

ECOLOGICAL SECURITY IN MAJDANPEK MINING AREA – A CASE STUDY

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Abstract. *Ecological security, at the local and global levels, is becoming one of the priority tasks of modern civilization. Contemporary world is facing many challenges, among which environmental problems have occupied most of the world's attention. Environmental protection is an unavoidable factor of internal stability and security of a country, so it is necessary to discover which factors threaten the environment and have an impact on ecological security. Mining activities have adverse effects on ecological security which, as a consequence, raises the necessity for continuous environmental monitoring in these areas. One of these areas is the municipality of Majdanpek in Serbia, where the principal part of inhabitants is employed in mining. This paper presents a case study on ecological security in the municipality of Majdanpek, through a subjective perception of the inhabitants' safety and vulnerability in terms of four key indicators: water, air, soil and biodiversity.*

Key words: *environment, ecological security, indicators, case study, municipality of Majdanpek.*

1. INTRODUCTION

Many authors have tried to define the term "ecological security". Cherry [1] believes that there are three approaches to defining ecological security. The first, nature-centric, starts from the understanding of nature as a separate entity and ecology as a science that deals with the relationships between organisms and their environment, so ecological security should be focussed on maintaining the optimal relationships among organisms, the issues of animal rights, the legal status of nature, and the relationship between humans and nature. The second approach is oriented towards people, it is human-centric, and interpretation of ecological security is based on a man as a user and controller of nature. In this approach, the basis of the interpretation of ecological security is the concerns

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over natural resources, the so-called "environmental refugees" and the conflicts between nations related to the environment, the role of international governmental and non-governmental organizations and how they affect international security through policy-making and international law [2].

The third approach can best be described as eclectic. It seeks to contribute to a general examination of the phenomenon of ecological security, taking into account the interdependence between life forms, ecosystems, social systems, individuals and technical systems.

Katrin Rogers indicates the necessity of a clear definition of ecological security, distinguishing between environmental security and ecological security. She suggests that the environmental security is used when talking about the protection of resources and ecological security for the identification and creation of conditions in which the physical environment of a community enables to meet the needs of the population without reducing the natural reserves [3].

In defining ecological security, authors start from the general concept of security. They find that the ecological security is one of the segments of general safety issues related to the level of degradation of the local and global ecosystem, the shortage of water, flooding and other natural disasters, the mass deforestation, as well as pollution of all the elements in the environment, including the degradation of biodiversity. Bakrač, Vuruna and Milanovic, in addition to linking environmental conditions to the conditions of overall security, point out that this type of security requires solving problems that may arise, among others, due to lack of resources, environmental degradation, biological hazards, and climate change [4].

According to Bazan, ecological security tries to "preserve local and planetary biosphere as a base, supporting system on which all other ventures and human activities depend [5]. For John Barnett, ecological security is the ability of the nation or society to resist environmental damage, risks of unwanted changes in the environment or tensions and conflicts that may arise [6].

So, from the above paragraphs that relate to the concept of ecological security, it could be concluded that the ecological security is a new, modern form of security emerged as a need to prevent threats to the environment, which protects the basic components of the environment, without which there is no survival of living things. Also, it encourages and requires the inclusion of a large number of participants who should provide policy guidance for survival and improvement of the quality of life of the population [7] [8].

2. METHODOLOGY AND CONCEPTUAL APPROACH

Industrial production, technical progress and new technologies of post-industrial development have brought unimagined prosperity to the development of the whole human race. At the same time, such development caused a series of complex processes and negative changes in the natural environment, endangering life on the planet Earth, and causing ecological crisis which became the characteristics of modern civilization.

The ecological crisis that manifests itself in violation of balanced conditions in nature is "caused by society", by uncontrolled exploitation of natural resources, the rapid growth of technology, the spread of industrialization and population growth. The crisis begins when the increased economic activities are beyond a certain capability of the natural system [9] [10].

The intensive exploitation of natural resources brings into question their use in the future. "The entire planetary ecological crisis is a consequence of a violation of balanced conditions and the impact on the environment, in the unity of its natural and social components and is a threat to stable functioning of the biosphere, and society, questioning the existence of a man as natural-social being." It is an expression of the historical conditions in industrial society, the image of technical-economic development that affects the behavior of social groups and a man in general.

Numerous data illustrate the current situation of certain natural resources on Earth: about 15.2 million hectares of forested land in tropical countries is deforested or its purpose is changed; land degradation covers approximately 3600 million hectares of land, of which 16% is the world's agricultural land; biodiversity is disrupted and 24% of the species of vertebrates, and 12% of the species of birds are threatened; nearly 2 billion people are confronted daily with the lack of water [11].

Changes in the environment, as a result of increasing economic growth and the need to satisfy various human needs, are damaging ecological security, not allowing for further social development and resulting in "a) endangering human health and life; b) negative economic consequences and c) political consequences". Temperature rise, the reduction of the ozone layer, as well as the pollution of soil, water and air cause cancer and permanently impairs the health, leading to increased mortality [12]. It is estimated that the total economic damage caused by the disturbed ecological balance, climate change and more frequent floods, landslides, rising sea levels, and drought is increasing every decade. The political consequences of environmental change may be different, such as instability of institutions, ecological migration, environmental terrorism, conflicts and wars for resources and many more.

Environmental problems are numerous and fairly difficult to solve. The responsibility for this falls on a man who, due to their environmental awareness, can protect or destroy nature. Therefore, it is necessary to start with solving environmental problems at the local level. First, it is necessary to identify the objective consequences of these problems and find the appropriate solutions. The important role in solving ecological problems also belongs to subjective attitudes of the population who is directly exposed to adverse environmental changes. For this reason, we have studied the attitudes about environmental issues among the inhabitants of Majdanpek, a small mining town in eastern Serbia.

Ecological security is one of the indicators of quality of life, social safety and sustainable development. In addition to objective indicators, it is paramount importance to carry out a subjective assessment and the perception of hazard in order to find the adequate measures for the protection and improvement of the natural components of the environment. Therefore, the survey was conducted in Majdanpek, which is known as a city of the mining industry, at a sample of 5% of the total population in this municipality. In 2015, we examined the attitudes of 298 residents on their perception of ecological security. Moreover, we examined their attitudes about potential threats to water, air, soil and biodiversity, and assessed their level of ecological security.

3. LOCATIONS OF THE CASE STUDY

The municipality of Majdanpek occupies an area of 932km² and includes 14 settlements. Administratively, the municipality is bordered by the municipalities of Branicevski district on the southwest (Golubac, Kučevo and Žagubica), as well as the 3 municipalities from Bor district (Kladovo, Negotin and Bor) on the east and south. Also, in the northern part it is bordered by the Danube which forms a natural border with Romania. The municipality has 18 686 inhabitants [13].



Fig. 1 Geographical position of Majdanpek

Majdanpek and the surrounding area have a seven thousand-year-old tradition in mining witnessed by archeological sites from early Neolithic: "Rudna Glava" and "Paurija". This wealth of ore was the reason for the development of the economy of mining and metal processing. Until the early 90s, this municipality was one of the most developed in the country, while a Copper Mine Majdanpek, Industry of Metal Processing and a Copper Pipe Factory were economic giants acknowledged all over the world. Out of all policy documents related to environmental protection, we will mention only two that we consider the most important: Strategy for Local Economic Development of Majdanpek 2010-2014, and Local Waste Management Plan in the municipality of Majdanpek. If we consider the Bor district, to which the municipality of Majdanpek belongs, mining is the largest generator of solid waste. Large-scale exploitation of copper ore has produced a large amount of waste that is not properly managed, so long-term adverse effects on the environment could not be mitigated. Due to the presence of certain amounts of copper minerals and non-complex valorization of other useful minerals during ore exploitation, huge amounts of hazardous waste is generated. Contaminants such as heavy metals are converted into soluble forms by natural leaching and they reach the surface and ground waters, pollute the soil, gain entry into crop plants and hence reach to humans through the food chain [14].

This municipality of Majdanpek has a problem with mine tailings from ore extraction. It has been recognized as the main threat to ecological security in the region and poses a challenge to the adopted Local Waste Management Plan.

The structure of the above-mentioned document shows a serious approach to the analysis of environmental problems which are the consequence of inadequate solid waste

management in this area. The introductory part provides the theoretical and legal review of these issues, shows the institutional network dedicated to solving the problems and in the end, provides an overview of solid waste in the municipality of Majdanpek and its impact on ecological security. The seriousness of the approach aimed at solving solid waste issues is pointed out in the last paragraphs, where the options of how the municipality can react to solve this problem have been explained.

4. THE RESULTS AND THE ANALYSIS OF DATA COLLECTION

By processing the data obtained, we came to the following conclusions: a significant percentage of the population of Majdanpek states that threats and risks to ecological security are waste, industrial pollution, the quality of drinking water, an insufficient number of wastewater treatment plants, a lack of facilities for hazardous waste treatment, environmental “black spots” in the industrial zone, the use of heating oil and diesel fuel with high sulphure content, thermal power plants, the vulnerability of forest resources, loss of biodiversity, or something else (Table 1).

Table 1 The opinions of respondents in Majdanpek about the greatest threats to ecological security

What is in your opinion the greatest threat to ecological security in your region?	M
Waste	77,5%
Industrial pollution	63,1%
Depleted uranium	22,1%
The quality of drinking water	59,7%
The insufficient number of wastewater treatment plants	19,8%
No sanitary municipal waste landfills	16,4%
No locations for safe disposal of hazardous waste	17,8%
No facilities for hazardous waste treatment	15,1%
No systems for collection and recycling	13,1%
Environmental “black spots” in the industrial zone	19,5%
Use of leaded gasoline	10,4%
Use of heating oil and diesel fuel with high sulphure content	12,4%
Thermal power plants	10,1%
Pollution of rivers by organic substances	18,8%
Over-exploitation of forest resources	35,6%
Inadequately controlled exploitation of plant and animal species	15,4%
Something else	8,1%

4.1. The quality of water in Majdanpek and ecological security of inhabitants

Water quality is one of the most important indicators of ecological security. The largest percentage of respondents in Majdanpek share the opinion that the quality of water in their municipality was compromised. From a total of 298 respondents, 50.7% confirmed this claim (Table 2).

Table 2 The quality of water in Majdanpek

Municipality	In your opinion, is the quality of water in your municipality compromised?			Σ
	No	Yes	Partially	
Majdanpek	29.8%	50.7%	19.5%	100.0%

Out of all respondents who believe that water quality is threatened, the highest percentage think that the level of ecological security is low and vice versa, those who believe that it is not threatened think that the level of ecological security is high. Similar data were obtained for the risk assessment of water quality and a feeling of ecological security. The highest percentage of respondents who think that the water quality is threatened feel it is ecologically unsafe and vice versa.

The value of the alpha coefficient indicates a statistically significant correlation between the risk assessment evaluation of the water quality and the ecological security of the surveyed respondents (Table 3).

Table 3 Water quality and ecological security assessment

In your opinion, is the quality of water in your municipality compromised?	Do you feel safe and secure when it comes to ecological security?			Σ
	Yes	No	Partially	
No	82.0%	18.0%	0.0%	100.0%
Yes	1.3%	92.1%	6.6%	100.0%
Partially	0.0%	0.0%	100.0%	100.0%

Of 151 respondents from Majdanpek who find that water in their municipality is threatened, even 92.1% did not feel safe and secure, which indicates that this group of people are more aware that water quality is one of the factors which compromise ecological security.

4.2. The quality of air in Majdanpek and ecological security of the inhabitants

Air pollution significantly affects the quality of life of each living organism, and consequently, the quality of human life. Rapid industrial development led to an increased number of air pollutants.

Table 4 Air Quality in Majdanpek

Municipality	In your opinion, is air quality in your municipality compromised?			Σ
	No	Yes	Partially	
Majdanpek	17.4%	63.8%	18.8%	100.0%

The largest percentage of respondents from Majdanpek considered that the air in their city was contaminated (Table 4). Statistical significance in the assessment of air quality is expected, given that Majdanpek is the city of the mining industry.

Table 5 Air quality and ecological security assessment

Majdanpek In your opinion, is the quality of air in your municipality compromised?	Do you feel safe and secure when it comes to ecological security?			
	Yes	No	Partially	Σ
No	98.1%	1.9%	0.0%	100.0%
Yes	12.6%	81.1%	6.3%	100.0%
Partially	0.0%	0.0%	100.0%	100.0%

Out of the total number of respondents from Majdanpek, 190 believe that the air is polluted, and even 81.1% of them do not feel safe and secure when it comes to ecological security (N = 190, 81.1%). Based on these results we can say that there is a statistically significant correlation between risk assessment of air quality and the feelings of ecological security among the respondents from Majdanpek (Table 5).

4.3. The quality of soil in Majdanpek and ecological security of the inhabitants

The soil is an important element of the environment, and its degradation and pollution directly affect the quality of life of every human being. The soil in Serbia is exposed to many negative factors that may be caused by both natural and anthropogenic activity. In particular, we should not ignore the presence of radioactive elements as a consequence of the NATO bombing of Yugoslavia in 1999.

As in the evaluation of the above-mentioned elements of the environment and the assessment of the soil quality, the largest percentage of respondents from Majdanpek (68.7% out of 298 subjects) consider that the soil quality is affected (Table 6). The highest percentage of subjects who found soil compromised claimed that ecological security is at a low level, while those who believe that soil was not compromised estimated that ecological security was high. However, the same percentage of those who think the soil quality was partially compromised opine that ecological security is either satisfactory or low. (Table 6).

Table 6 Soil quality and ecological security assessment

In your opinion, is the quality of soil in your municipality compromised?	Do you feel safe and secure?			
	Yes	No	Partially	Σ
No	44.9%	34.7%	20.4%	100.0%
Yes	26.2%	68.7%	5.1%	100.0%
Partially	3.7%	7.4%	88.9%	100.0%

The values obtained indicate the connection between the attitudes of respondents from Majdanpek concerning the vulnerability of soil quality and a feeling of ecological security. Out of 195 respondents from Majdanpek who opined that soil was affected, 68.7% did not feel ecologically safe and secure (Table 6). The results indicate that there is a statistically significant correlation between the assessment of soil quality and a feeling of ecological security.

4.4. The quality of biodiversity in Majdanpek and ecological security of inhabitants

Biodiversity is a very important component of the environment. The diversity of flora and fauna has an impact on environmental quality. In contrast to the risk assessment of other elements of the environment, in case of a loss of biodiversity we see that 31.5% of the respondents considered the biodiversity was affected (Table 7).

Table 7 Quality of biodiversity

In your opinion, is the quality of biodiversity in your municipality compromised?				
Municipality	No	Yes	Partially	Σ
Majdanpek	39.6%	31.5%	28.9%	100.0%

The highest percentage of respondents who felt the biodiversity was not compromised, estimated ecological security as high, while those who considered that it was compromised or partially compromised considered it low. Somewhat different results were obtained with a feeling of ecological security. The highest percentage of those who considered that biodiversity was not compromised felt ecologically safe and secure, those who considered it to be partially compromised felt partially ecologically safe and secure, and even 95.7% of those who considered that it was threatened felt ecologically unsafe (Table 8).

Table 8 Quality of biodiversity and ecological security assessment

Majdanpek		Do you feel safe and secure?			
In your opinion, is the quality of biodiversity in your municipality compromised?		Yes	No	Partially	Σ
No		59.3%	22.0%	18.6%	100.0%
Yes		4.3%	95.7%	0.0%	100.0%
Partially		1.2%	45.3%	53.5%	100.0%

($X^2 = 2.04$ (df=4) Sig. 0,000)

Out of 86 respondents from Majdanpek who claimed that biodiversity was partially affected, 53.5% of respondents felt partly safe.

The obtained values X^2 and Sig. at the level of the samples show a significant correlation between the sense of ecological security among the respondents from Majdanpek and the assessment of respondents' life quality ($X^2 = 13.71$ (df = 4) Sig. 0.008) (Table 9).

Table 9 The evaluation of quality of life and ecologically security

Municipality of Majdanpek		The assessment of quality of life			Σ
Do you feel safe and secure?		High	Satisfactory	Low	
Yes		33.3%	28.0%	38.7%	100.0%
No		22.6%	24.5%	52.9%	100.0%
Partially		36.8%	8.8%	54.4%	100.0%

5. CONCLUSIONS

Based on the data obtained, we cannot claim with certainty that the attitudes of the citizens of Majdanpek about the level of their ecological security are associated with the assessment of quality of life.

Ecological security was assessed in terms of the quality of water, air, soil and biodiversity. The highest percentage of respondents who supported the claims about environmental degradation estimated that the level of their ecological security is either satisfactory or low and claimed that they felt unsafe or partly ecologically safe and secure.

However, when it comes to biodiversity, the highest percentage of respondents, about half of them, considered that biodiversity in their municipalities was not compromised and, therefore, assessed ecological security as high. On the contrary, those who believed that the living world in their microenvironment was threatened or partially compromised considered that the level of ecological security was low.

To support the above findings, we can confirm the claim that man is one of the most powerful ecological factors. Humans intervene in all events on the Earth's surface, and by their actions have deeply changed living space and have determined the direction of development of the biosphere. Human activities, as ecological factors, are conscious and organized exploitation of nature. In doing so, man is jeopardizing the ecological factors of the environment and even their own survival. In surface exploration of mineral deposits, there are many threats to the earth's surface, the earth's crust, groundwater and surface waters, the air layer of the earth's crust. Furthermore, the emissions threaten soil, water and the microclimate of a wider area.

The development of mining activities in Majdanpek has led to environmental damage, which, as a consequence, has negative impact on biodiversity, water, air and soil. Therefore, the inhabitants of Majdanpek can perceive that mining activity has had an impact on water, air, soil and biodiversity, which are considered an essential elements of the environment. For this reason, the majority of the inhabitants of Majdanpek lack the feeling of ecological security because the ecological balance in their environment was violated.

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EKOLOŠKA BEZBEDNOST U RUDARSKOJ OBLASTI MAJDANPEKA - STUDIJA SLUČAJA

Ostvarivanje ekološke bezbednosti kako na lokalnom tako i na globalnom nivou postaje jedan od prioritarnih zadataka savremene civilizacije koja se suočava sa mnogim problemima, među kojima važno mesto zauzimaju ekološki problemi. Zaštita životne sredine je nezaobilazni faktor unutrašnje stabilnosti i bezbednosti zemlje, zbog toga je potrebno otkriti uzroke ugrožavanja životne sredine koji utiču na ekološku bezbednost. Rudarska industrija je jedan od faktora koji ugrožavaju ekološku bezbednost, pa je potrebno sprovesti kontinuirano nadgledanje životne sredine u ovim oblastima. Jedno od ovih područja je opština Majdanpek u Srbiji, čije je stanovništvo pretežno uključeno u rudarstvo. Ovaj rad predstavlja istraživanje studije slučaja ekološke bezbednosti u opštini Majdanpek, kroz subjektivnu procenu stepena ekološke bezbednosti stanovništva i procenu ugroženosti putem četiri ključna indikatora: vode, vazduha, zemljišta i biodiverziteta.

Ključne reči: životna sredina, ekološka bezbednost, indikatori, studija slučaja, opština Majdanpek.