**	319	493	10	22
2007.	**75**	**75**	492	560	8	13
2008.	**85**	**94**	810	426	13	18
2009.	**85**	**96**	534	506	11	11
2010.	**89**	**106**	731	480	15	22
2011.	**105**	**141**	570	736	29	47
2012.	**105**	**145**	855	648	16	40
2013.	**103**	**131**	820	770	21	35
2014.	**98**	**106**	546	431	20	22
2015.	**105**	**131**	843	540	30	39
AIR QUALITY CATEGORY			**III**			

Based on the data from the previous table in the following figures, a graphic representation of the measured annual SPM concentrations is given, followed by an indication of the measured maximum concentrations, and a trend of the increase in the number of days of exceeding the SPM in the period from 2006 to 2015.



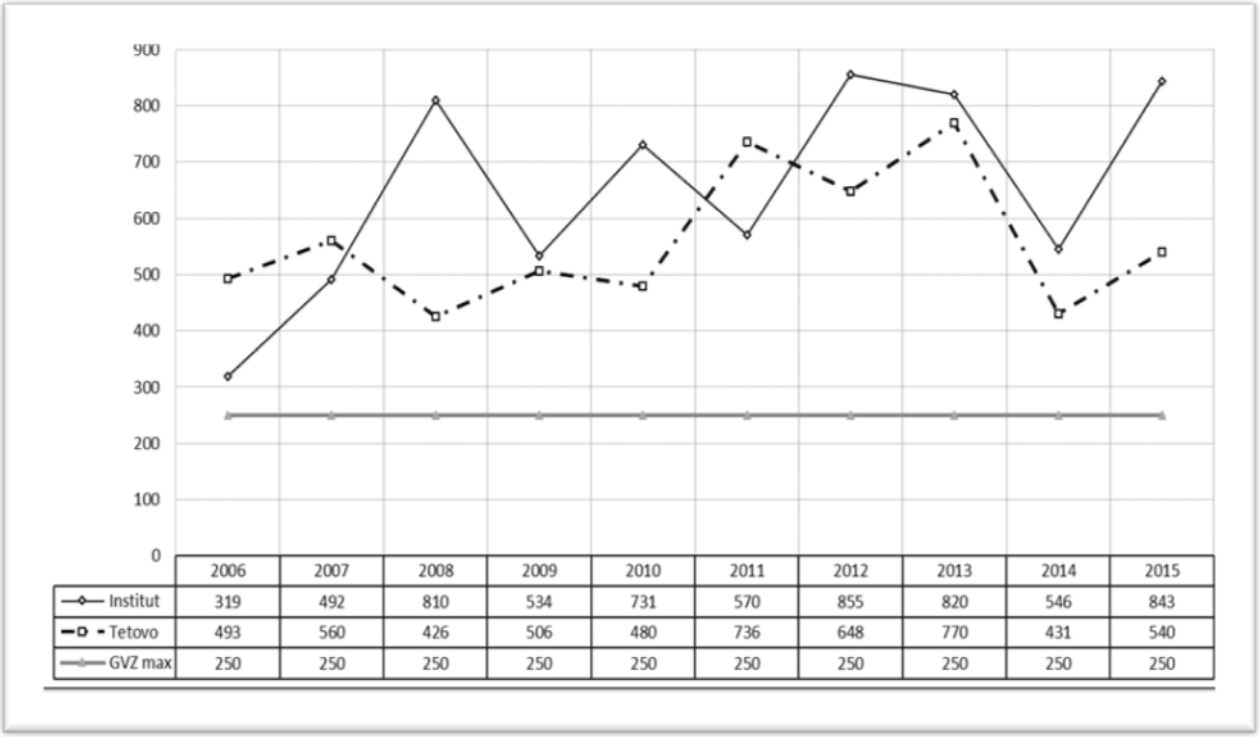
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Institut	70	75	85	85	89	105	105	103	98	105
Tetovo	84	75	94	96	106	141	145	131	106	131
GVZd	90	90	90	90	90	90	90	90	90	90

Figure 1. a) Graphic representation of the measured annual average SLM concentrations in the period 2006. - 2015.



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Institut	70	75	85	85	89	105	105	103	98	105
Tetovo	84	75	94	96	106	141	145	131	106	131
GZVd	90	90	90	90	90	90	90	90	90	90

Figure 1. b) Graphic presentation of the trend of the SLM growth in the period 2006. – 2015.



	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Institut	319	492	810	534	731	570	855	820	546	843
Tetovo	493	560	426	506	480	736	648	770	431	540
GVZ max	250	250	250	250	250	250	250	250	250	250

Figure 1. c) Graphic representation of maximum measured concentrations of ULM in the period 2006-2015.

3. ANALYSIS OF TRENDS IN MEASURED CONCENTRATIONS OF SUSPENDED PARTICLES USING THE MANN-KENDALL TEST AND THE SEN'S METHOD IN THE PERIOD 2006. – 2015.

According to the measured annual concentration of suspended particles, the Institute established a Mann-Kendell test and analyzed and evaluated the trend in the period from 2006 to 2015 (Table 2), giving a graphical representation of the actual inclination of the measured concentrations obtained in MAKESEN- with the help of Sen's method.

Table 2. Mann-Kendall's Mann-Kendall Statement for tracking the trend of floating particles at the metering point Institute

period	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**		
concetratiom	**70,0**	**75,0**	**85,0**	**85,0**	**89,0**	**105,0**	**105,0**	**103,0**	**98,0**	**105,0**	+	-
		5	15	15	19	35	35	33	28	35	9	0
			10	10	14	30	30	28	23	30	8	0
				0	4	20	20	18	13	20	6	0
					4	20	20	18	13	20	6	0
						16	16	14	9	16	5	0
							0	-2	-7	0	0	2
								-2	-7	0	0	2
									-5	2	1	1
										7	1	0
number of the same series	0	0	0	1	0	0	1	0	0	2	36	5

VAR (S)	**Z_s**	**α**	**$Z_{cr.05}$**	**Q**	**RATING**
125	2,73	**	1,96	4	GROWING

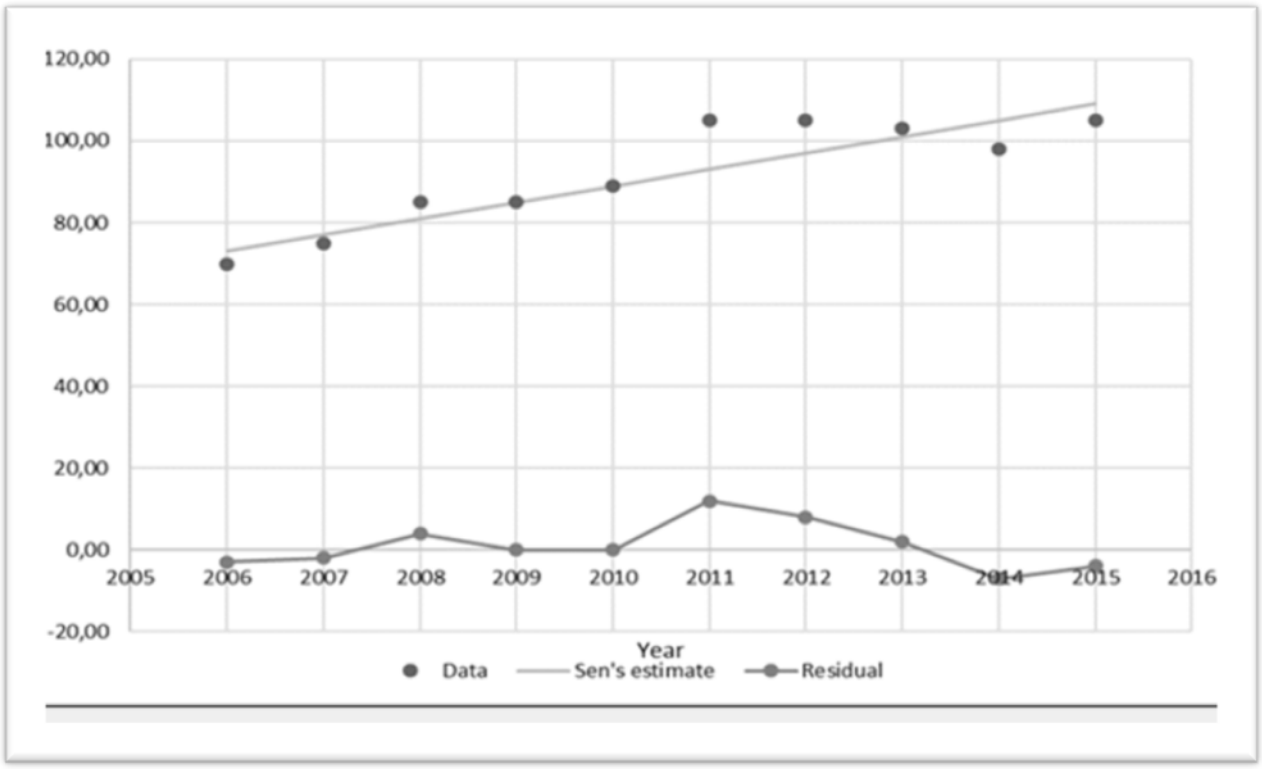


Figure 2. Display of the actual inclination of measured concentrations of suspended particles obtained in MAKESEN using the Sen's method for the measurement site Institute in the period 2006 – 2015

According to the measured annual concentrations of suspended particles at Tetovo Meter, a Mann-Kendell test was formed and an analysis and evaluation of the trend in the period from 2006 to 2015 was performed (Table 3.).

Table 3. Mann-Kendall's Mann-Kendall S statistics for tracking the trend of floating particles at the measuring point "Tetovo"

period	2006.	2007.	2008.	2009.	2010.	2011.	2012.	2013.	2014.	2015.		
Conc.	84,0	75,0	94,0	96,0	106,0	141,0	145,0	131,0	106,0	131,0	+	-
		-9,00	10,00	12,00	22,00	57,00	61,00	47,00	22,00	47,00	8	1
			19,00	21,00	31,00	66,00	70,00	56,00	31,00	56,00	8	0
				2,00	12,00	47,00	51,00	37,00	12,00	37,00	7	0
					10,00	45,00	49,00	35,00	10,00	35,00	6	0
						35,00	39,00	25,00	0,00	25,00	4	0
							4,00	-10,00	-35,00	-10,00	1	3
								-14,00	-39,00	-14,00	0	3
									-25,00	0,00	0	1
										25,00	1	0
num of the same ser.	0	0	0	0	0	0	0	0	1	1	35	8

VAR (S)	Z_s	α	$Z_{cr.05}$	Q	RAITING
125	2,34	*	1,96	5,88	GROWING

A graphical representation of the actual slope of the measured concentrations of SO2 obtained in MAKESEN with the help of Sen's method for the measurement site Tetovo in the period from 2006 to 2015 is given in the figure below.

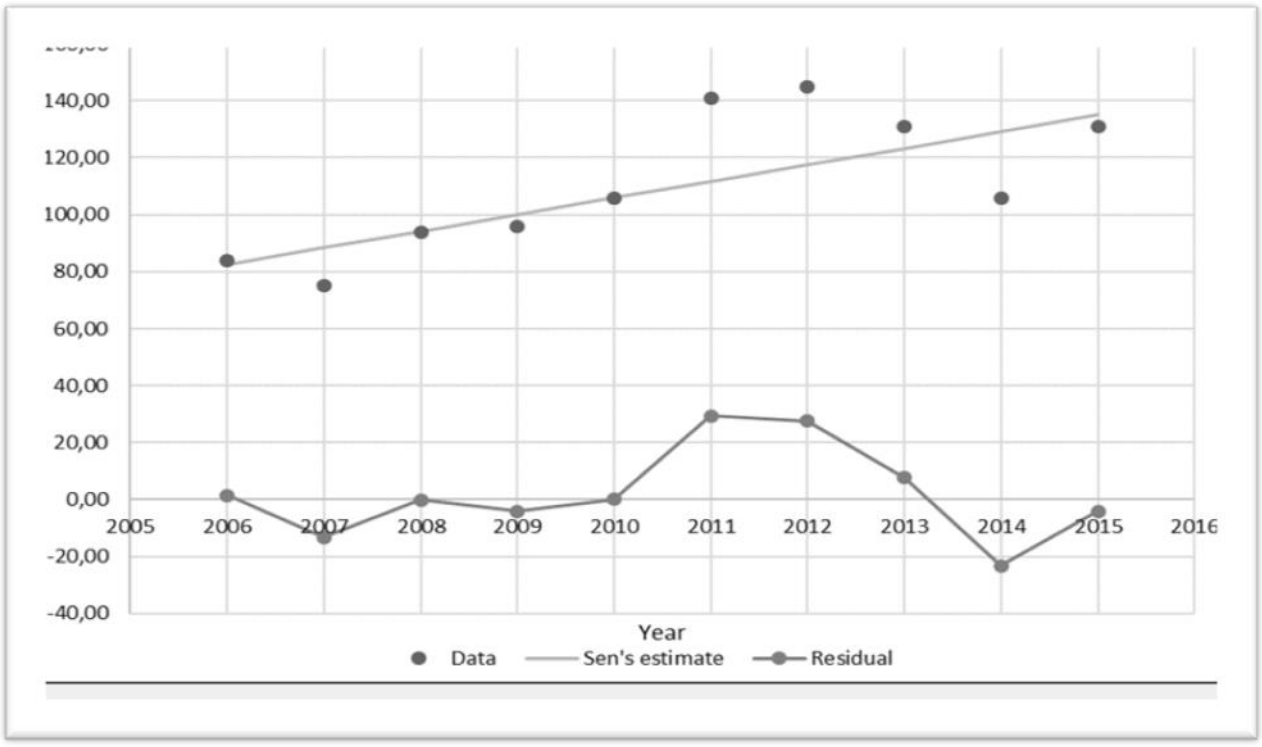


Figure 3. Presentation of actual pitch of measured concentrations of suspended particles obtained in MAKESEN help of Sen's method for measuring site Tetovo in the period 2006 – 2015

4. CONCLUSION

Based on the analysis of continuous monitoring in the area of the city of Zenica in the period from 2006 to 2015, the following can be noted:

- the average annual concentration of suspended particles was 110.9 μg/m^3, which is an annual allowable value of 90 μg m^3,
- permissible daily value of 250 μg / m3 of suspended particles is exceeded as much as 269 times, which is on average 13.5 days during each year,
- The maximum measured 24-hour concentration of suspended particles was 843 μg/m^3 and was measured at the Institute of Measurement in 2015,
- according to the measured values of total airborne particles in the air, the air quality falls into Category III according to Article 28b of the Air Protection Act (Official Gazette of the FBiH no.04 / 10),

Based on the statistical analysis of trends (Mann Kendall test and Sen's method), it can be generally stated that:

- trend of concentration of suspended particles in the Zenica basin in the period 2006-2015. Depending on the position of the measuring stations, the level of significance α = 0.01-0.05,

According to the results of continuous monitoring of air quality in the Zenica basin, it can be concluded that the air is of the third category of quality, because tolerant values for suspended particles, precipitated dust and heavy metals in deposited dust are exceeded. Air III of the category represents excessively polluted air. Such bad air requires taking measures to protect the health of people and the environment. To achieve a reduction in pollutant emissions, it is necessary to introduce systematic measures to reduce and control emissions for improving air quality. Some of the recommended measures to prevent and reduce emissions are: controlling consumption and fuel quality in the energy sector, using renewable energy sources, gradually replacing ECA vehicles with EURO standards, then controlling home furnaces and using environmentally-friendly energy resources, urban planning, and the like.

Zenica is an industrial city, which with its development and growth will have a big problem with the emissions of all pollutants. Therefore, it is necessary to work on the improvement, and invest maximum efforts in order to minimize the emissions.

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ENVIRONMENTAL AND HEALTH EFFECTS OF INADEQUATE DISPOSAL OF ANIMAL WASTE IN ZENICA-DOBOJ CANTON

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ABSTRACT
According to the available data in the Zenica-Doboj Canton area, about 22,500 t/year of animal waste (1., 2. and 3. categories) is generated. However, it is assumed that this quantity is much higher. On the other hand, in the Zenica-Doboj Canton area, as well as in the whole of Bosnia and Herzegovina, there are no adequate facilities for the disposal of animal waste, which is the biggest problem in the management of animal waste. Most of the animal waste is disposed of by burial in the pits of the tomb, it is deposited on municipal landfills, and in the worst cases it is rejected on the banks of the river, in the forests or on other locations without burial. Such inadequately handled animal waste presents a risk both for the environment and for the public health, especially in the case of animal carcasses or parts of carcasses of animals killed or euthanized due to infectious diseases, mainly zoonoses such as brucellosis, Q fever, echinococcosis, leishmaniosis and others. Vectors, such as rodents, birds, insects and others, divide animal waste further into nature, leading to the spread of infectious material and the cause of the disease (zoonosis) further in the environment. Activities on building adequate capacity for animal waste management in BiH should begin in 2019, as foreseen in the "Strategy for the management of animal by-products and animal waste in Bosnia and Herzegovina with action plans (for the period 1.1.2019 - 31.12.2023 years)".
Key words: animal waste, environment, public health, infectious material, zoonoses, vectors.

1. INTRODUCTION

Animal waste is an organic material that is rapidly decomposed under atmospheric influence by creating gases of unpleasant odors (ammonia, sulfur dioxide) and other degradation products (fatty acids, aromatic acids) that directly or indirectly contaminate all elements of the environment, air, soil and water. Such places become habitats for stray dogs, rodents, carnivores and insects.[1] Animal waste consists of whole animal carcases or parts of carcases or products of animal origin that are not intended for human consumption, including eggs, embryos and animal seeds. Of course, in animal waste there are also side products produced during the finalization of raw materials of animal origin, all of which include wastewater and air, regardless of whether they are the result of hygienic, technological or diagnostic-therapeutic measures carried out on animals or in the facilities in which they are located, or facilities in which animal products are finalized.[11]

The current legislation in Bosnia and Herzegovina (BiH)[2,9], and so in the Zenica-Doboj Canton, is mostly in line with EU Directives 1069/2009, 142/2011, 1097/2012, regulating the management of animal waste. However, the problem is the implementation of existing legislation in BiH and the Zenica-Doboj Canton, especially considering the lack of adequate capacities for adequate management of animal waste.

Bosnia and Herzegovina does not have built capacities for the disposal of animal waste, which is a major problem, since animal waste can negatively affect all components of the environment, air, soil, water, flora and fauna, and public health.

Zenica-Doboj Canton is one of the ten cantons of the Federation of Bosnia and Herzegovina (FBiH). It consists of the city of Zenica and 11 municipalities. It is located in the central part of Bosnia and Herzegovina and the third is in the area of the FBiH. Nevertheless, in the Zenica-Doboj Canton, the situation is somewhat better compared to the rest of Bosnia and Herzegovina, since it is the only region that has some functional facilities for the disposal of animal waste. There is a small animal waste incinerator, one co-incinerator in the cement factory and one smaller rendering company as a part of the poultry breeding and poultry meat production company. However, it should be emphasized that this is a small capacity, in which only about 20-25% of the total amount of animal waste generated in the Zenica-Doboj Canton area is disposed of.

It is also important to note that in the Zenica-Doboj Canton, in comparison with BiH, the majority of food producers, that is, companies that produce animal waste, are concentrated, such as the three major producers of poultry meat and poultry meat products, seven craft slaughterhouses of the large and small cattle, and a large number of medium and small processing facilities, as well as a large number of poultry farms and large and small cattle farms.

2. PROBLEM ANALYSIS

According to the available data, in the Zenica-Doboj Canton there are about 22,500 tons / year of animal waste, and in the territory of BiH about 97,500 tons / year.10 Thus, it can be concluded that in the Zenica-Doboj Canton, on average, a larger amount of animal waste is generated in the respective to other cantons and regions in BiH (FBiH and Republika Srpska - RS). Of the total amount of animal waste generated in 2017 in the Zenica-Doboj Canton, about 90% refers to Category III, about 8% for Category IIa and about 2% per Category I.[10] In consultations with waste generators from the Zenica-Doboj Canton area, but also from other cantons and regions, it can be concluded that annually higher amounts of animal waste are generated.

It is known that most of the animal waste, about 75-80%, is disposed of and stored in burial pits, livestock cemeteries, as well as municipal landfills, watercourses, forest land, agricultural land and other locations. All these sites are partially conditional or non-conditional for the disposal of these waste categories and do not meet the standards of BiH and the EU for the disposal of animal waste.

However, the legislation only envisages the use of burial pits and livestock cemeteries for the disposal of animal waste, until the capacity for its adequate disposal is built up. In this way, animal carcasses and parts of carcasses of dead animals and / or euthanized from contagious diseases, such as brucellosis, bovine plague (BSE), plague of small ruminants, Q fever, blue-tongue and other diseases are mainly taken care of. Such infectious animal waste should be totally harmlessly removed in the incinerator or co-incinerator, but due to its insufficient capacity, it is also buried in the burial pits and livestock cemeteries.

A particular problem is the selection of the location for the burial pits and livestock cemeteries, since these locations must be outside the populated area, away from the drinking water source, from watercourses, agricultural land, roads and other infrastructures.[6,8] Site selection is done at the local / municipal level by city / municipal structures, in coordination with the competent cantonal structures, primarily the cantonal veterinary inspection.

Therefore, the selection of a location for the construction of a burial pit and livestock cemetery is influenced by factors that can be pedologic, climatic and ecological: flora and fauna, the presence of water sources and source zones, climatic factors (precipitation, floods), the amount of animal waste to be disposed of, public health, available and necessary material resources, humidity and soil degradation, maximum level of groundwater, distance from watercourses and water reservoirs, type and quality of the land, accessibility and communication connection of the terrain, porosity and watertightness of the soil, stability and slope of the terrain, cultural habits and customs of the local population, the presence of urban, agricultural, industrial, protected and other areas that must be at a certain distance from the site in accordance with the regulations on construction, water and environmental protection.

After selecting the site, the construction of a burial pit or livestock cemetery is under way. When constructing a cemetery or pit, it is necessary to provide the following: that the thickness of the soil layer covering the animal waste is at least 1 meter; the depth of the pit is at least 4 to 5 meters, and the bottom of the pit is at least 1 to 2 meters above the highest groundwater level; that the sidewalls of the pit are made of solid material and must be masonry so as to leak liquids, unless the burial tombs are built completely inseparable from double reinforced waterproof concrete; that the area around the pit is at least 50 cm wide and constructed of solid material with a fall to the surrounding terrain; that the pit grave must have a top plate of solid material with a lid that must be raised from the surrounding terrain, and the cover of such a construction prevents the release of unpleasant smells and can be locked.[6,8] The burial pit or cattle livestock cemetery must be fenced, marked and have the appropriate entrance for the reception of vehicles and people with disinfectant barrier for wheel disinfection and disinfection of vehicles. The entry must be controlled in such a way as to prevent the entry of unauthorized persons and animals.

Therefore, it can be said that animal waste in the burial pits and livestock cemeteries is partially disposed of in an appropriate way, since there are no other facilities for its disposal. However, all infectious animal waste is not disposed of in the burial pits and livestock cemeteries. Experience has shown that owners and / or animal keepers do not report to every sick animal, although they are legally obliged to do so when it comes to zoonotic diseases. It is thought that 10-20% of diseased animals have not been reported, and the reasons may be many, from not recognizing the symptoms of the disease to the deliberate failure to report of the infectious disease due to fear of financial damage. In such cases, owners and / or holders of animals independently take care of animals that have died from contagious diseases, while also taking care of aborted calves and other contaminated substances. Such infectious animal waste is often disposed of in insufficiently deep pits, so that due to heavy rain or digging by other animals (carnivores) it can easily reach the surface of the soil. In this way, this infectious material extends further into the environment and negatively affects all its constituent elements, including the negative impact on public health.

The causative agents of infectious diseases (bacteria, viruses, etc.) can survive a different time in the environment, depending on the type of cause and climate factors. It is known, for example, that *Brucella spp*. can survive about 2 months in water and soil, especially moist, then several months in hay, dust, fence, and it is thought to be able to survive up to 8 months in liquid fertilizer.

Considering that in 2018. an increase in the number of diseased brucellosis animals (mainly sheep) was recorded, and according to existing regulations, such animals must be euthanized, it can be concluded that there has been an increase in the quantity of animal waste in category I, compared to previous years.[3,4]

People who first come into contact with infected animals and contaminated material are more likely to suffer from disease then other people, and because of "first contact" they fall into a risk group. Therefore, for example, brucellosis is also referred to as professional disease, because it is most commonly experienced by farmers (owners and / or animal keepers), hunters, veterinarians, laboratory workers and other professionals.[7] The situation is similar with other zoonotic diseases. Although in 2018. an increase in humans and animal brucellosis was registered in all of BiH, and therefore in the Zenica-Doboj Canton, the origin of the disease can not be established, but inadequate care of animal waste is considered to be a risk and contributes to the spread of disease in humans and animals.

Of the total amount of animal waste produced, only a small proportion refers to infectious animal waste, while the major part relates to animal waste from farm production, from slaughterhouses, meat processing plants and meat products production, and to the production plant leather and other. As noted, given the limited capacity for the disposal of animal waste in the Zenica-Doboj Canton, this waste is mainly disposed of at municipal landfills in this or other cantons, and sometimes in watercourses, forest land and other unsuitable locations. In the Zenica-Doboj Canton, no municipal landfill is eligible for the disposal of animal waste, but some take over and take care of certain categories of animal waste, classified according to the Rulebook on waste categories with lists.[12] However, large quantities of this waste end in the environment, in riverbeds , forest land, etc., where it is deposited by generators of this waste. This is due to the fact that they are not able to handle it in an adequate way, or the available method requires high costs, or sometimes it is just irresponsibility.

In addition to all of the above, a special problem is also fertilizer or farm manure, which is included in category II of animal waste. Mostly, the manger is used to cultivate agricultural land, but the amount of manure used often exceeds what crops can take, leaving the rest to "escape" into the air or into surface water. Such outdated and irregular treatment of animal waste can lead to serious environmental pollution problems.

3. CONCLUSION

Current methods of treating animal waste lead to significant contamination of the environment with animal waste and products of its degradation, and it can be said that they have a negative effect on public health. Inadequate disposal and management of animal waste causes pollution of all components of the environment: soil, water and air. The mentioned management of animal waste, especially for a long period of time, can lead to pollution of surface and groundwater. Vectors such as insects, rodents, birds and others, attracted by this waste due to the strong smell of decomposition products, find it, dig it and further spread it in the environment, and with these wastes can also spread diseases such as Q fever, BSE, rabies, salmonellosis , brucellosis, echinococcosis, and others. Waste of animal origin can therefore be the source of infections in other healthy animals as well as zoonotic infections in humans. Also, using water contaminated with animal waste for bathing, irrigation or drinking, individuals may be exposed to infectious material or other contaminants from this waste. Animal waste also adversely affects the air in its surroundings, as its decomposition releases unpleasant odors that spread to the environment, and is mainly due to gaseous compounds, such as ammonia and hydrogen sulphide. Products of degradation of animal waste contaminate the soil in the surrounding area and exclude it from further use because it is no longer conditional for agricultural production or some other purposes, especially considering the increase in the risk of zoonotic infections. This waste also adversely affects water (liquid and standing, above ground and underground), since the discharge of products of degradation of animal waste into water, according to previous experience, often leads to increased oxygen consumption in water, ie, the increase in the value of biological oxygen consumption (BPK_5) and values of suspended matter in water. It follows from this that it is necessary to determine the exact quantities of waste generated in the Zenica-Doboj Canton area, as well as the entire BiH, and establish appropriate capacities for its adequate disposal.

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ANALIZA UTICAJA DRVNOG PEPELA U POSTUPKU KOMPOSTIRANJA MULJA S KOMUNALNIH UREĐAJA ZA PREČIŠĆAVANJE OTPADNIH VODA

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REZIME
U radu je predstavljeno istraživanje uticaja dodatka drvnog pepela u postupku kompostiranja smjese mulja i biootpada kao dio kompleksnijeg istraživanja mogućnosti kompostiranja mulja sa komunalnih prečistača otpadnih voda i njegove upotrebe u poljoprivredi kao poboljšivača tla. U postupku kompostiranja su praćene različite kombinacije, odnosno, supstrati za kompostiranje u kontrolisanim uslovima okoline sa prisilnom, aeracijom. Dodatak pepela osnovnom supstratu doprinosi uspostavljanju optimalnih uslova za startanje procesa kompostiranja i zavisno od veličine udjela utiče na parametre procesa i kvalitet proizvedenog komposta.
Ključne riječi: mulj, biootpad, proces kompostiranja.

1. UVOD

U postupcima prečišćavanja komunalnih otpadnih voda kao nusprodukt pojavljuje se mulj. Zbrinjavanje ovog mulja predstavlja poseban problem zato što se po svom karakteru i hemijskom sastavu ne može odlagati na deponije komunalnog otpada a ujedno često ima i štetne efekte. To podrazumijeva da se ovaj mulj mora kontrolirano zbrinjavati. Tretman mulja s komunalnih postrojenja za prečišćavanje otpadnih voda i mogućnost njegove primjene u poljoprivredi u skladu sa načelima održivog razvoja u današnje vrijeme sve više dobiva na važnosti. Razgradnjom organske materije u mulju do anorganske postupkom kompostiranja, one se ugrađuju u glinaste i humusne čestice i postaju dostupne biljkama za rast [1]. Detaljna analiza parametara procesa kompostiranja i uspostavljanje optimalnog sistema (optimalne recepture i uslova procesa) i modela za praćenje postupka može doprinijeti definisanju konačnog sistema zbrinjavanja muljeva i projektovanju postrojenja za obradu istih.

2. MATERIJALI I METODE

Za potrebe istraživanja korišten je mulj sa prečistača komunalnih otpadnih voda i miješani biootpad. Početne karakteristike analiziranog mulja su sljedeće : vlažnost - 84%, organska materija - 61,29%, pH vrijednost - 8,0, sadržaj C -47,80 mg/kg, sadržaj N-3,10 mg/kg. Biootpadi dodavani mulju su: kuhinjski biootpad (kora krompira, jabuke mrkve, i ostaci zelenih dijelova biljaka), zeleni biootpad (pokošena trava, lišće bjelogorice, ostaci i stabljike biljaka), drvenasti biootpad (usitnjeno granje, slama pšenice, suhe stabljike kukuruza). Ovako pripremljen biootpad dodavan je mulju sa različitim procentualnim učešćem formirjući različite kompostne smjese - uzorke prikazane u Tabeli 1.

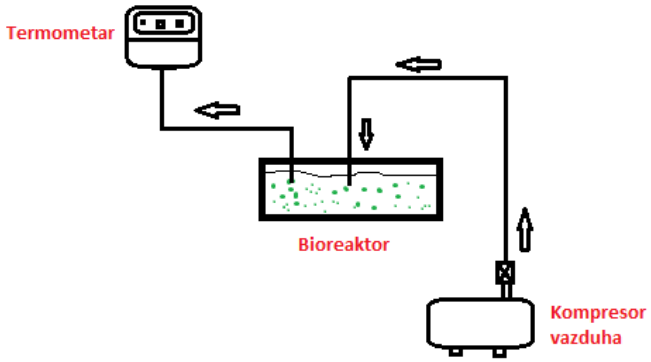
Tabela 1. Kompostne smjese

Br. uzorka	Udio mulja (%)	Udio miješanog biootpada (%)	Udio pepela (%)
1	48,5	48,5	3
2	47	47	6
3	45,5	45,5	9
4	68,5	28,5	3
5	67	27	6
6	65,5	25,5	9

Svi uzorci su postavljeni u plastične spremnike zapremine 6,4 dm^3 (slika 1.).

Sl 1. Sistem povezanih međusobno izoliranih bioreaktora

Opšti koncept kontrolisanog aerobnog kompostiranja predstavljen je shemom na slici 2.



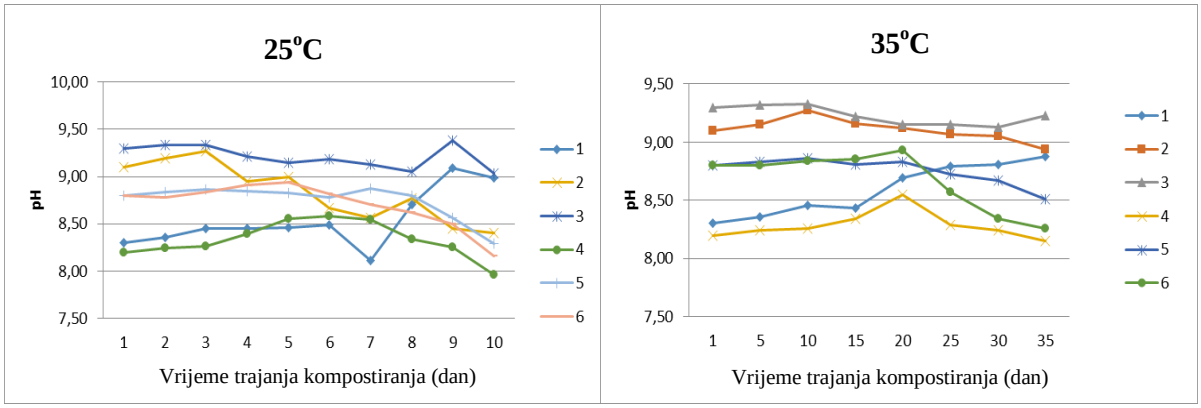
Sl 2. Shema opšteg koncepta kontrolisanog postupka kompostiranja

Prosti sistem za kontrolisano kompostiranje se sastoji od sljedećih komponenti: laboratorijskog bioreaktora, kompresora vazduha i plastičnih cijevi kojima se dovodi zrak do bioreaktora. Svim spremnicima je sistemom plastičnih cevi omogućena svakodnevna aeracija povezivanjem na vanjski kompresor. Prostorija u kojoj su postavljeni uzorci zaštićena je od vanjskih uticaja. Proces kompostiranja je za iste uzorke praćen na dva temperaturna nivoa, 25°C i 35°C. U radu je provedeno eksperimentalno istraživanje uz korištenje odgovarajućih analitičkih i statističkih metoda.

3. REZULTATI I DISKUSIJA

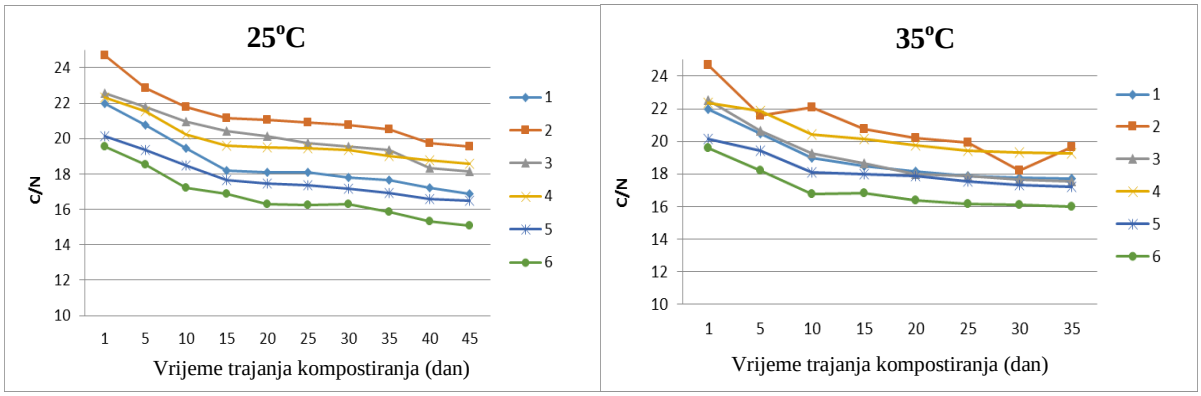
Vrijednost pH generalno utiče na brzinu razgradnje organske materije (regulišući brojnost i aktivnost mikrobiloške populacije), kao i na raspoloživost hranjiva i toksičnih elemenata [2]. Većina bakterija, gljivica i aktinomiceta razvija se kod pH vrijednosti između 5,5 i 8 pa je to i optimalna vrijednost za kompostiranje. Tokom razgradnje organske materije dolazi do izdvajanja amonijaka, koji dovodi do povećanja pH vrijednosti, dok nakon termofilne faze i u uslovima dobre prozračnosti amonijak

oksidira u nitrate, što postepeno smanjuje pH vrijednost [2]. Periodično su mjerene pH vrednosti a rezultati tih merenja su prikazana na Slici 3.



Slika 3. Dinamika promene pH vrednosti tokom kompostiranja uzoraka na 25°C i 35°C

Kod svih uzoraka primjetna je visoka početna pH-vrijednost (>8). Najveću pH vrijednost imao je uzorak 3 (9,3). Tokom kompostiranja pH vrijednost nije značajno varirala. Zbog sadržaja pepela koji nije dozvoljavao "zakiseljavanje" procesa, pH vrijednost nije imala uticaja na startanje procesa.. Takođe, tokom procesa primijeti se težnja da proces ide ka neutralnom području. Krajnja pH-vrijednost u kompostu takođe nije bila ispod 8. Na temperaturi okoline od 35°C uzorci 2 i 3 su tokom procesa dostizali pH-vrijednost iznad 9. Ostali uzorci su bili u preferiranom intervalu. Izraženo alkalni komposti (komposti sa pH većom od 9) mogu imati nepovoljan uticaj na razvoj biljaka u zemljištu na koje su aplicirani [2]. Izmjerene vrijednosti sadržaja C i N, odnosno odnosa C/N prikazane su na Slici 4.



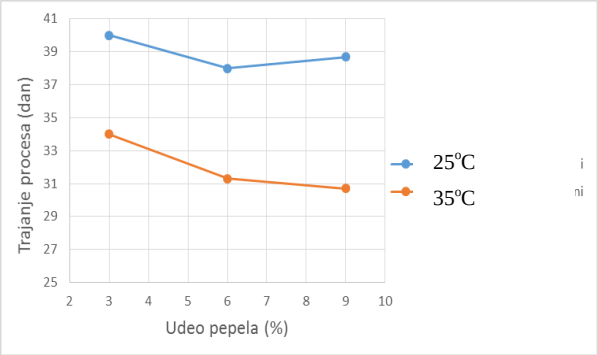
Sl 4. Dinamika promjene C/N odnosa tokom kompostiranja uzoraka na 25°C i 35°C

Brza razgradnja organske materije rezultira padom organskog ugljika i akumulacijom hranjiva i mikrobiološke biomase što dovodi do smanjenja C/N odnosa, mada tok razgradnje zavisi i od C/N odnosa, početne smjese za kompostiranje [3]. Minimalna početna vrijednost C/N odnosa na kojoj će doći do odvijanja procesa kompostiranja je 14 [4]. Početni C/N odnos analiziranih uzoraka se kretao od 19,57 (uzorak 6) do 24,71 (uzorak 2) dok je nakon 35 dana odnos C/N pao na vrijednosti između 14 i 21. Posmatrajući dinamiku promjene C/N odnosa u pojedinim smjesama, može se uočiti da je kod svih uzoraka, i na 25°C i na 35°C, evidentan postepen pad odnosa C/N tokom procesa kompostiranja. Tabelom 2 su predstavljeni rezultati mjerenja maksimalno postignute temperature i dužine trajanja procesa kompostiranja za sve uzorke u oba temperaturna nivoa.

Tabela 2. Maksimalna temperatura i dužina trajanja procesa kompostiranja

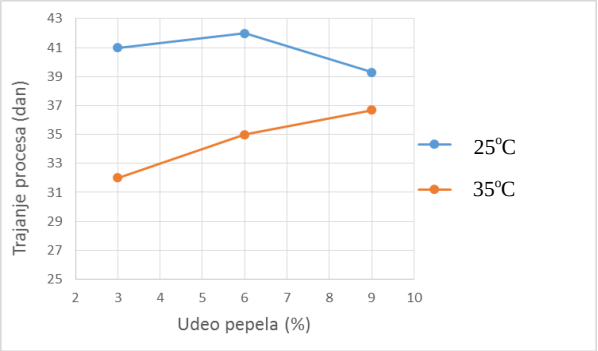
Br. uzorka	Temperatura okoline (°C)	Max. temperatura kompostiranja (°C)	Trajanje procesa (dan)
1	25	53,1	40
	35	59,2	34
2	25	53,8	38
	35	58,2	31,3
3	25	53,7	38,7
	35	58,3	30,7
4	25	48,9	41
	35	55,3	32
5	25	52,3	42
	35	60,2	35
6	25	53,2	39,3
	35	58,5	36,7

Uticaj sadržaja pepela na brzinu procesa kompostiranja prikazana je Slici 5 i Slici 6 .



Sl 5. Uticaj dodatka pepela na brzinu procesa kompostiranja kod uzaka 1,2 i 3

Kod uzoraka sa jednakim udjelom miješanog biootpada i mulja (uzorci 1,2 i 3), povećanje udjela pepela ima za rezultat određeno ubrzanje procesa. Na temperaturi okoline 35°C vrijeme trajanja procesa kompostiranja se smanjuje sa povećanjem udjela pepela, dok se na temperaturi 25°C vrijeme trajanja procesa smanjuje do udjela pepela od 6%, a poslije toga se povećava sa povećanjem udjela pepela.



Sl 6. Uticaj dodatka pepela na brzinu procesa kompostiranja kod uzaka 4,5 i 6.

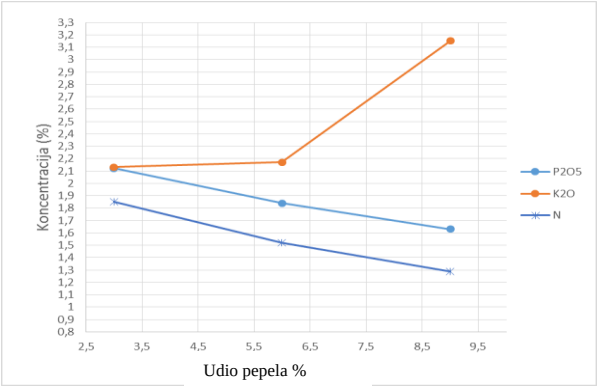
Kod uzoraka 4,5 i 6, na temperaturi od 35°C vrijeme trajanja procesa kompostiranja se povećava sa povećanjem udjela pepela, dok se na temperaturi 25°C vreme trajanja procesa blago povećava do

udjela pepela od 6%, a posle toga se smanjuje sa povećanjem udjela pepela. Na temperaturi od 25°C, udio pepela ubrzava proces oko 1 dan za uzorke sa jednakim udjelom mulja i miješanog biootpada, dok na temperaturi okoline od 35°C udio pepela može ubrzati proces i do 4 dana. U gotovom kompostu su analizirane vrijednosti nutrijenata koji karakterišu kvalitet komposta. Rezultati ove analize prikazani su u Tabeli 3.

Tabela 3. Hemijska svojstva gotovog komposta

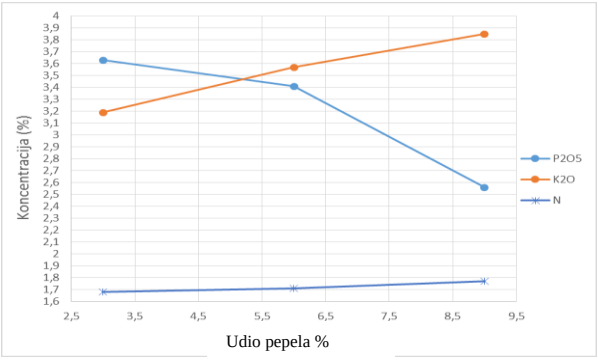
Sadržaj elemenata	Uzorak					
	1	2	3	4	5	6
C %	32.7	32.9	29.0	28,8	29.4	28.2
N %	1.8	1.5	1.2	1,7	1.7	1.8
Organska materija %	48.5	48.1	39.6	45,2	44.1	48.9
P_2O_5 %	2.1	1.8	1.6	3,6	3.4	2.5
K_2O %	2.1	2.1	3.1	3,2	3.5	3.8
Mg %	1.2	1.1	1.0	1,2	1.1	1.4
P %	2,6	2,0	1,9	2,2	3,5	3,1
K %	2,5	2,6	3,4	3,3	3,8	3,9
Ca %	1.8	2.3	2.5	2,1	2.1	2.3
Vlaga %	53.2	56.2	59.3	56,3	62.	61.2
pH	9.2	8.9	9.2	8,1	8.5	8.2

Odnosi pojedinih parametara gotovog komposta prikazani su dijagramima na Slici 7 i Slici 8.



Sl 7. Zavisnost kvaliteta komposta od sadržaja pepela za uzorke 1,2 i 3

U uzorcima 1,2 i 3 kod kojih su jednaki udjeli mulja i biootpada sadržaj P_2O_5, K_2O i N je iznad vrijednosti koje se propisuju za ove vrste gnojiva [5]. Povećanjem udjela pepela sadržaj K_2O raste a P_2O_5 i N opada.



Sl 8. Zavisnost kvaliteta komposta od sadržaja pepela za uzorke 4,5 i 6

Kod uzoraka 4,5 i 6 kod kojih je udio mulja veći od udjela biootpada vrijednosti glavnih nutrijenata su iznad zahtijevanih vrijednosti kao i kod prethodne grupe uzoraka. Povećanjem udjela pepela sadržaj K_2O raste a P_2O_5 opada. Ako posmatramo koji uzorci „proizvode“ najveće količine hranljivih sastojaka, možemo vidjeti da su to uzorci kod kojih je udio miješanog biootpada manji od udjela mulja.

4. ZAKLJUČAK

Na osnovu dobivenih rezultata možemo zaključiti sljedeće:

- dodatkom pepela u odgovarajućem omjeru obezbeđuje se optimalna pH vrijednost kompostne smjese za startanje postupka kompostiranja kod supstrata sa niskom pH vreijdnošću (zakiseljeni supstrati),
- u kontrolisanim uslovima okoline i kontrolisanim doziranjem drvnog pepela moguće je uticati na dužinu trajanja postupka kompostiranja smjese mulja s komunalnih pečistača otpadnih voda i biootpada.
- u kontrolisanim uslovima okoline i kontrolisanim doziranjem drvnog pepela moguće je uticati na sadržaj nutrijenata koji karakterišu kvalitet komposta dobivenog u postupku kompostiranja smjese mulja s komunalnih pečistača otpadnih voda i biootpada.

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ASSESMENT OF THE USABILITY OF WASTE MATERIAL FROM THE EXCAVATION IN REINFORCED EMBANKMENT ON THE SECTION KLOPCE-DONJA GRACANICA OVER THE STATIC DEFORMABILITY MODULE

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ABSTRACT

In this paper, based on the results of the measurement of the static deformability module for the experimental section of the reinforced embankment, an analysis and evaluation of the usability of excavated material on section Klopce - Donja Gracanica, Corridor Vc had been made according to defined conditions of the design for production of the reinforced embankment and the Road Construction Guidelines. The aim is to prepare and install adequate excavated material on section Klopce - Donja Gracanica, Corridor Vc which would significantly reduce the amount of earth material that would be deposited on the landfill. It would also reduce the amount of material from the borrow pit. The principle of exploiting the excavated material for the ultimate goal has a reduction in environmental impact and a reduction in construction costs. The paper has analyzed the usability of only a certain category of excavated material, the heterogeneous rock mass (Cretaceous carbonate *Flish), for which the test results will be presented. These tests can be replicated to following sections of the Corridor Vc motorway with similar geological and morphological conditions. In order to preserve the environmental it remains to examine conditions of other categories of excavated material on the Corridor Vc motorway, especially soft rock and clay (coherent and non-coherent) material.*

Keywords: reinforced embankment, static deformability module, excavation material, reduction of environmental impact,

1. INTRODUCTION

During the construction of the motorway, section Klopče - Donja Gracanica, it will generate huge amounts of waste material from the excavation. The category of excavated material depends on the geological conditions in which excavation has been performed. On section Klopče-Donja Gračanica, the terrain has specific geological conditions. Mesozoic formations build up the largest part of the investigated site and they are represented by sediments of Jurassic-Cretaceous and Cretaceous carbonate Flish and Oligo-Miocene polyfacial complex. The terrain along this section belongs to the Internal Dinarides belt and is characterized by complex structural and tectonic structure. From the area, which belongs in the north to the foothill side of the so-called Nemila cover it enters to the marginal, contiguous belt on one side of Tithonian-Valanginian and Upper Cretaceous flysch (eastern part) and on the other side of the Sarajevo-Zenica basin (west of the route). Tectonic unit of Jurassic Cretaceous and Upper Cretaceous carbonate Flysch represents the edge of a typical folded zone in which the flysch deposits are strongly tectonized. The tectonic units of the Sarajevo-Zenica basin include Oligomyocene and Miocene sediments. Flish is characterized by a frequent exchange of soft and solid lithological members. Cretaceous-Jurassic flysch, on the subject section, made sandstone with frequent alternation of clayey-marl sediments. The ratio of sandstone and clayey-marl sediments is changing. The soft flysch members are usually dominant. The primary relations within the sediments are preserved only sporadically. According to the material composition, within Cretaceous carbonate Flish were selected: gray-greenish marls of leaf-like and the layered texture, brown and red shales, sandstone and gray limestone [1]. The general characteristic of flysch, as rock masses on the subject section, is the heterogeneity of the material and the variability of the lithological composition, both horizontally and vertically. Large differences in physic-mechanical characteristics, including intensive tectonic processes leading rock massif (limestone) to a high degree of heterogeneity. On the section of route Klopce - Donja Gracanica during the excavation of cuts in the construction phase, there are generated a huge amount of material from excavation, as a category of construction waste. The waste rock mass from the excavation has a huge volume and it is a problem at landfills (regulated and unregulated) by taking large spaces. Disposal of waste material from the excavation to landfills may have more or less harmful effects on the environment, both biotic and abiotic factors. Disposal of waste from excavations at landfills requires a serious and highly professional approach to finding geotechnical solutions that are adequate to ensure the stability of the landfill. Often, the procedures for waste disposal at landfills are very expensive and demanding, so it is necessary to look for alternative and cheaper solutions. There are many technologically and economically acceptable processes that allow exploitation of excavated waste in a way that will greatly reduce the environmental impact. The treatment of rock masses from the excavation and its use on the route for installation on embankments and reinforced embankments can significantly reduce the waste materials from the excavation at landfills, and a proper use will reduce the costs of the motorway construction. There are different categories of material that occur during the excavation of the rock mass on the route. In order to use the excavated material in the embankment and a reinforced embankment on the motorway route, it must satisfy the requirements laid down in the Road Construction Guidelines. The aim of this paper is to analyze measurement data of the static deformability module in order to evaluate the usability of the material from the excavation in the reinforced embankment. Therefore, in order to investigate the possible usability of the material from the excavation into the reinforced embankment, the experimental section of the reinforced embankment, was made in interval from the pillar of the viaduct Klopce to P259 + 7m, with a total length of 78.0 m1 Figure 1.

Figure 1. Preparation of layer of reinforced embankment

Usability testing of materials for installation into the reinforced embankment on the route of the road is carried out in order to assess the ability of the soil and other rock materials for mechanical compaction. In this paper, based on the measurements results of static deformability module, we analyzed and evaluated the usability of excavated material in the reinforced embankment on section Klopce - Donja Gracanica, according to defined conditions from the design of reinforced embankment and requirements of Road Construction Guidelines. The assumption is that the heterogeneous material from the excavation in the sediment of the Cretaceous carbonate flysch, on section Klopce - Donja Gracanica, meets the prescribed conditions of usability in the reinforced embankment.
The usage of excavated material in the reinforced embankment will reduce the volume of waste material in the landfill, reduce amount of material from the borrow pit and reduce costs. The main aim of this paper is to reduce the impact on the environment.

2. TEST METHOD

In process of making the experimental section of reinforced embankment, a coherent rock material from the excavation was used, which was previously prepared in a mobile crusher to a fraction of the prescribed size 0-150 mm. The prepared material was disassembled in layers of thickness up to max. 50 cm, which is loaded with a roller to the required load capacity. On the prepared surface, the static deformability module of the derived layer was measured Figure 2. Measurements were made with a static plate of 30 cm in diameter.

Figure 2. The procedure of measure of static deformability module

The layout and number of measuring points per layer surface is defined according to instructions of supervisory authority, and in accordance with the requirements given by Road Construction Guidelines. Distribution and number of measuring points is shown as follows:

- Layer 1, 3 trials
- Layer 2, 2 trials

- Layer 3, 3 trials
- Layer 4, 3 trials
- Layer 5, 3 trials

The number of experiments per surface of the reinforced embankment exceeded the amount prescribed by the Road Construction Guidelines.

3. TEST RESULTS

Data collection for the evaluation of usability of excavated material on the experimental section of reinforced embankment was carried out through the performed measurement of static deformability module, in site. The measurements were made in the phase of making reinforced embankments for each layer, after the substrate was prepared. The reinforced embankment was made in layers of thickness up to 50 cm. In Table 1, the values of the static deformability module Ev1 and Ev2, and Ev2/Ev1 ratio, are given.

Table 1. The results of measuring of static deformability module [2]

Location of test	Ev1 (MN/m^2)	Ev2 (MN/m^2)	Ev1/Ev2	Trial	Criteria: Guidelines[3]
P – 256 L – 3 m od zida	85,44	169,81	1,99	1	Ev2 > 80 MN/m^2
P – 256 L – 1 m od zida	44,41	155,17	3,49	2	
P – 256 + 8 m	67,05	175,17	2,61	3	
P - 256	33,09	118,42	3,58	4	
P – 256 – 15 m	43,45	177,63	4,09	5	
P - 256	76,13	195,65	2,57	6	
P – 256 + 10 m	79,10	195,65	2,47	7	
P – 256 – 10 m	63,28	128,57	2,03	8	
P – 258	62,89	175,32	2,79	9	
P – 257 + 10 m	49,63	146,74	2,96	10	
P - 257	47,09	121,62	2,58	11	
P – 257 + 10 m	39,55	120,54	3,05	12	
P – 257 – 5 m	73,91	198,53	2,69	13	
P – 257 – 10 m	23,99	82,82	3,45	14	
Average value	56,36	154,41	2,88		
Minimum value	23,99	82,82	1,99		
Maximum value	85,44	198,53	4,09		
Standard deviation	18,77	35,48	0,60		

As a condition, minimum average value according to the requirements of Road Guards Guidelines is given. The values Ev2 / Ev1 are also displayed. Test results should be reached:

- Average value: Ev2 >80MPa if Ev2/Ev1 < 3
- Minimum local value: Ev2 >70MPa

The values of Ev2/Ev1 <3 are valid only if the values of the static deformability module are below the minimum allowed [3].

The measurement values shown in Table 1, in graphic form are shown in Figure 3.

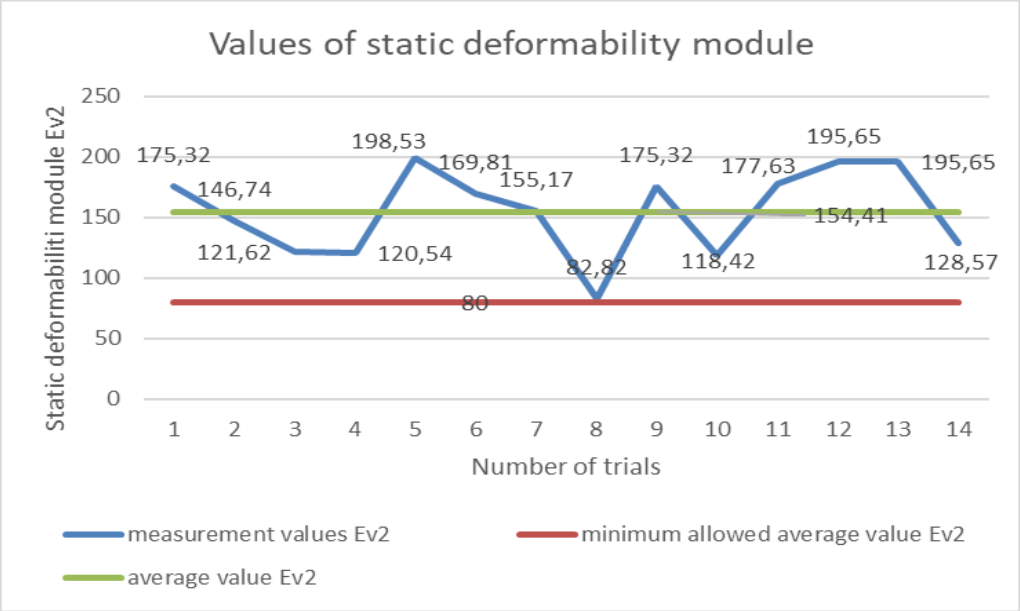

Figure 3. Graphic display of measurement results of static modulus of deformation .

In the diagram it can be seen that the average value of the static deformabiliti module was much above the minimum average value of Ev2 = 80 MN / m2, which is specified in the Road Construction Guidelines. The individual values of static deformabilit module were variable but the minimum value was Ev2 = 82 and more than minimum individual value was Ev2 = 70 MN / m2 given by the Road Construction Guidelines. The values of the Ev2 / Ev1 ratio shown in Table 1 were generally less than 3. Some cases exceed this value, which in this case does not matter if the minimum measured value is Ev2 = 82.82 did not exceed the required value.

4. ANALYSIS OF MEASUREMENT DATA

For the measured values of the static deformability module, shown in Table 1, it is seen that the average values (154.41 MN / m2) are significantly higher than the default minimum average value Ev2 = 80 MN / m2. By analyzing the obtained results, it has been proved that the heterogeneous material from excavation in the Cretaceous carbonate Flish on the motorway section Klopce - Donja Gracanica is used for making reinforced embankments, because the load parameters correspond to the requirements set in the Road Construction Guidelines. By using heterogeneous material from the excavation on the route will significantly reduce the amount of soil material at the landfill. By using heterogeneous material from the excavation from the route will reduce the amount of material from the borrow pit. The important effects of the use of excavated materials are the reduction of environmental impact and reduction of construction costs.

5. CONCLUSION

According to the obtained testing results of static deformability module can be concluded that the material generated by excavation in heterogeneous rock mass on the section Klopce-Donja Gracanica, Corridor Vc, can be used for the construction of embankments and reinforced embankments. The measurement results are much above then requirements of the Road Construction Guidelines. The effects of using material from the excavation into the reinforced embankment are:

- small amount of soil material that ends at landfills
- small amount of material from the borrow pit
- lower costs of building reinforced embankments and motorways in general

From all of the above, it is evident that the use of material from the excavation of cuttings for the construction of reinforced embankments can achieve a significant effect of reducing the environmental impact.

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SMART & GREEN GOING DIGITAL: THE CROSSROAD OF BIH'S NATIONAL ACTION PLANS AND THE EU'S SMART CITIES' STRATEGIES – AN OVERVIEW OF NEW PROJECT PROPOSALS

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Bosnia and Herzegovina

ABSTRACT

Regarding the "smart" part, mentioned in the title, this paper will take into consideration the EU Smart Cities' strategies as examples of good practices. It will deal with only two European cities: Vienna (as officially the smartest one) and Dubrovnik. Regarding the "green" part, an emphasis will be put on the fact that our City of Zenica has, just recently, become one of them. Explanations on both concepts, smart and green cities, are also integrated. On the other side, the paper takes look at the developed action plans on all three levels in Bosnia and Herzegovina: local, cantonal and national level (LEAP, KEAP and NEAP), but puts the main focus on the Cantonal Plan. All considered APs are publicly available documents (mostly, on the relevant authorities' websites). It will also consult the most recent developments regarding the digital opportunities and the clean energy field (i.e. M. R. Greenberg's Digital Energy Innovations to Advance Clean Energy Systems). Given the mentioned corpus, the paper's main contribution will consist in cross-checking the areas mentioned in the APs for potential upgrading, and as well, project proposals based upon them, and the new opportunities brought by the 4th Industrial Revolution, i.e. digital technology. Therefore, the paper will present enhanced versions of the potential project proposals, more adjusted to the most current developments and technological possibilities.

Keywords: smart cities, green cities, action plans, digital technology, new projects

1. INTRODUCTION:

1.1 Concept of Smart City and Green City

A new paradigm for development of cities is a "smart and green" development. These two aspects have been interconnected from their start, and today are, even more, interwoven. One of common denominators is environment, i.e. its protection and sustainability. According to a recent study by the International Energy Agency, cities generate somewhere between 60 and 80% of world energy use and 76% of the world's energy related CO_2. Intelligent, ICT based solutions regarding urban planning, housing, transportation, and waste management could help environmental protection. Therefore, the broad and relevant frameworks for concepts of smart and green city are the EU Objectives on climate and energy, which set well-known 20-20-20 goals to the EU Member States. These goals mean the Member States have to reduce greenhouse gas emissions by at least 20% from 1990 levels by 2020, to improve energy efficiency by 20% and to attain a 20%-share of EU energy consumption produced from renewable resources (2020 Climate & Energy Package). In addressing these targets, the EU has taken actions in a few areas: Emission trading system (ETS), National emission reduction targets, Renewable energy – national targers, Innovation and financing, Energy efficiency. Reaching these goals means fulfilling the main purposes of green and, more broadly, smart cities, since their purposes are defined as attempts to incorporate information and communication technologies (ICT) to enhance the quality and performance of urban services such as energy, transportation and utilities in order to reduce resource consumption, wastage and overall costs. The overarching aim of a smart city is to enhance the quality of living for its citizens through smart technology. (Smart City, Techonpoedia)

2. AN ADVANCED EXAMPLE: Digital Innovation in Clean Energy

Many cities have already undertaken actions on improving citizens' life quality. An exquisite example of "smart" and "green" going hand in hand is Singapore. Namely, according to M. R. Greenberg's Digital Decarbonisation, Singapore plans to centrally integrate digitalization into its plan to further reduce the carbon footprint of its energy system while maintaining high levels of energy security and economic competitiveness. Doing so will require speeding digital innovations, and Singapore plans to be an international leader in fostering such innovations. The same author, also, states that Singapore's government is implementing several infrastructure and innovation platforms and programs to support the goals of the Smart Nation initiative. These include the Next Generation Nationwide Broadband Network, which seeks to provide ultra-high-speed broadband access to all physical addresses; the Smart Nation Sensor Platform, a sensor and data collection initiative; Virtual Singapore, a 3D city modeling and collaborative data platform; and AI Singapore, an initiative to enhance the country's artificial intelligence capabilities.

3. CITIES AS BEST PRACTICES' EXAMPLES

The "smart city" platform offers a wide scope of possibilities. Examples of two European cities, shortly presented, bring their definitions of objectives and ways of developing practical proposals for merging of ICT and environmental/urban issues.

3.1 Vienna

Vienna, as officially the smartest city in the world, proclaims in its long-term (by 2050) Smart City Wien framework strategy (Smart City Wien, 2014) intention of preserving and further evolving the city as a liveable, socially inclusive and dynamic space for future generations. This development of a city assigns priority to, and interlinks, the issues of energy, mobility, buildings and infrastructure, and emphasizes three objectives: 1. radical resource preservation, 2. development and productive use of innovations/new technologies and 3. high and socially balanced quality of life. The Strategy further elaborates on these three objectives, providing more specific objectives and explanations for each one.

3.2. Dubrovnik

The vision and model of the smart city of Dubrovnik (Aleksić, 2015) focuses on life quality, competitiveness and sustainability. According to its Strategy, Dubrovnik aims to be a HiTech city, socially responsible, environmentally aware, entrepreneurial, open and safe, and internationally recognized brand that in its core actions places welfare of its citizens. Regarding specific objectives, it elaborates on 1. improving service efficiency, 2. developing smart services in culture and tourism and 3. internal effectiveness.

3.3 Zenica

On the local level, regarding the topic of green cities, our city of Zenica has just „joined the club“, i.e started its path towards being a green city. In the course of 2018, Zenica started developing "Green Cities Action Plan": the working team has been nominated and consists of international and local experts on environmental protection, energy efficiency, space planning, and law provisions. The main purpose of this initial phase is establishing a vision of sustainable „green“ development of the City (Talks on development of GreenCities Action Plan for the City of Zenica / Razgovori o izradi Green Cities Action Plan dokumenta za Grad Zenica, 2018).

4. ACTION PLANS

The mentioned action plan presents a common tool for addressing various communal issues. These plans are official documents for developing urban and rural areas on the local, cantonal and national level. They encourage communities to take responsibility, or a part of it, for environment, to use natural sources rationally and to create organisational and financial preconditions, as well as human resources, for environment protection.

In line with the authority level which coordinates plans' development, there are LEAPs (Local Environmental Action Plans), KEAPs (Cantonal Environmental Action Plans) and NEAPs (National Environmental Action Plans).

All three types regard developing and planning, and – on the basis of the environmental status, environmental issues and defined actions – contribute to improvement of the environment status of the relevant area (s municipality, a canton or a state). Also, they help decisions-makers to direct and rationalize activities on improvement of the current state and efficient environment protection management. In addition, they clearly define the environment protection strategy which further serves for fund rising (e.g. more favorable credit lines, investments, donations, etc.) for resolving concrete environment issues in the future. They also help rising public awareness.

5. PROJECT PROPOSALS

Researching the mentioned corpus, showed worldwide examples, too advanced to be followed, and other examples with which some common developmental objectives may be shared in the near future. In order to provide a view on current status of local and regional status on environmental issues, actions plans of eight municipalities of Zenica-Doboj Canton (i.e. LEAPs of Breza, Maglaj, Kakanj, Tešanj, Zavidovići, Doboj, Zenica, Žepče), the KEAP and the NEAP, were consulted. A very important resource, provided within action plans, is a part on needed project proposals. On the basis of their knowledge, about areas they are in charge of, relevant authorities prescribe the forthcoming actions. Cross-checking these project proposals showed not only some common issues, present in several municipalities (e.g. one such issue is a waste disposal and, other, tourism development) but possibilities for their upgraded solutions, i.e. ICT-based ones. Some enhanced versions of solutions for mentioned two areas are the one regarding to waste management, **smart3C®** - Smart Clean City

Cloud an **Smart integrated waste management solution** and the one considering tourism, **smartDMCloud** – Smart Destination Management Cloud.

5.1. smart3C® - Smart Clean City Cloud

smart3C® - Smart Clean City Cloud is a smart integrated waste management solution for cities.

Considering the still insufficiently developed and quite expensive ICT infrastructure in cities, as well as the fact that all local and cantonal action plans intertwine problems related to the non-selective collection of waste and wild dumps, the first phase of development of a modern smart system for waste management should include applications to interact with all important stakeholder as well as gather information.

The use of smart devices, IoT sensors as well as advanced waste monitoring systems would represent the ultimate goal and unavoidable functionality of such a platform. This should be the second phase of platform development.

The figure below shows the functional platform architecture along with all stakeholders, and the functionalities and important factors for all stakeholders.

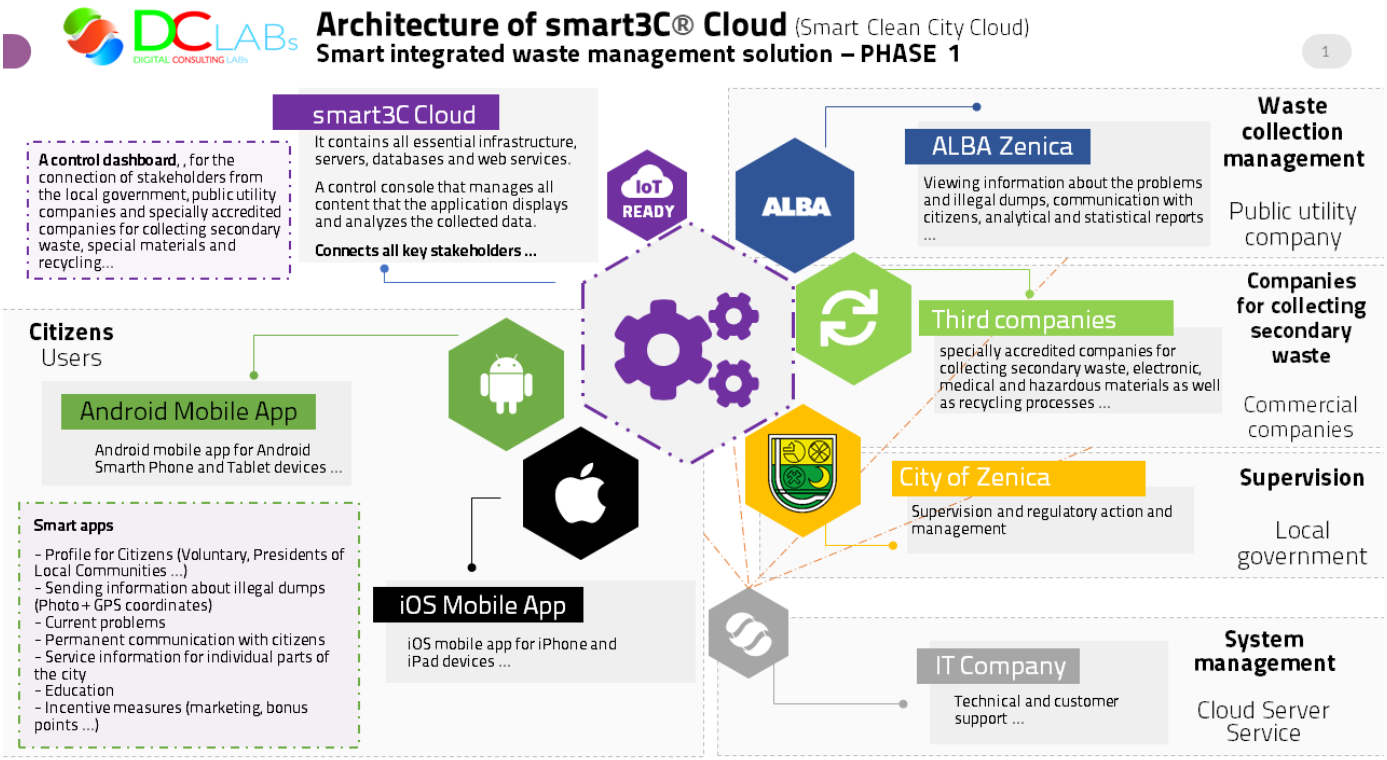

Figure 1. smart3C® Concept – Digital Consulting LABs, Zenica

Smart3C® Platform will connect Citizens, as service users and central stakeholders, whose satisfaction, opinion and feedback will be measured through the use of mobile applications.

On the other hand, through the use of the web application - control dashboard, a public waste collection company will be connected, as the main partner for the collection and management of waste, the third company, as commercial partners, whose market needs development support (hazardous substances, electronic waste , medical waste, recycling).

The City of Zenica, as a local community, will have access to all live information, and at any moment will be able to see the efficiency of individual processes, the number of problems and ways of solving them. The platform will have the possibility of communicating with citizens, and analytical and statistical information and data collection, which would be the basis for the development and implementation of new policies in the field of waste management.

5.2. smartDMCloud® – Smart Destination Management Cloud

smartDMCloud® – Smart Destination Management Cloud is a smart platform that includes smart travel guide applications, feedback collection functionality, travel trends, and a bonus points system, which includes collecting individual prizes for tourists.

Smart platform should integrate local government, city local travel office (according to new action plans, will replace cantonal tourist community offices) and service providers, as important stakeholders of local tourist offers.

The figure below shows the functional platform architecture along with all stakeholders, and the functionalities.

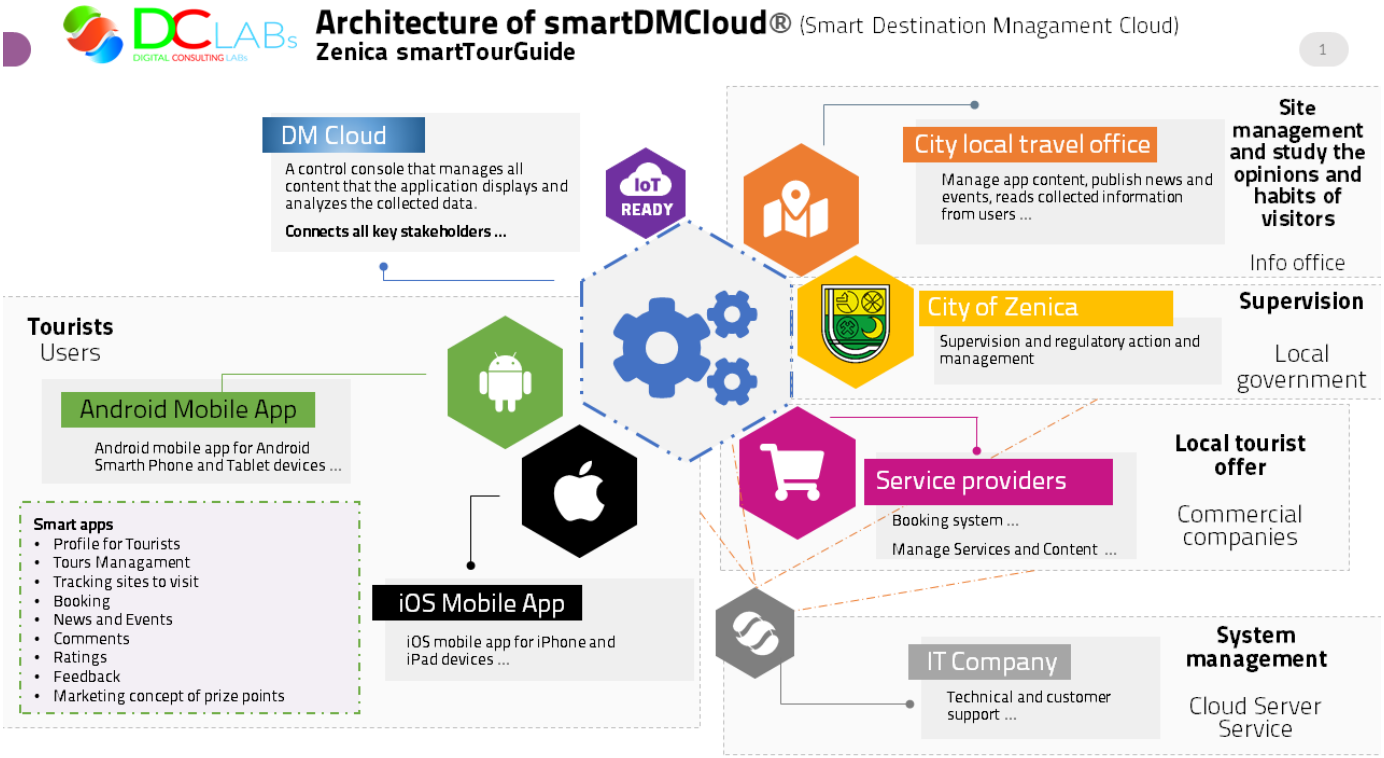

Figure 2. smartDMCloud® Concept – DigitalConsultingLABs, Zenica

The platform should be IoT ready, for integrating smart sensors for parking, local marketing boards and other smart devices, which will enhance overall tourist experience.

6. CONCLUDING REMARKS

The general ICT infrastructure in local urban environments implies a still relatively underdeveloped and expensive network, but a very wide use of smartphones.

Telecommunication companies are keen to implement new mobile networks, but they are still far from the 5G generation, which will definitely make the most of the use of IoT technology. 3G networks are fully functional, and the first 4G networks are announced.

Business processes are still not at all or, at minimum level, digitized and, especially, in terms of customer relationships. The population is generally composed of 60% of pensioners, so that the processes of education and changes in the habits of life are very difficult.

Due to general globalization and high level of technology development, particularly the young population in recent years has been changing, quite a lot and pretty fast, its habits and behaviors. They are very good at adapting to new technologies.

Taking into account the above facts, it is necessary to develop smart platforms that will, on the one hand, have the task of digitizing processes in business environments, special in the sphere of public enterprises and their easier and better connection with end users as well as local authorities as process supervisors.

Better flows of information as well as analytical and statistical data will help create better policies but, also, bring citizens closer to public services of the local communities, through improved transparency, availability and openness of local services and governments.

Newly developed platforms should also have support for connecting IoT devices, which would enable the use of smart sensory solutions and the use of artificial intelligence, and improve processes in terms of automation and maximizing efficiency through better ways of delivering services, as well as, reducing costs for emitting emission and achieving a healthier environment for life.

The creation and development of such solutions is possible only through the joint and close cooperation of the government, local public companies, universities and solution providers, but also with the inevitable support of funds for development and knowledge exchange with the EU partners.

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THE ANALYSIS OF TECHNOLOGICAL WASTEWATER MANAGEMENT IN THE DAIRY INDUSTRY

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ABSTRACT
This paper analyzes technological waste water in the dairy industry.
This paper presents a qualitative and quantitative analysis of technological waste water on the example of dairies. Measures and activities for sustainable management of technological waste water in the dairy industry and the reduction of the technological wastewater management of the dairy industry are explained. Then, the method of choosing the right technology and the example of the best process of treatment of sewage from the dairy industry from the aspect of technological, economic and environmental justification in the mentioned industry is given.

Keywords: technological wastewater, dairy industry, BAT technologies.

1. UVOD

The dairy industry consumes large quantities of water, which is needed in various processing and processing operations.
Wastewater from the dairy industry includes, depending on the production program, residues of raw and pasteurized milk, whey, butter, cheese, yogurt, packaging, washing and cleaning agents, residues of various products in laboratory testing, mechanical oils and fats, combustion oils, etc.
For example, cheese, powdered milk and evaporating plants produce larger quantities of wastewater from milk pasteurisation, and data on the amount of water used in the dairy industry indicate the volume of water needed to process a certain amount of milk.
The composition and amount of waste in waste water also depends on technical and technological discipline, and it should not go to sewage, but to wastewater treatment plant. Dairies use large amounts of water during processing, processing, cleaning and washing.[1]
Wastewater in the dairy industry can be divided into three main categories:
1. Process water - includes water used in the cooling and heating process. These wastewaters do not contain pollutants and may be reused or minimally decomposed into the composition of rainwater.
2. Industrial wastewater - mainly fueled by the cleaning of equipment in contact with milk or dairy products, by dipping milk and dairy products, cheese pressing and whey separation, CIP cleaning options, after malfunctions and even operational errors.

3. Sanitary Waste Water - Most commonly occurs in sanitary nodes. Sanitary waste water is usually piped directly into a wastewater treatment plant with or without prior mixing with industrial waste water. [2]

The production of milk and dairy products is a long and complex technological process consisting of a number of technological options and techniques, and as such affects the environment. In order to improve the production and processing of milk as well as to achieve enormous savings, it is necessary to act first and foremost. One of the ways of preventive action is the introduction of cleaner technology in production processes of milk and dairy production and processing.

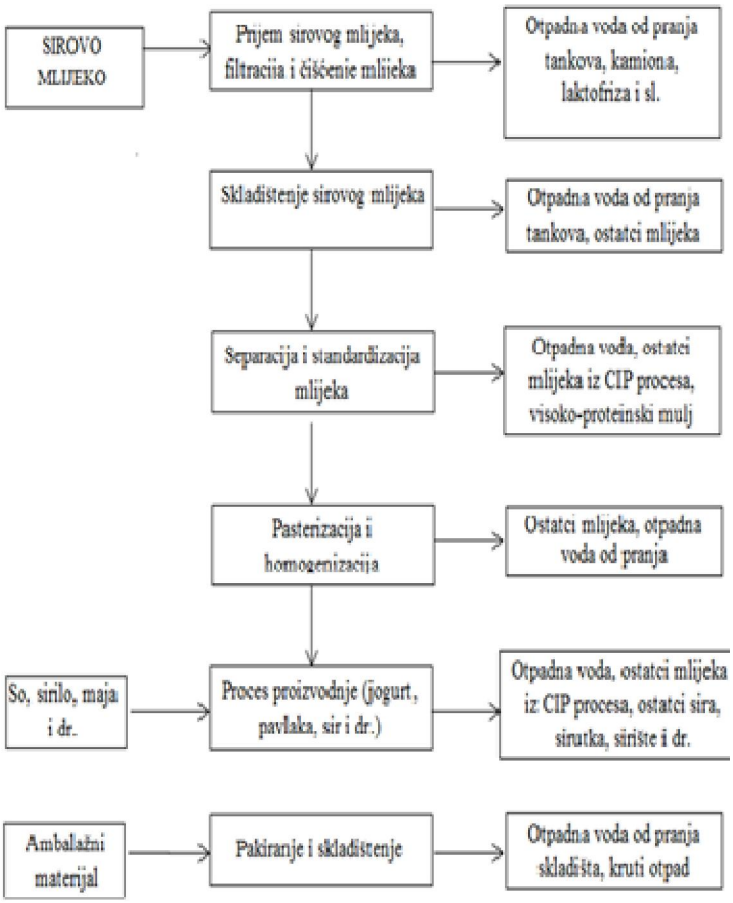
2. ORIGIN AND CREATION OF WASTEWATER

Industrial wastewater is generated by the use of water in technological processes and energy production.

In order to gain insight into the composition of wastewater, it is necessary to specify: [3]

- the content of components specific to the given production, such as phenols, petroleum derivatives, surface active substances, toxic, radioactive and dangerous substances;
- the total amount of organic contamination expressed in BPK5 and HPK;
- active water reaction (pH value);
- degree of mineralization;
- content and nature of suspensions, etc.

A dairy who is the subject of this research is supplied with water from the public water supply. The amount of water used is recorded by water meter. Technological wastewater is created in the process of washing and disinfection of technological lines, washing machines, appliances, technological equipment, working rooms and surfaces.



Slika 1. Blank Diagram of Technological Process of Milk Production and Place of Creation of Technological Waste Water.

In picture 1. block diagram of the technological process of milk production and the location of technological waste water is shown. It shows that technological waste water is created when: milk from tanks into tanks, standardization, pasteurization, storage of products, filling in packaging, floor washing and surface, car wash, shoe washing machines, devices and technology lines, as well as product control etc.

3. QUALITATIVE AND QUANTITATIVE CHARACTERISTICS OF TECHNICAL WASTE WATER FROM MILK INDUSTRY

Technological waste water from dairies is a variable composition. They typically have a high BPK, especially wastewater from the process of making pavilions, butter, cheese and whey. The high level of KPK and the high concentration of suspended matter can present a problem in waste water from this industry as well as the presence of other pollutants such as phosphorus, nitrogen and chlorides. There may also be a problem with the wide range of pH and the temperature of technological wastewater.

3.1. Qualitative and quantitative characteristics of technological waste water on the example of the concerned dairy

The following table shows the results of the analysis of the quality of waste water released on 10.09.2018.

Tabela 1. Results of the analysis of the quality of the waste water discharged, 10. 09. 2018. godine

PARAMETER	MEASURING UNIT	MEASURED VALUE	Limit value Public sewerage [8]	Limit value for surface water [8]
Water temperature	ºC	25,6	40	30
pH value	pH jedin	4,64	6,5-9,5	6.5-9.0
Total suspend. substances	mg/l	287	<400	35
Chemical Oxygen Consumption, HPK-Cr	mgO_2/l	1968	700	125
Biological oxygen consumption BPK_5	mgO_2/l	633,1	250	25
Precipitating substances	ml/l	6,0	10	0,5
Detergents total	mg/l	7,13	10	1,0
Chlorides	mgCl/l	260,9	250,0	250,0
Total nitrogen N	mg/l	3,26	100	15
Total phosphorus P	mg/l	14, 9	5.0	2.0
Total oils and fats	mg/l	9,5	100	20
Flow, Q	m^3/dan	41,4		

The results of the efluent quality test in the concerned dairies, shown in Table 1, show that the organic load expressed through BPK_5 and KPK, total suspended matter, sediment, total detergent and total phosphorus exceeds the emission limit values released into surface water bodies , as set forth in the Decree on the Conditions of Pollution from Wastewater in the Environment and Public Sewerage Systems (Official Gazette of FBiH, No. 101/15) [4].

Based on the measured values of the parameters in the wastewaters shown in the table and their comparison with the limit values prescribed by the Decree on the conditions of discharge of wastewater into the environment and public sewerage systems it is seen that the input of pollutants

into the watercourse or river from the operation of the concerned dairies exceeds the permissible values . A higher value of wastewater pollution is noted through suspended matter, HPK, BPK5 and some other parameters. Such wastewater quality from the dairy farm was also expected, as it is not purified prior to discharge into the recipient.

4. METHODS FOR REDUCTION OF TECHNICAL WASTE WATER IN THE CONCERNED DAIRIES

Comparison of the measures taken and to be undertaken by the dairies concerned with the measures available in the best available techniques in the food, beverage and milk industries (Technical Guidance - Food Industry: Sector of Milk Production and Processing (document under the BREF EU Document) Best Available Techniques in Food, Drink and Milk Industries, EC, August 2006), is presented in the following table.

Tabela 2. Comparison of measures taken in dairies with measures given in the best available techniques in the food, beverage and milk industries.

Prevention measures for reducing technological wastewater		
Mjere	*Mjere date u BAT-u*	*Komentar za predmetnu mljekaru*
Water consumption monitoring	- Installing individual water meter metering units per production plant	This measure does not apply to the concerned dairies. Water meters should be installed to measure the water consumption of each production plant (eg sage, cheese production department, etc.). In this way, it would be exactly where the greatest water consumption was and could repair unnecessary water losses if they exist.
Reduced water consumption	- Use automatic water opening / closing controls - Separation of Output Flows for Optimization of Use, Reuse, Recycling and Disposal - Dry cleaning of equipment and installations - Pre-soak flooring and open equipment to prevent impurities before cleaning - Management of water, energy and use of detergents - Low pressure cleaning with foam - CIP cleaning and its optimal use	Milk is in various ways trying to reduce water consumption. By implementing these recommendations and measures in the concerned dairies, a number of environmental benefits would be achieved, such as reducing water consumption and reducing wastewater, reducing wastewater waste water, increasing the possibility of re-use of water and reduced energy use for water heating and reduced use of detergents and other hygienic means. It should be noted that some of these measures are already being applied to dairies but improvement of already existing and specified measures will be achieved. An example of one of the measures taken in dairies to reduce water consumption is a line of cheese spreads where the water supply process is automated and the stream automatically interrupts to a certain amount of water. Also in the units there are built-in washbasins, then high-pressure sprinklers are used to reduce water consumption.
Reduction of wastewater production	Measurement and flow control	By applying this recommendation to dairies, there would be a reduction in the amount of waste materials, products and water, as well as reduction of wastewater production. Measures are being taken in milk to reduce wastewater production, but they are not sufficient to meet the legal regulations regarding the amount of waste water that is discharged into the watercourse.
Elimination or reduction of pollutants in waste water	Separation of water flows to optimize re-use and treatment - Dry cleaning of equipment	By applying these recommendations, water pollution can be reduced by separating clean from dirty water. The dairies apply a detailed mechanical cleaning of the

	and installations - Supply and use of siphon in floors	facility and plant before washing and watering, and takes care of the application of cleaning and hygienic means which in some way reduces the burden of waste in waste water. It is also necessary to use siphons in the floor to prevent solid substances from getting into the waste water, which reduces suspended matter, BPK, KPK, grease and oil etc.
Recycling and re-use of water	-CIP cleaning and its optimal use -The use and recycling of water for cleaning in dairies	Part of the water used in CIP washing is collected in a hydrophore pool and subsequently used for washing. Then the ice water in the circular stream returns to the ice water pool, cools and returns to the system. This is part of the recommendations used in dairies but there are numerous ways to reuse water in dairies with certain eg advanced water treatment

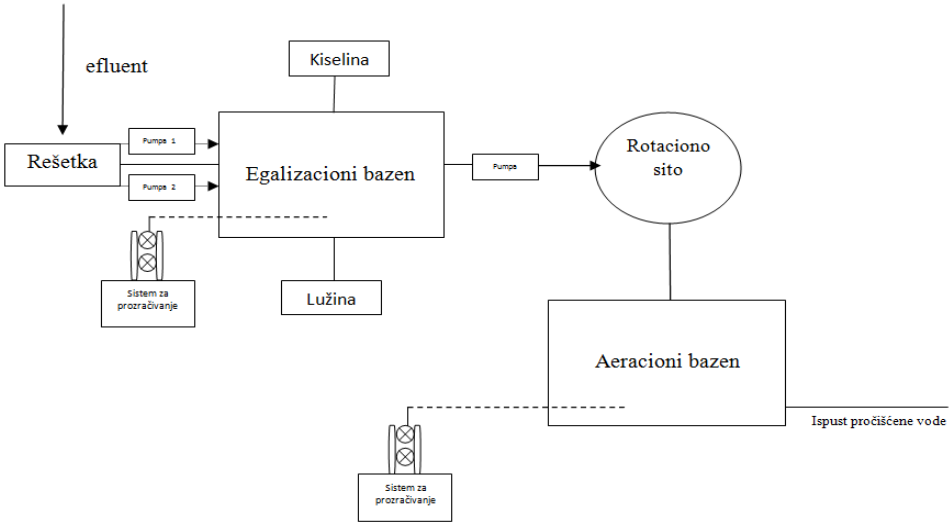
Based on the table, it is concluded that water consumption and the emergence of larger quantities of wastewater are a more significant environmental problem in the process of milk processing and production, and that special attention should be paid to them. Specifically, dairies should take significant measures to reduce water consumption and reduce technological waste water, as far as possible some of the measures presented in the previous table. I believe that attention should be paid to measures based on the concept of prevention and reduction of consumption and those that do not require excessive costs, which are shown in the examples as profitable and affect the achievement of set goals in terms of reducing consumption and achieving ecological benefits, without altering or reducing the planned volume of production and the specific quality of final products

5. CONCEPT RESOLUTION OF WASTE WATER DISTRIBUTION IN DAIRY INDUSTRY

5.1. Description of the technological waste water treatment process

In order to achieve the required wastewater quality in accordance with the prescribed limit values for the discharge of wastewater into another receiver, it is necessary to select a system that allows adjustment of the process of purification of the load and the required quality of purified water, which is discharged into the second receiver, in the river. Picture 2 shows a schematic of the process of purification of waste water in the concerned dairies with the aim of reducing pollutants by the load of technological waste water discharged from dairies.

Wastewater in dairies are quality-specific and are burdened with special organic substances, detergents, oils and greases, increased pH value, total suspended matter and other pollutants. According to the results of the examination of the state of the wastewater quality of the subject dairies carried out by the authorized laboratory, water quality indicators that occasionally exceed the permitted values are: suspended matter, organic load expressed through HPK and BPK5, pH value and some other pollutants. The proposed technological solution aims at achieving a certain degree of efficiency in the waste water treatment process and improving the quality of the effluent (degree of organic load removal, suspended substances, etc.), all in order to meet the prescribed standards for the quality of the effluent and the recipient releasing the technological waste water. To achieve the required quality of wastewater to drain into another receiver, it is necessary to separate, according to the latest measurements (Table 1 - shown earlier in the paper): suspended matter, then reduce the organic load, maintain the pH value within the limits prescribed by certain requirements, of total phosphorus in waste waters and reduce the content of other pollutants in order to achieve the best quality of effluent. To achieve the above mentioned requirements, the system shown in Picture 2 is proposed.



Slika 2. Scheme of Wastewater Treatment Process

6. CONCLUSION

Technological water consumption, drainage and wastewater treatment is the most significant environmental problem in processing and milk production.

Based on the measured values of pollutants in wastewaters shown in this paper, it can be concluded that a noticeable higher value of water pollution is expressed through suspended matter, HPK, BPK5 and other parameters as well as pH variation.

Since the quality of the effluent does not meet the prescribed criteria for the discharge of surface water, it is necessary to build a system for the purification of technological waste waters, using the most appropriate technology for purification from the technological, economic and ecological point of view. The measurement results presented in the paper show that the organic load, the pH value, the suspended particles occasionally exceed the limit values prescribed by the Decree.

The proposal of the wastewater treatment system in the concerned dairies is based primarily on reducing the organic load in wastewater expressed through BPK5 and KPC, and reducing suspended matter, phosphates and other harmful substances as well as correcting the pH value. In order to achieve the required wastewater quality which is in accordance with the prescribed limit values for wastewater discharge into the second receiver, a system has been selected to adjust the process of purifying the load and the required quality of the purified water that is released into the second receiver. The proposed measures, activities and conceptual solution of the dairy treatment system of the dairy are aimed at achieving a certain degree of efficiency in the waste water treatment process and improving the quality of the effluent (degree of organic load removal, suspended matter, etc.), all in order to meet the prescribed standards for the quality of the effluent and the recipient in which the technological waste water is discharged.

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CONCEPT OF TECHNICAL-TECHNOLOGICAL SOLUTION OF WASTEWATER TREATMENT OF MILK INDUSTRY USING GPS-X SOFTWARE

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ABSTRACT

Technical and technological solutions for wastewater treatment of milk industry are presented in this paper. In the first part of the paper, a description of the operation of the milk production plant, the inventory of liquid waste streams, the monitoring of the quality of wastewater by previous measurements and the comparison with the relevant standards and BAT recommendations and the current treatment of wastewater are given. The choice of the appropriate solution was done by simulating the GPS-X software. Subsequently, the basic characteristics of the elements of the system for wastewater treatment are described. The final solution was selected based on the quality of the effluent ie. its acceptability with respect to the recipient, economic and spatial aspect. The achieved reduction of pollutants ranges from 70 - 90%.
Keywords: wastewater treatment, milk industry, GPS-X, SBR reactor

1. INTRODUCTION

Milk and dairy production is one of the fastest growing food sectors in Bosnia and Herzegovina. The current annual capacity is about 400 million liters of milk. The most significant environmental problems in milk production and processing are large water consumption, high energy consumption, significant volume of waste water, presence of organic matter in wastewater.

Wastewater from the dairy industry by its origin (characteristics) can be sanitary-fecal and technological. Technological waste water is created when washing dishes, packaging, machines, washing machines and tanks. Because of the larger amounts of organic pollutants in the wastewater of the milk industry, it is necessary to perform their treatment before discharge into the recipient. As waste water is discharged into watercourse of second categorie, it is necessary to achieve a high degree of purification.

The aim of this paper is to develop a technical and technological solution for the management of waste water from the milk industry in multiple scenarios and to choose the best from the aspect of the quality of the effluent to its eligibility with respect to the recipient. In this case, it is a milk industry that is active in Bosnia and Herzegovina.

2. QUALITY OF WASTE WATER OF MILK INDUSTRY FACILITY

According to the place of origin and the chemical characteristics, the waste water of the company whose wastewater is treated in this work are classified into the following categories:

- Sanitary - fecal,
- Precipitation waters, i

- Technological waste water.

The data presented in Table 1 show that HPK, BPK5, pH, suspended matter and toxic substances exceed the maximum permissible concentrations according to the Decree on Wastewater Discharge Conditions and Public Sewerage Systems and significantly exceed the Water Level II Class Limits according to the Water Management Classification Regulation BiH.

Table 1. Data on quality of discharged watewater for analyzed milk industry for 2017

Parameter	Unit	Results	Results	Limit values		
		Discharge E1	Discharge E2	**River**	Public sewerage	II class river
Flow	m^3/day	10,3	0,3			-
Temperature	^oC	15,4	15,6	30	40	-
pH	-	4,35	7,76	6,5 - 9	6,5 – 9,5	5,8 – 8,5
Color	Pt/Co skala	16,01	12	-	-	-
Oxygen content	mg O_2/l	6,87	6,95	-	-	-
Precipitating matter according to Imhofu	ml	0,3	0,2	0,5	10	-
SM	mg/l	123	14	35	400	30
HPK	mg O_2/l	197	64	125	700	12
BPK_5	mg O_2/l	118	16	25	250	4
Electrical conductivity	µS/cm	562,2	342	-	-	-
Ammonium nitrogen	mg N/l	0,34	0,56	10	40	-
Total nitrogen	mg N/l	5,2	0,21	15	100	-
Total phosphorous	mg P/l	1,45	0,31	2	5	-
Toxicity ($48LC_{50}$)	%	40,48	73,25	>50	>50	>50
Total oil and grease	mg/l	3,4	1,3	20	100	-

3. TECHICAL- TECHNOLOGICAL SOLUTION OF TREATMENT OF WATEWATER

When the characteristics of the wastewater and characteristics of the receiver are known, it is possible to determine the required degree of wastewater treatment. It is theoretically possible to completely remove BPK5, but in practice the purification is carried out to the degree to which the receiver can be charged without deteriorating its quality. Waste water purification is carried out using physical, chemical, physical and chemical processes and biological processes. According to the degree of purification, given the applied processes and processes carried out on the waste water treatment plant, we distinguish:

- preliminary or preliminary level of purification (grid, pump station, flowmeter, grease and oil separator);
- first degree of purification or primary purification (egalization pool, primary sediment);
- second degree of purification or secondary purification (biological procedures, SBR, MBR);
- a third degree of purification or tertiary purification.

The basic characteristics of the wastewater industry in the milk industry that must be taken into consideration when designing the cleaning equipment are:

- Flow variations;
- Variable pH value;
- Waste water may have a lack of nitrogen;
- Waste water can have high phosphorus content if phosphoric acid is used for cleaning. Full-fat milk also has a high phosphorus content;
- Treatment of wastewaters results in lower sludge content due to low content of suspended matter, lower nutrient ratio and microorganisms;
- It is necessary to set the maximum burden of pollution when designing the oxygen supply.

Before watering in the purification plant, it is necessary to reduce water pollution at source or by using pre-treatment:

- Separation of water according to one or more criteria: suspended matter, BPK, high salinity, etc .;
- Installation of grids for removing large waste;
- Provide equalization of flow and load;
- Flotation of dissolved air for the removal of grease, oils and suspended matter;
- For processes where BPK5 has values between 1,000 and 1,500 mg / l, consideration should be given to the use of an anaerobic process
- For waste water of lower concentrations, the most convenient use of aerobic processes is, for example, a capping filter with high filtration speed
- Conventional active sludge system for wastewater with lower concentrations of waste materials;
- Other active sludge variants (pure oxygen, SBR, MBR) can be used wherever economically feasible;
- Hybrid aerobic reactors can also be used, such as a dived biological aerated filter.

3.1. Simulation of results of SBR device by using GPS-X software for selected milk industry

When modeling wastewater treatment systems for milk industry, grids, an asymmetric pool and a primary precipitator are used as a follow-up SBR reactor element. Figure 1 shows the model of wastewater treatment plant with SBR reactor.

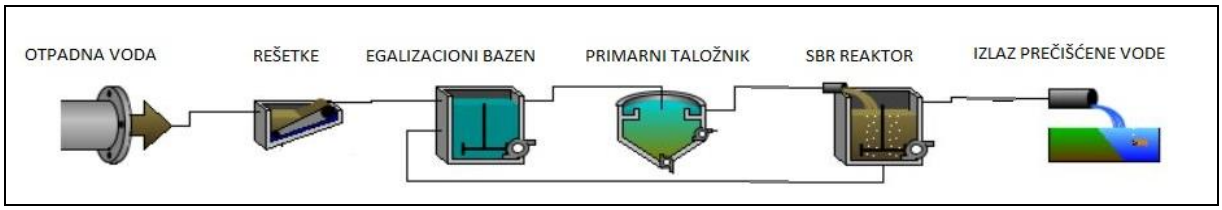

Figure 1. Facility for wastewater treatment by using SBR reactor

The following tables show the results of the SBR reactor simulation of the selected milk industry. It can be seen from the results that the purified water from the proposed solution meets the maximum permissible concentrations of pollutants for the watercourses II category.

Table 2. Characteristics of waste water after passing through grids

		WASTEWATER AFTER GRIDS	WASTE FROM GRIDS
Flow	m^3/d	14,55	5,326
SM	mg/l	21,53	74,15
HPK	mg/l	148,1	141,50
N	mgN/l	3,98	1,96
P	mgP/l	1,05	2,479
pH	-	4,606	5,38

Table 3. Grid operating data

		WASTEWATER AFTER GRIDS	WASTE FROM GRIDS
Total removal of particles	%	27,41	-
Quantity of waste from grids	kg/d	-	86,97

Table 4. Characteristics of waste water at exit from the egalitization pool

		WASTEWATER AFTER EGALIZATION
Flow	m^3/d	15,38
SM	mg/l	105,8
BPK_5	mg/l	99,7
HPK	mg/l	133,4
N	mgN/l	4,22
P	mgP/l	1,206
pH	-	5,125

Table 5. Operational data of the egalitization pool

		WASTEWATER IN EGALIZATION POOL
Retention time	h	9,77
Volume	m^3	16,6
Quantity of oxygen	mgO_2/l	15,68

Table 6. Waste water characteristics at the exit from the primary setlement

		CLEAR WATER	RETURN OF WASTEWATER
Flow	m^3/d	14,62	5,229
SM	mg/l	46,86	39,43
BPK_5	mg/l	150,5	77,36
HPK	mg/l	308,2	93,11
N	mgN/l	4,24	4,50
P	mgP/l	1,204	1,5
pH	-	7,644	5,699

Table 7. Operational data of primary setlement

		WASTEWATER IN SETLEMENT	RETURN OF WASTEWATER
Retention time	h	4,327	-
Surface load	$m^3/(m^2.d)$	21,47	-
Efficiency of SM removal	%	40,29	-
Efficiency of BPK_5 removal	%	8,642	-
Efficiency of N removal	%	11,15	-
Efficiency of P removal	%	16,32	-
Flow og waste sludge	m3/d	-	8,933
Quantity of sludge	kg/d	-	83,3

Table 8. Wastewater characteristics in the reactor

		WASTEWATER IN REACTOR
Flow	m^3/d	-
MLSS	mg/l	11,27
MLVSS	mg/l	14,76
HPK	mg/l	22,97
N	mgN/l	0,53
P	mgP/l	1,679
pH	-	7,142

Table 9. Operational data for SBR reactor

F/M	$kgBPK_5/(kgMLVSS.d)$	2,62
Organic load	$kgBPK_5/(m3.d)$	2,384
Volume	m^3	15,523
Height of water	m	4,96
Aeration	h	0,5816
Mixing	h	1,126
Precipitation	h	1,6351
Discharge	h	0,3344

Table 10. Simulation results in GPS-X software using SBR wastewater treatment technology

PARAMETERS		DISCHARGE OF WASTEWATER	MDK for II category river
Flow	m^3/d	14,6	-
SM	mg/l	9,515	30
BPK_5	mg/l	3,964	4
HPK	mg/l	11,568	12
Ammonium N	mgN/l	0,673	-

Nitrite N	mgN/l	0,3850	-
Nitrate N	mgN/l	0,2630	-
Total N	mgN/l	9,662	-
Total P	mgP/l	1,329	-
pH	-	7,4	5,8 – 8,5

For system elements: egalization pool, primary sediment, and SBR reactor, three pumps need to be installed to allow water to drain into the next device. The relevant flow rate of 15 m3 / h is set to the pump CVM AM / 4 with the following characteristics:
- power: 0.3 kW,
- flow: 4.8 m3 / h,
- Revolution: 2850 rpm,
- degree of efficiency: 77.2 - 81.3%
- frequency: 50 Hz.

For sludge reuse, DRK 05-1B pump will be used with the following features:
- power: 0.4 kW,
- flow: 5.5 m3 / h,
- Revolution: 2850 rpm,
- degree of efficiency: 76 - 79.7%
- frequency: 50 Hz.

3.2. Simulation of MBR device using GPS-X software for selected milk industry

When modeling the wastewater management system for milk industry, grids and an egalitization pool have been used as supporting MBR components, while primary and secondary sediments are not required. Figure 2 shows the model of waste water treatment plant with MBR.

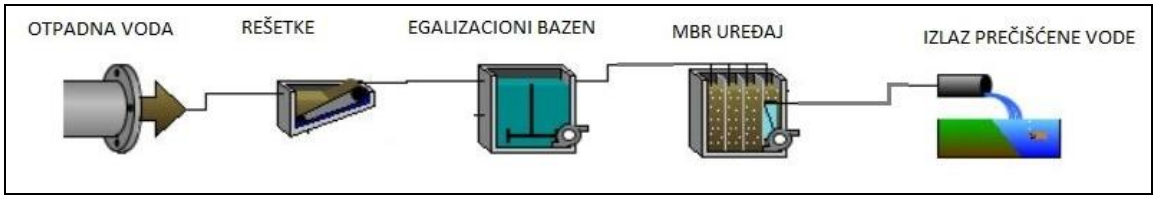

Figure 2. Sewage treatment plant using MBR device

Table 11 shows the results of the simulation of the MBR device operation for the selected milk industry. It can be seen from the results that the purified water from the proposed solution meets the maximum permissible concentrations of pollutants for the watercourses II category.

Table 11. Simulation results in GPS-X software using MBR wastewater treatment technology for the dairy industry

PARAMETERS		DISCHARGE FROM PLANT	MDK for II category river
Flow	m^3/d	13,56	-
SM	mg/l	22,06	30
BPK_5	mg/l	1,695	4
HPK	mg/l	9,265	12
Ammonium N	mgN/l	1,318	-
Nitrite N	mgN/l	0,5661	-
Nitrate N	mgN/l	1,484	-
Total N	mgN/l	1,239	-
Total P	mgP/l	1,33	-
pH	-	6,61	5,8 – 8,5

6. CONCLUSION

GPS-X software has made it easier to choose the best waste water treatment solution because it did not have to go through the entire budget to see which system has the highest degree of efficiency. When searching literature in the field of the topic of this paper, it was concluded that the SBR reactor and MBR device would be the best choice for the treatment of opacifiers of selected milk industries. Simulations in GPS-X software have shown that both proposed devices have a high degree of wastewater purification. Although the MBR device occupies less space, the SBR reactor with the accompanying elements is the ultimate wastewater treatment solution for both industries. The crucial factor for selecting SBR reactors is its economic viability, as it has less investment costs and less maintenance costs than the MBR device.

As a proposal for reducing the occurrence of larger quantities of wastewater, it is recommended to use more rational water plants when washing plants and equipment. Rational water consumption would lead to a significant reduction in waste water treatment costs, which would greatly facilitate dairy business.

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THE 4TH HELIX IN THE QUADRUPLE ONE: THE CONTEMPORARY CONCEPT AND THE CASE STUDY OF BOSNIA AND HERZEGOVINA IN THE FIELD OF ENERGY AND AGRICULTURE

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ABSTRACT

The triple-helix model, which consisted of government, industry and university, just recently got updated in the quadruple one, which now, as the 4th helix, includes the civil society. The paper will start from the political concept of civil society, and its main features, i.e. actors. The paper will advance to the role of civil society within the quadruple helix, and finally, reach its present role in Bosni and Herzegovina. Within this role, as the practical examples, of the civil society's engagments, will be presented two separate attempts of an NGO (i.e. Green Council) to influence an ongoing process of defining policies and, more importantly, relevant documents (i.e. the State Strategy on Energy and the Strategy on Agriculture and Rural Development BiH) and to advocate for changes of these strategies in the way of adjusting them to the relevant EU recomendations for the benefit not only of primary stakeholders but all citizens of Bosnia and Herzegovina. On the basis of this paper, a conclusion imposes itself that, although, an improvement has been made and the voices of the civil society are more easily heard nowdays, still more time will be needed for them to be truely acknowledged by the relevant authorities.

Keywords: quadruple helix, civil society, NGO, policies, influence

1. INTRODUCTION

Regarding development of triple-helix model, Etzkowitz (2002) explains that bilateral relations between government and university, academia and industry and government and industry have expanded into triadic relationships among the spheres, especially at the regional level. Therefore, these triadic relationships represented the structure of the later triple helix which related to connection among university-industry-government, established for the mutual benefit of all three parties and generated by knowledge-based development.
With changes occurring in the system of creating and organizing knowledge, this helix also altered. It lacked a part. As Cavallini et al. (2016) identified that knowledge creation has been now trans-disciplinary, more reflexive, non-linear, complex and hybridized. Furthermore, inclusion of the fourth helix becomes critical since scientific knowledge is increasingly evaluated by its social robustness and inclusivity. Public interest is important in this regard. The fourth helix highlights new discoveries and innovations that improve social welfare e.g. eco-innovation.
Triple helix has been enhanced by the fourth helix, represented as participation of civil society in the overall process of innovating, and more broad, knowledge creating. Cavallini et al. (2016) add that this also allowed moving towards 'open innovation', where innovation becomes a process inclusive of "all stakeholders as active players in jointly creating and experimenting in the new ways of doing things and creating new services.

2. CIVIL SOCIETY – CONCEPT AND ITS MAIN ACTORS

A great account of main characteristics of civil society was given by John Kean in his book „Civil Society", published in 1998, describing features of community understood as civil society, various historical and political points of its development, its significance for democracy and defense of democratic values, introduces the term of multitude of civil societies, ponders on character of contemporary civil societies and values supported by these societies as are concerns for the benefits of the overall society and common good.

While in triple-helix model, academic community and business sector provided necessary scientific „ecosystem", government was in charge of legal and financial aspects needed for innovations, civil socitey was seen as a sphere of application of knowledge. But, in quadruple helix, this civil society role has changed and it became an active stakeholder. Due to development of ICT, participation of civil society experienced fundamental change. Now, it was enabled to take part in the whole process with regard to its main feature, already mentioned: concern for benefits of the overall society.

3. CIVIL SOCIETY IN BOSNIA AND HERZEGOVINA

There are two distinct periods regarding ways of citizens' organizing: period before the war in 1992 and after it. Before the war, in the 1980s, some civil intiatives appeared, but after the war, in word of C. Milan „the mushrooming of civil society organizations" took place. Among many CSOs and their different objectives and engagments, an emphasis here is put on civil society's practical engagment on improving life quality and conditions of business operating for a great deal of society via scholar contributions and impacts made on relevant policies and policy-makers. Regarding policies, as relevant, here are considered those related to the State Energy Strategy and the Strategy on rural development of BiH.

3.1. Examples of civil society's practical engagement

3.1.1 Analysis of the Framework Energy Strategy

The Analysis of the Framework Energy Strategy of BiH can serve as an example of a CSO practical engagement. It is a policy document which, due to its importance and scope (i.e. a large number of fields that impact climate change are involved here), has to be open for public disscusion by all interested stakeholders. Since the Green Council's point of view is that the most important goal of

strategic planning in BiH must be a citizen, his/her security, sustainability, employment, satisfaction, quality of life and the health of all generations, it took part in analyzing the State Framework Energy Strategy. Some of the Council's recommendations were:
- The overall strategy has a conservative rather than a developmental character.
- The ecologically viable strategic scenario has been completely omitted.
- Specific data on sustainable development and greenhouse gas emissions has to be updated.
- It is necessary for the Strategy to unequivocally highlight the imperative of respecting the priorities of the EU Strategy (arising from the legal obligations of BiH within the Energy Community).
- In general, it seems that BiH has not particularly ambitiously defined the priorities for the suppression of greenhouse gas emissions - as already mentioned – nor the "green" scenario does eliminate the full use of coal in the production of electricity and heat.
- It is needed to develop new models of collective and individual electricity production and new models of funding through energy co-operatives and public-private partnerships.
- In the Strategy of BiH, energy efficiency has not been set as an indispensable integral part of the overall strategy and the key segment of the energy market and the value chain of all sectors considered (electricity, oil, gas), but is considered separately, in the Chapter on Energy Efficiency.
- Energy efficiency is an interdisciplinary area and it must be approached interdisciplinary. Environmental protection through EE, green jobs, green public procurement, the latest EU demand for the so-called "nearly zero-energy buildings" (NZEB), education that brings developments of new technologies, as well as the construction sector, which is the largest consumer, but also the polluter, are not adequately addressed. EE implies in its definition the quality of life and health, what, also, has not been mentioned in one sentence.
- The energy market (electricity, coal, natural gas, oil products and thermal energy) has been largely descriptive and without a detailed assessment of the impact on the achievement of the set goals.
- The strategic document should be aligned with the obligations set out in the Paris Climate Change Agreement.
- There are no new business models in the Strategy to enhance the competitiveness of thermal power plants (resource efficiency, back stop technology, conglomerate, etc.).
- Energy poverty is a big challenge in BiH, and it is caused by low incomes and energy inefficient housing. A new approach to the protection of vulnerable consumers has to be identified, including helping consumers reduce energy costs for consumers by supporting investment in energy efficiency and providing guidance.
- It is clear that BiH has delivered the insufficiently ambitious goals (even in comparison with the countries of the region) *(*Green Council, Politike okoliša koje nose ekonomski razvoj BiH, 2017).

3.1.2 Analysis of the Agriculture and Rural Development Strategy BiH

Also, regarding a recent Strategy on Agriculture and Rural Development BiH, the Green Council made an analysis and, among others, concluded that it was primarely a political document, adopted under the influence of pressure and it was, even, created only to satisfy a certain formality on the basis of the EU request, and not really to bring enhancement and changes to rural development of BiH and its citizens' welfare (Green Council, 2018). In line with the constructive role of civil society, Green Council, in the same Analysis, recommended the following:
- The objective of a new strategy should be a real and concrete enhancement of life in the rural parts of BiH.
- The issue of missing data should be dealt with and the issue of more quality collection of statistical data, respectively. First, an agricultural survey has to be done.
- From the very beginning, in the process of making strategy, it is necessary to include all key players, having an impact on life and development of rural areas.
- In a state analysis and other parts of a plan, precisely define real expectations from the private sector and donors;
- On the basis of comprehensive analysis set strategic and operative objectives;
- Every measure has to have a stronghold in the state analysis, and contribute and fulfill at least one objective;

- Clearly separate direct support measures, rural development measures, and other general and/or administrative measures. Direct support measures should not be treated in strategic documents for rural development;
- Present budget according to measures and sub-measures;
- Key aspects of implementation method should be written concisely and in a more quality way;
- Develop a monitoring plan, including definitions of milestones, as a plan for evaluating the achieved results (in points of milestones and at the end of period);
- Since advisory services are becoming an inseparable part of the EU rural policy measures, use that practice in BiH;
- Specially nurture policies on environment protection, on green public procurements and circular economy;
- Establishment of functional IPARD structure for BiH (Green Council, Politike okoliša koje nose ekonomski razvoj, 2018).

The above mentioned remarks and recommendations are singled out from a larger body of text, which the Green Council produced on this topic. The points, stated here, only speak in favor of the role of civili society and its engagment on advocating for improving quality of state policies, since they impact quality of life of all citizens. This kind of egagement, also, asks for a high level of professional knowledge about a topic discussed and, along with it, it combines many, various expertises, i.e. it is a practical example of interdisciplinary and multidisciplinary cooperation.

4. CONCLUDING REMARKS

The civil society transformed its role form a passive one into an active and it competently participates in many ongoing processes, including policy-making. Examples of this participation are two analysis done by group of experts, gathered under the Green Council from Sarajevo. They provided a critical overview of two state strategic documents which set long-term policies, vital for all members of BiH society. One is the State Strategy on Energy and other the Strategy on Agriculture and Rural Development BiH. Taking care for the benefits of the overall society is seen in the Council's recommendations which try to improve the overall status of BiH and its citizens by urging for sustainable policies in both cases and adequate roles of all key players (among which are universities and academic community). The civil society's voices have been heard, but since there is no crucial changes done by the other side, i.e. authorities, it is likely it will take more time, attempts, analyses and recommendations to be done before CSOs truely exercise their right of being an equal participant in decision-making processes of the society they live in.

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THE SCOPE OF ENGLISH LANGUAGE TEACHING ON RENEWABLE ENERGY WITHIN OBJECTIVES OF RESI PROJECT

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ABSTRACT

This paper brings a proposition of potential scope of English language teaching for master study program developed within the Tempus project RESI. First, the paper will explain the mentioned project and its objectives. After it, it will present the concept of renewable energy, and as well, the whole curriculum designed within this project. Also, it will take into consideration the English language module of the first study cycle and, on the basis of the Curriculum Development Good Practice Guide and the UNESCO's Textbook for Sustainable Development, the paper will offer a module focused on renewable energy. The paper's contribution will be in defining module aims, learning outcomes, teaching and learning methods, indicative syllabus content, learning delivery, assessment rationale, generic assessment criteria, learning resources, and employability and transferable skills. Within the indicative syllabus content, it will elaborate on features of technical language teaching, tailor-made for future engineers, in the field of renewable energy, i.e. it will make connections between the most important areas of renewable energy and language skills, students need to develop, for a real working environment.

Keywords: English language teaching, curriculum development, technical language, renewable energy

1. INTRODUCTION

Project RESI was implemented within the Tempus Program of the EU. It lasted for three years (2014-2016), encompassed eleven project partners, including the University of Zenica, and was coordinated by the University of Hohenheim (Germany). The project main objectives were: 1. Supporting renewable energy in Western Balkans (WB) and capacity building, 2. Introducing master studies on renewable energy in WB, 3. Introducing PhD studies in renewable energy in WB, 4. Building network between universities and industry, 5. Supporting staff in regard to scientific publications and conference proceedings and 6. Introducing innovation methods and internship practices.
Regarding this paper, the focus is on the second project objective, within which the following activities were included: 1. Western Balkans Working Group (WBWG) and EU partners creating the regulations for the master study program; 2.WB countries travelling to EU project members; 3. Information discussed in WBWG and common practices identified; 4. The documentation and regulation of the master program defined; 5. The master program as a mean of students' preparation for the professional work and scientific research; 6. The candidates as potential students to continue the PhD program.

The tasks within the 2nd and 3rd activity, when zoomed-in on, were: "Development of new modules' syllabi (i.e. Definition of compulsory and elective modules and Development of new modules for master and PhD) (Karaj & Müller, 2014)
All stated activities and tasks were undertaken and as a result a proposal of master study program was designed.

2. THE RENEWABLE ENERGY CONCEPT AND THE CURRICULUM ADJUSTED

2.1 Concept of renewable energy sources (RES)

The definition of renewable energy sources points to energy sources that are constantly renewed or replenished and hence are permanently available. Renewable energy sources e.g. include sunlight, wind, hydroelectricity, biomass, geothermal heat and waste. Renewable energy sources are CO_2-neutral; thus their use does not negatively impact the climate. (Smart City Wien, 2014)

2.2. Curriculum of renewable energy sources

Given the scope of renewable energy sources, and their nature, on the one side, and the teaching methodology and practice, on the other, the University of Zenica (i.e. its Faculty of mechanical engineering as a RESI project partner), developed a curriculum adjusted to the local and regional needs for educating engineers in this field. A proposal of subjects for master study program was as follows (from the Facutly's website):

I – semester	**ECTS**	**II - semester**	**ECTS**
1. Advanced energy technologies	6	1. Hydropower Plants	6
2. Computing fluid dynamics	6	2. Solar Power Plants	6
3. Energy scenarios and long-term goals of renewable energy sources	6	3. Wind Power Plants	6
4. Environmental Engineering	6	4. Biomass Energy	6
Elective courses (student chooses one subject from the list): 1. Energy efficiency 2. Applied statistics 3. Climate change	6	Elective courses (student chooses one subject from the list): 1. Methodical construction of power plants 2. The design of power plants using a computer 3. Modeling and simulation of energy transport in fluid flow	6
III – semester	**ECTS**	**IV - semester**	**ECTS**
1. Fundamentals of scientific research and development and innovative work	3	Master thesis	30
2. Energy-processing and environmental measurements	5		
3. Environment Impact Assessment (EIA) for Power Plants	5		
4. Research Project in Renewable Energy	12		

Engineering (intership with industry) Elective courses (student chooses one subject from the list): 1. Monitoring systems and energy management 2. Social, economic and legal aspects of renewable energy sources 3. Environmental Management Systems	5		

3. THE ENGLISH LANGUAGE MODULE

3.1. The English Language Module for the First Study Cycle

As it can be seen, English Language as a teaching subject was not stated. Given its importance, it is necessary to have this subject incorporated somehow into the overall teaching process.
In order to develop an English Language Module for the above presented master study, the General English Language Module, taught at the first study cycle, first has to be considered. Given the General Teaching Process Plan of the Faculty of mechanical engineering (available on the Faculty's website), the English Language Course aims to work on basic English grammar in order to level students' knowledge. Its learning outcome states that at the end of this subject, students will be able to use basic grammatical structures and functions in English. In line with this, syllabus encompassess: 1. lectures (focused on: English sentence, sentence structure and word classes; Subclasses: (e.g. nouns – subclass: concrete, abstract etc; verbs – subclass: auxiliary, modal, lexical verbs); Expressions of quantity; Simple verb tenses: *Present Simple, Past Simple, Future Tense*; language functions such as describing, comparing etc.) and 2. Exercises (focused on the grammar structures, practiced through pattern drills, substitution drills, permutation, reduction and transformation, and through various communication activities in the form of dialogues or monologues etc.).

3.2. The English Language Module for Master Study Program on Renewable Energy Sources

The following module, firstly, tries to comply with the overall proposed curriculum for the master study on renewable energy sources and, secondly, considers the English language acquisition done by students in the course of the first study cycle. On the basis of these two "pillars", it offers a module on English Language for Students of Renewable Energy Sources (RES), with an emphasis on features of specific technical language, i.e. puts an emphasis on scientific vocabulary (key words and common expressions used within a specific field).
Also, considering the lack of textbooks on English Language for RES Engineers, this paper may serve to argue in favour of designing one, which should be done in accordance with the units proposed in the study curriculum, i.e. lessons for both teaching and a book should comply with the master program, and therefore, curriculum subjects can be used as a foundation for English Language teaching material. More closely, the lessons for a one-semester module could include language repertory from the four different subjects which students listen in the course of that semester.

3.2.1 Module aims

The module aims are to: - teach students the most commonly used words (and group of words) in the relevant teaching subjects for the reason of competent participation in the teaching process and for later professional engagements with employers, clients, peers, etc.; - improve students' overall language skills with a focus on speaking; - teach grammatical skills.

3.2.2 Learning outcomes

After completing this module successfully, students will be able to: use in written and oral form (i.e. for analysis and discussion) field-specific vocabulary to explain relevant scientific issues concerning renewable energy sources; participate in the teaching process delivered in English by foreign or domestic lecturers; develop their scientific engagements (writing papers, participating in conferences, etc.) in English; and, advance their language skills for potential employment in relevant industry branch.

3.2.3 Teaching and learning methods

The teaching and learning methods should instigate both team work and individual one, and therefore, should include: lectures, seminar works, student's papers (their development and presentations).

3.2.4 Indicative syllabus content

The module focuses on lexical approach and tries to teach engineering terminology used for renewable sources. In line with this content, it strongly supports acquisition of specific professional vocabulary needed for the overall communicating (writing, speaking and reading). It also supports learning grammar and, in addition to the RES scientific areas, a grammatical unit should accompany every lecture.

3.2.5 Learning delivery

Different materials can be prepared to support teaching process: scope of texts from the engineering field, abstracts of relevant scientific papers, scientific papers, internet excerpts, technical manuals for some measuring devices, exercises with solutions, relevant language databases (developed and publicly available for some specific fields), guidebooks on standards written in English, rulebooks, various glossaries etc.

3.2.6 Assessment rationale

Students will be assessed on the basis of their active engagement (during classes; specially, concerning development of speaking skills with the use of specific, scientific vocabulary) and practical work (papers, presentations, etc.). Also, students will have to do a written exam as a part of the overall assessment.

3.2.7 Generic assessment criteria

Evaluation of oral skills will focus on: 1. clarity (including pronunciation and fluency); 2. knowledge of the subject; and 3. structure and organization.
Evaluation of written work will focus on: 1. grammatically correct use of English; 2. use of technical language when appropriate; 3. structure and organization.

3.2.8 Assessment Criteria

Assessment criteria regard three points: 1. improvement of speaking and writing skills, 2. a practical analysis and interpretation of relevant technical issues and 3. a clear communication of ideas and thoughts.

3.2.9 Learning resources

Students will have access to a faculty library, including relevant databases. In addition, they will be recommended to use:
- Carleton-Gertsch, Louise: Words in context (Thematischer oberstufenwortschatz)
- Bovée, Courtland L.; Thill, John V.: Suvremena poslovna komunikacija
- Katić, Marina: English for Environmental engineering

- Kovačević, Živorad: Lažni prijatelji u engleskom jezku (zamke doslovnog prevođenja)
- Šestić, Lada: Gramatika tehničkog engleskog sa rječnikom

3.3 Scope of English Language Module

The module, envisioned for students of the first year of master study, should serve to teach them, among others, key vocabulary of their scientific field. Therefore, it should explain the most commonly present words and groups of words for every subject.
In the following are given these subjects with the proposed key words, which should be pointed out in the teaching material, explained in detail regarding their specific meanings in the field and exercised by students to use them in various grammatical positions.

- **Advanced Energy Technologies:**

Vocabulary building should encompass key words/groups as:
advanced energy technologies; useful forms of energy; energy indicators; energy conversion.

- **Computational Fluid Dynamics:**

Vocabulary building should encompass key words/groups as:
fluid mechanics; computer models; computer simulations; nonlinear algebraic equations; linear differential equations; constant coefficients; differential equations; partial differential equations; statistical description; turbulence.

- **Energy Scenarios and Long-Term Goals of Renewable Energy Sources:**

Vocabulary building should encompass key words/groups as:
different energy scenarios; laws on energy; purchase of energy; sale of energy; planning and development of the energy sector; distribution networks and infrastructure; new alternative sources; LEAP (Long-range Energy Alternative Planning); sustainability; impact on the climate; energy efficiency; availability and demand for energy.

- **Environmental Engineering**

Vocabulary building should encompass key words/groups as:
plants; facilities; procedures and technologies; reduction of emissions; negative impact; pressures on the environment; protection of the environment.

- **Hydropower Fascilities:**

Vocabulary building should encompass key words/groups as:
types of hydropower plants; cascade flow; relative and absolute motion; one-dimensional and multi-dimensional movement; velocity triangles; radial and centrifugal flow; conservation of energy; inertia; stator; rotor; active and reactive power; peak and base strength; load curve of the power system.

- **Solar Energy Systems**

Vocabulary building should encompass key words/groups as:
solar energy; solar geometry; solar thermal applications; heat exchanger; air heating collectors; solar drying; solar distillation; volumetric receiver; thermal storage; solar cells; thin film; precipitation; evaporation; site selection; land requirements; support structures; assembly and installation.

- **Wind Power Plants:**

Vocabulary building should encompass key words/groups as:
wind turbines; aerodynamic theory; lift and drag forces; flow conditions; rotor solidity; losses on the blade; rotor; generator; transmitter; brakes; power output curve; pitch; stall; turbine setting; adverse effects.

- **Biomass Energy**

Vocabulary building should encompass key words/groups as:

energy conversion in biomass; energy crops; integrated waste management; biomass fuel; substrate; briquettes; pellets; biogas; anaerobic digestion; biofuels; biodiesel; bioethanol; combustion.

- **Basics of Scientific–Research and Development-Innovative Wor**

Vocabulary building should encompass key words/groups as:
scientific method; hypothesis; knowledge management; research topic; critical reviews; citations; footnotes; multidimensional education, LFM.

- **Energety-Process and Environmental Measurements:**

Vocabulary building should encompass key words/groups as:
measurement systems; measuring instruments; measurement uncertainty; temperature measurement; viscosity; humidity; thermal anemometry; laser anemometry; surface tension; signal; coefficient; heat conduction; heat flux; thermography; calorimetric measurements; optical measurements; acoustical measurements; air quality monitoring; air quality measurement; sampling of air; sampling of water; sampling techniques; analysis of measurement; error analysis; portable instruments; pressure gauges.

- **Methodology of The Environmental Impact Assessment:**

Vocabulary building should encompass key words/groups as:
environmental impact assessment; legal and institutional basis; the initial phases; methodology of environmental impact; consultation and public participation; documentation of the environment impact assessment and quality control, environmental permit for renewable energy technologies.

- **Energy Efficiency:**

Vocabulary building should encompass key words/groups as:
indicators of energy efficiency; national plans for energy efficiency at the national level (NEEAP); plans for sustainable use of energy (SEAP); energy audit; consumer rights; financing energy efficiency improvements; public awareness campaigns.

- **Applied Statistics:**

Vocabulary building should encompass key words/groups as:
probability theory; statistical set; descriptive statistics; statistical samples; correlation analysis; measurement errors; errors theory; optimization plans.

- **Climate Changes:**

Vocabulary building should encompass key words/groups as:
atmosphere; climate; radiation; ozone; free radicals; greenhouse effect; Freon; chlorofluorocarbons (CFCs); acid rain; ultraviolet radiation; global warming; Kyoto protocol.

- **Methodical Construction Of Power Plants:**

Vocabulary building should encompass key words/groups as:
methodical construction; scope of application; limitations; methods of conceiving; development of functional structures; morphological matrix; conventional methods; intuitive methods; evaluation and decision-making; Eco design.

- **Design of Sustainable Energy Sources Systems:**

Vocabulary building should encompass key words/groups as:
biomass; solar energy; geothermal energy; hydropower; wind energy; structural shapes.

- **Modeling and Simulation of Energy Transport in Fluid Flo**

Vocabulary building should encompass key words/groups as:
mathematical tools; vector and tensor calculus; differential operators; integral theorems; mass; momentum; differential form; heat and mass transport; numerical methods; transport phenomena; turbulence properties; two-phase flows.

- **Systems for Energy Monitoring and Management**

Vocabulary building should encompass key words/groups as:
SCADA; EMS; energy usage; energy intensity; energy management; continuous automatic control and regulation; industrial automation; remote input-output modules; investment estimations; ISO standards.

- **Social, Economic and Legal Aspects of Renewable Energy Sources**

Vocabulary building should encompass key words/groups as:
social aspects; economic aspects; legal aspects; cost-benefit analysis; non-carbon energy sources.

- **Environmental Management Systems:**

Vocabulary building should encompass key words/groups as:
planning; implementation; operation; inspection; corrective measures; functional organization; macro and micro level; effectiveness; measuring instruments; environmental parameters; monitoring; air emissions; air quality; soil; noise; vibration; data processing; record keeping; reporting.[1]

4. CONCLUDNG REMARKS

Given the growing importance of environmental issues, the idea on establishing a master study on Renewable Energy Sources came as an answer to market need for engineers educated in this field. On the other side, the great deal of communication in today's globalized world happens in English, and therefore, strong command of English represents an inevitable condition for any person entering labour market.
The English Language teaching on RES should be a support to this overall process of educating new engineers. It practically equips them with the additional and required knowledge. Further, this support enhances employability and transferability skills of students, what practically means they are provided with core, professional knowledge (on RES) and other competitive skills (fluency in the professional/technical English) they can easily and practically use on labour market.

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[1] Full description of syllabus for every stated subject is available in the Master Study Program for RES at the Faculty of Mechanical Engineering's website.