University of Belgrade, Technical faculty in Bor
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INTERNATIONAL MINERAL PROCESSING & RECYCLING CONFERENCE

XIV INTERNATIONAL MINERAL PROCESSING AND RECYCLING CONFERENCE

Editors:
Jovica Sokolović
Milan Trumić

May 12-14, 2021, Belgrade, Serbia

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THE IMPACT OF MINERAL RESOURCES EXPLOITATION ON THE ENVIRONMENT

S. Mihajlović[1#], N. Đorđević[1], A. Patarić[1], M. Blagojev[2]
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ABSTRACT – The paper shows how the exploitation of mineral resources may lead to environmental degradation. Planning the exploitation of certain mineral raw materials requires a detailed analysis of all the necessary works in order to fully eliminate or reduce to a minimum any negative impact on the area where the mining activity is performed. Also, it is important to emphasize that natural resources are very difficult to renew, so in case of uncontrolled exploitation, danger of permanent loss occurs. Therefore, the exploitation of mineral raw materials should be based on the principles of sustainable development, and the measures for the protection of the space where the exploitation is performed should be carried out according to the prescribed rules and legal provisions.

Keywords: Exploitation of mineral raw materials, Sustainable development, Environmental protection

INTRODUCTION

Environmental pollution, as a consequence of human activities, is increasing progressively. For these reasons, the principles of environmental protection are extremely important in all countries, which contribute to the protection of living and working space on a global level through individual activities. The degradation of living and working environment directly endangers people's health as well as plant and animal species. Also, soil, water and air are contaminated, thus directly affects the quality of food. Therefore, it is extremely important to develop and modernize the monitoring system of all parameters that show quality of soil, water air and food. In order to reduce the level of pollution and disturbance of the natural balance under the influence of anthropogenic factors, it is necessary to have a knowledge about technology that will be applied for certain purposes. When it comes to the exploitation of mineral resources, a multidisciplinary approach to such activities is necessary to completely eliminate or minimize all negative impacts on the area where the necessary actions are performed. Also, it is extremely important to keep in mind that natural resources are non-renewable or difficult to renew, so in case of uncontrolled exploitation, they are in danger of permanent loss.

Connecting all types of production and technological processes with environmental protection has led to the occurrence of an ecological economy. On the other hand, the economic aspect of sustainable development has contributed to the more efficient use

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of available natural resources, [1, 2]. Namely, sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs, [3]. The concept of sustainable development was created to preserve the environment, to unite all partial measures and separate policies and thus give a better result, [4]. The significance of above mentioned gained in importance when the International Association for the Protection of the Environment and Natural Resources became involved in sustainable development formation with its activities. In 1980, the Association developed an environmental protection strategy, which set the basic task of achieving sustainable development through the protection of natural resources. This concept was later taken over by the World Commission on Environment and Development, better known as the Bruntland Commission, which prepared a report in 1987 called "Our Common Future". The report emphasized a more politically acceptable idea of sustainable development than those promoted in the 1972 "Growth Limits", [5].

The concept of sustainable use and protection of natural values, and thus natural resources, is based on the strategy of spatial development and the national strategy of sustainable use of natural resources and goods. Strategies define the issue and level of research of natural resources and goods by types, spatial distribution, diversity, scope and quality. Also, balance sheet categories are determined, situation changes , valuation method and conditions of sustainable use are predicted, [6].

POSSIBLE NEGATIVE IMPACTS ON NATURE IN MINERAL RAW MATERIALS EXPLOITATION ZONE

The activities carried out during the exploitation of mineral raw materials, which are planned within the mining works, lead to a change in the existing natural state and appearance of the area where they are performed. For these reasons, it is extremely important to make detailed analysis of all works from the aspect of their potentially negative impact on the environment. The company engaged in the exploitation and processing of mineral raw materials has the obligation to adapt its work to modern devices and technological lines in order to minimize the negative impact on the environment, [7, 8]. A modern approach to the exploitation of mineral resources must meet the criteria of sustainable use, in order to avoid uncontrolled exploitation and irreversible degradation of the natural ecosystem. During the techno-economic analysis for deposit opening, it is necessary, among other things, to pay attention on two important factors:

1. Economic effects of exploitation
2. Environmental effects

For the use of natural resources, the so-called waste-free technologies. Waste-free technologies for benefication of mineral raw materials in their exploitation imply complex utilization of all components from the ore and return by recycling to the process of production of the entire waste material. Furthermore, this technology implies the return to the production process of previously produced final products whose service life has expired, so they appear as waste. Along these lines, the total amount of waste material is reduced, and environmental pollution is scaled down to a

minimum. On the Earth is less and less living space, clean air and water, which implies to two important facts, during designing the technology of exploitation of mineral goods: the selected technological line should takes up as little space on the earth's surface and it should have minimal environmental pollution effect.

Generally, it can be said that during the process of exploitation of mineral resources, both underground and surface, the negative impact on the environment can be classified into three groups:

1. Depletion of reserves
2. Destruction of the natural environment
3. Environmental pollution

In areas of underground exploitation, environmental degradation is less noticeable, compared to places with surface exploitation, but it is present indeed. Namely, during underground exploitation, the terrain often subsides due to corridors that are below the surface of the earth, so this should be strictly taken into account. Also, in the vicinity of mines with underground exploitation, tailing dumps, mine facilities with bunkers, workshops and various warehouses, as well as facilities for human habitation, are located on the surface of the earth. Due to the effects of atmospheric precipitation and wind, erosion of the deposited tailings can occur. Acidic mine waters often appear, which can pollute the surrounding land, underground and surface watercourses. Of course, the intensity of each mentioned phenomena as well as the consequences of their action depends on the method of exploitation (surface or underground exploitation), as well as on the type of mineral raw material that is exploited (metals, non-metals, coal). Schematic representation of some of the described negative impacts on the environment during surface and underground exploitation of mineral raw materials are shown in Figure 1, [9].

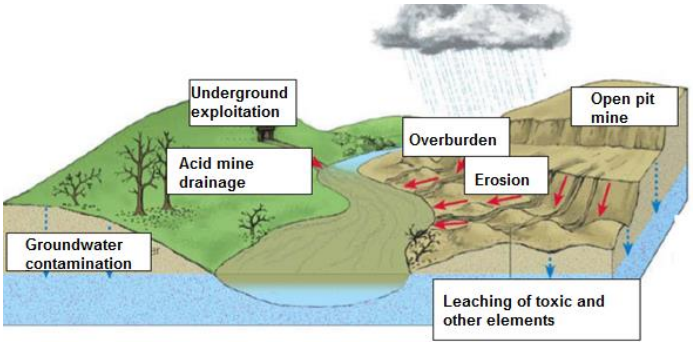

Figure 1 Negative impacts of mineral exploitation on the environment

USE OF NATURAL RESOURCES IN THE REPUBLIC OF SERBIA AND ENVIRONMENTAL PROTECTION

Our country also pays special attention to the protection of the living environment and the controlled use of natural resources. In 2012, the Government of the Republic of Serbia adopted the National Strategy for Sustainable Use of Natural Resources and Goods, which defines the framework for sustainable use and protection of natural

values of the Republic of Serbia for coordinated, cross-sectoral management of natural resources, [10]. The Ministry in charge of environmental protection is responsible for the implementation of the Strategies. The goals of the National Strategy for Sustainable Use of Natural Resources and Goods are already largely integrated into the goals of multisectoral strategic documents: National Environmental Protection Program, National Environmental Approximation Strategy for the Republic of Serbia, Cleaner Production Strategy in the Republic of Serbia, Waste Management Strategy and the National Sustainable Development Strategy. The established basic goals of the National Strategy also fit into the goals of the Europe 2020 strategy document (COM (2010) 2020), in the segment of ensuring sustainable growth and providing conditions for less losses due to unsustainable use of natural resources. The main goals to be achieved by implementing this Strategy are:

1. Aiming and providing conditions for sustainable use of natural resources and goods, by creating a basis for setting plans, programs and bases for each individual natural resource or good (within this goal, 32 general sectoral goals are defined)
2. Reducing the negative impact of resource use on the economy and the environment, by establishing basic indicators to be monitored (26 general sectoral objectives)
3. Contribution to directing development towards sustainable production (through less and more efficient use of natural resources) and consumption (change of established consumption patterns) (10 general sectoral goals).

The strategy divides natural resources into 7 categories: mineral resources; renewable resources; forests and forest resources; protected areas, biodiversity, geodiversity and landscape diversity; fish resources; water resources and land resources. For each of these resources, the situation, the existing legal and institutional framework, challenges and goals for their sustainable use and measures for achieving their sustainable use are presented.

In order to better regulate the area of exploitation of mineral raw materials in the Republic of Serbia, an ecological permit for exploitation has been introduced. An environmental permit for a company who wants to engage in the exploitation of a specific mineral resource, at a specific location, aims to confirm the high level of protection that will be implemented, including the protection of water, air and land. There is also a fee for the use of mineral resources. For example, non-metallic mineral raw materials are widely used for the purpose of obtaining construction materials. Therefore, all companies engaged in their exploitation pay a fee for the use of non-metallic raw materials for the purpose of obtaining construction materials. The amount of compensation is determined by the Government of the Republic of Serbia and is clearly defined in a document called the Decree on the amount of compensation for the use of non-metallic mineral raw materials for obtaining construction materials, [11].

Today, the exploitation of mineral raw materials in our country and on a global level, as already mentioned, is increasingly focused on preserving the environment as one of the most important aspects of sustainable development. Having all this in mind, it can be concluded that the criteria for the acceptability of the exploitation activity are becoming stricter, considering its impact on the entire environment. The Republic of Serbia is keeping pace with world trends when it comes to mining practice by

implementing measures that balance three important components, namely: economy-ecology-sociological component. The contribution of mining to sustainable development is rationality in the management of mineral resources as the only non-renewable resource. Rationality is implemented through complex planning of mineral resource complex management through strategic, [12]. The strategic document is a product of the development of the management strategy of the mineral complex and has the following three phases:

1. Analysis of the state of potential, reserves, exploitation and consumption of mineral raw materials

2. Management strategy of the mineral resource complex of the Republic of Serbia in the next 20 years

During the formation of the Strategy for the Management of the Mineral Resources Complex of the Republic of Serbia, the starting points of the first phase are: Geological potentials and geological reserves; Exploitation of mineral resources; Environmental protection and safety and health at work; Legal and Institutional Framework and the Education System. On the basis of a detailed situational analysis, i.e. analysis of the existing situation, a draft policy of exploitation of mineral raw materials is formed, which is further the framework for defining the Strategy of mineral resource complex management. This strategy has national character and is an integral part of the Economic Development Strategy of the Republic of Serbia. Within the third phase, it is necessary to constantly monitor the implementation of programs, measures and activities, as well as their innovation and updating.

While adopting legal regulations for the field of mining and exploitation of mineral raw materials, it is very important to analyze and compare with legal regulations for other natural resources in Serbia, such as water, forests and agricultural land. However, the fact that mineral raw materials are the only non-renewable natural resources whose location cannot be changed, should always be put in the foreground. Also, in practice, the interest in the exploitation of mineral raw materials most often conflicts with the rebuttable interests of the protection of these resources. Namely, there is an important difference between the legal regulations in the field of mining, which is mainly focused on the conduct of economic activity, mostly on its technical aspect, while the regulations of other related areas focus on resource management, resource protection, resource financing. and economic activity.

CONCLUSION

Necessary activities during the exploitation of mineral raw materials and environmental protection measures form one entirety, which is the only way to contribute to sustainable development. The existence of sustainable development only makes sense when a balance is reached between the use of natural resources on the one hand and nature conservation on the other. The success of a society in this area directly depends on the level of awareness of the population about the importance of a healthy environment and the preservation of natural balance and natural laws. People, as the main link in a complex system where the economy and ecology are closely connected, must always keep in mind the importance of preserving the environment,

because because they are also part of that environment. By preserving nature, they also preserve themselves in it, with the controlled use of of all that nature has given them.

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REFERENCES

1. Mihajlović, S., Blagojev, M. (2019) Eksploatacija prirodnih resursa u funkciji održivog razvoja. In: V naučno-stručni skup sa međunarodnim učešćem „Politehnika". Beograd, Srbija. Zbornik radova, 188-192.
2. Mihajlović, S., Jovanović, V., Sekulić, Ž., Kašić, V. (2018) Principi održivog razvoja kao direktni faktori u zaštiti životne sredine. In: VI Savetovanje sa međunarodnim učešćem: „Zaštita životne sredine i održivi razvoj","Rudarsvo i energetika 2018". Sremski Karlovci, Srbija, Zbornik radova, 59-63.
3. Štrbac, N., Vuković, M., Voza, D., Sokić, M. (2012) Održivi razvoj i zaštita životne sredine. Reciklaža i održivi razvoj, 5, 18-29.
4. Mladenović, M., Arsić Trajković, M., Mihajlović, M. (2017) Održivi razvoj i zaštita životne sredine. Ecologica, 86, 462-467.
5. Brundtland Report (1987), https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf (Accessed on April 24th, 2020)
6. Ilić, B., Mihajlović, D., Omanović, A. (2016) Upravljanje prirodnim resursima i njihova održivost. In: VI Međunarodni simpozijum upravljanja prirodnim resursima, Zaječar, Srbija. Zbornik radova, 25-26.
7. Gligorijević, J., Kostić, M., Kostić, D. (2018) Zaštita životne sredine kao komponenta održivog razvojasa osvrtom na značaj ekoloških indikatora. Ecologica, 89, 58-62.
8. Cvetanović, D., Nedić, V., Jovović, D. (2018) Regulativa u oblasti zaštite životne sredine, inovativnosti konkurentnost preduzeća. Ecologica, 90, 434-439.
9. http://vtsnis.edu.rs/wp-content/plugins/vts-predmeti/uploads/predavanje-2.pdf (Accessed on April 22nd, 2020)
10. http://www.rsjp.gov.rs/9.9_nacionalna_strategija_odrzivog_koriscenja_prirodnih_resursa_i_dobara.pdf (Accessed on April 20th, 2020)
11. https://www.mre.gov.rs/doc/geologija-rudarstvo/24_Uredba%20o%20visini%20naknade%20za%20koriscenje%20nemetalicnih%20mineralnih%20sirovina%20za%20dobijanje%20gradjevinskog%20materijala.pdf (Accessed on March 20th, 2020)
12. Pavlović, V., Kolonja, B., Ilić, M., Milanović, R. (2010) Održiva strategija upravljanja mineralno-sirovnskim kompleksom Republike Srbije. In: IX Međunarodna konferencija o površinskoj eksploataciji „OMC 2010", Vrnjačka Banja, Srbija, Zbornik radova, 370-375.