

SUSTAINABLE ECONOMY OF NON RENEWABLE RESOURCES AND CONFLICT WITH ENVIRONMENT

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Abstract:

Mining is one of the technology processes which significantly affect the environment. Contemporary science is often focused on renewable resources, but non renewable resources and their mining are also present and deserve more intense research, due to its complex role in the economy. On the other point of view, non renewable resources as mining products are necessary to maintain and improve the life quality level. This conflict is not sustainable in long term perspective. From the aspect of sustainable development the primary task is to ensure the development right for future generations. It means that intensive level of interdisciplinary research is necessary to provide initial conditions (available reserve of ore) and utilization dynamic of mineral resources. This paper analyzes some aspects of correlation between sustainable development and mining. Mathematical model that describes the mentioned ideas is developed in this manuscript, including the conflict of economic goals, principles of environmental protection and sustainable development.

Keywords: *environment, non renewable resources, sustainable development, conflict of interest, mathematical model, sustainable economy, sustainable development goals.*

JEL Classification: *Q01, Q32, Q56*

1. Introduction and background

Mining as an economic activity has a long tradition dating back thousands of years and is still ongoing. This means that the exploitation of mineral resources has been carried out over a long period of time (Ghorbani et al., 2023), which means that the available mineral resources are not yet fully discovered and have not been exhausted.

Exploitation of mineral resources as a important economic activity has an impact on the environment (Stevovic et al., 2014) on the one hand and on the other hand, their depletion will probably occur in some future period due to the limitation of mineral resources and the extended scope of their exploitation. Both of these facts directly affect the sustainable development of the society in a negative way (Li et al., 2023). In the future, we will switch to renewable energy sources (Stevović et al., 2021).

The environmental impact is reflected in relief changes, deforestation, changes in the natural habitat characteristics, dislocation of chemical elements and compounds that were not previously found in a certain area, the risk of tailings spill which result in pollution of watercourses and in other negative effects (Stevović et al., 2014). Figures 1, 2 and 3 demonstrate the

consequences of mining activity on the relief in the following sites: Copper mine Majdanpek, Drmno and Kolubara. The conflict of goals arises because the present generation is entitled to exploit the available mineral resources for the purpose of its development, but provided that the same right is not compromised for future generations. Logically, the issue of how to resolve this conflict arises since it is obviously not possible to carry out mining activities without reducing their potential in the future and without an impact on the environment. Both the reduction of the potential of mineral resources and impact on the environment reduce the resource base for future generations.



Figure 1: The appearance of the Copper Mine Majdanpek site from a bird's eye view
(Source: Google earth)



Figure 2: The appearance of Drmno site from a bird's eye view
(Source: Google earth)

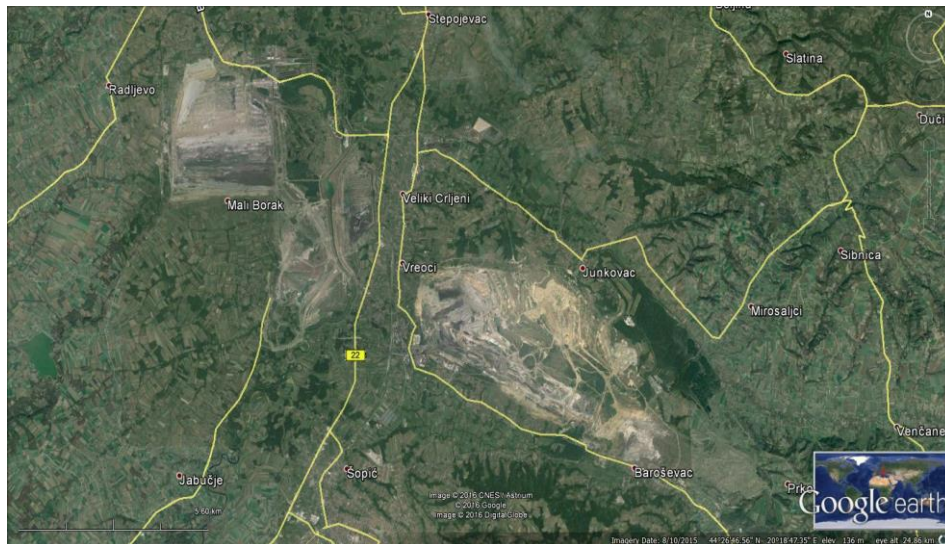


Figure 3: The appearance of Kolubara site from a bird's eye view
(Source: Google earth)

The conflict of goals related to sustainable development arises for the following reasons:

- Available mineral resources are limited;
- The rate of exploitation of mineral resources is increasing and
- Cumulative negative impact of mining on the environment is growing over time.

All the above mentioned reasons inevitably lead to the conclusion that mineral resources will be exhausted at some future point in time. Thus will not be the basis for the development of future generations on the territory of the Republic of Serbia and the imperative will become transfer to the renewable resources (Stevović, 2017), as one of the mode on solving energy crisis upcoming, as it is presented in the literature (Gabriel, 2023).

From the perspective of sustainable development, this fact represents a considerable problem which requires a new source of growth of the quality of life and health (Cimpoeru Maria et al., 2023) of future generations to compensate for the exploitation of mineral resources of the present generation. The only rational answer that would enable resolution of this conflict of goals is that the gain achieved by exploitation of mineral resources by the present generation should enable the transfer to other sources of development for future generations. This practically means that part of the gains from the mining activity must be invested in other resources which will enable the development of future generations.

2. Materials and methods

2.1. The conflict of sustainable development goals

A common definition of sustainable development is that it is the right of one generation to use natural resources to meet its own needs without compromising the right of future generations to meet their own needs (Konaré et al., 2023). Due to its generality, this definition does not demonstrate in detail the directions of specific activities and attitude towards the available natural resources. It also fails to specify which needs a certain generation is entitled to and should not be threatened for future generations. In a loose interpretation this definition could oblige the present generation to transfer the existing resources to future generations in at least the same condition in which they found them. This explains the attempts in the literature and practice to define sustainable development more precisely.

According to another definition, sustainable development means that the future should be a better and healthier place to live (Stevovic et al., 2017). This approach means that the existing resources must be handed over to future generations in a better condition than they were found. The

literature (Stevović et al., 2019) provides the following economic definition of sustainable development: „Development of a strategy for managing the property, natural and human resources, as well as financial and physical assets for the long-term increase in the community wealth. Sustainable development as a goal rejects policies and practices that support the maintenance of the current standard of living based on depletion of the productive base, including natural resources, and leaving future generations with a poorer perspective and greater risks than the present ones.“

2.2. Sustainable development goals and sub-goals

It is evident that the economic definition primarily emphasizes growth of the community wealth and maintenance of the risk level. This definition, although more specific, reduces sustainable development only to the community wealth and the risks that are threatening that wealth. However, sustainable development is a more complex problem, as it is explained in the literature (Stevovic et al., 2021). It encompasses other dimensions such as sociological, culturological and existential, which often cannot be fully expressed in economic categories.

For this reason the United Nations formulated 17 goals and a large number of sub-goals that should be reached in order to achieve sustainable development¹. Some of those goals are:

- Eradication of poverty;
- Eradication of hunger;
- Providing access to affordable, reliable, sustainable and modern energy sources for all;
- Decent work and economic growth;
- Responsible production and consumption, and
- Others.

Due to the large number of goals and sub-goals², some authors believe that this number of goals is too large and that the focus has shifted from priority to impractical comprehensiveness. In addition to the fact that the goals defined by the United Nations are comprehensive, to a certain extent they are also contradictory if the total available resources are not known. Namely, the eradication of poverty and hunger, which are undoubtedly humane and binding goals, can at the same time be in conflict with preservation of the environment if chemical means that endanger the soil fertility in the long term are used for agricultural production (Raihan, 2023). The same applies to the exploitation of mineral resources: if growth is achieved through the increased exploitation of mineral resources, it can ensure sustainable development only in a shorter period, until the mineral resources are exhausted.

The mentioned reasons suggest that a solution to the conflict of sustainable development goals should be sought for each economic activity separately and within the limits of its characteristics and capacity for sustainable development (Zarbakhshnia et al., 2023). Mining as a specific branch of economic activity requires special attention from the aspect of sustainable development, especially if observed over a longer period of time.

3. Resulting mathematical model simulating the conflict of economic goals

According to the Statistical Yearbook of the Republic of Serbia, the mining activity has a share of approximately 1.3% in the gross national product of Serbia³ (Mining activity = RSD 49,711*10⁶ ; total gross national product of Serbia = RSD 3,876,403*10⁶ for 2013) Although the share of the mining activity in the total gross national product of Serbia is relatively small, taking into account the importance of raw materials for other activities, this industry represents a significant factor in the stability of the economic system.

¹ <https://sustainabledevelopment.un.org/sdgsproposal> (January 23, 2023.)

² <http://www.nature.com/news/un-sustainability-goals-need-quantified-targets-1.15933> (January 25, 2023.)

³ <http://webzrs.stat.gov.rs/WebSite/userFiles/file/Aktuelnosti/StatGod2015.pdf> (January 27, 2023.)

In addition to providing a significant basis for sustainable development at the present moment, the mining activity is characterized by the following:

- Limited amounts of mineral resources;
- Constantly growing needs for raw materials;
- Increased speed of mineral resources exploitation;
- Price fluctuation of mining products on the market;
- Consumption of specific means of production with a harmful impact on the environment;
- Consumption of a large amount of energy for the development of the mining production process and
- Other negative impacts on the environment that represent a direct consequence of physical changes on the mining sites.

The mining activity obviously fulfills the basic goals of sustainable development defined by the United Nations as regards the right to work and economic growth, but with certain limitations as a consequence of non-renewable deposits of minerals and raw materials (Kügerl et al., 2023). In view of the characteristics of mineral resources, it is evident that they have a limited exploitation period and that none of the above definitions offers the achievement of the sustainable development goals in respect of the exploitation of mineral resources.

In these circumstances a logical question from the perspective of sustainable development arises: „How to ensure the right of future generations to develop if the mineral resources are depleted at some future time?“, taking into account also the trends of population growth, according to the literature (Stevović et al.). The answer to this question could be sought in the domain of the contributions of the mining activity made to the growth in social wealth and the disposal of the achieved wealth in the right way (economic definition of sustainable development). Namely, if exploitation of mineral resources generates certain value, then it is necessary to invest part of that value in future development (Adebayo, 2023). In doing so, part of the investment does not have to refer to the primary mining activity; it can be invested in alternative sources of growth of social wealth.

Mathematical model that describes the mentioned ideas could be:

$$P = T_{\pi} + T_{\varepsilon} + T_{\rho} + T_{\Omega} + \delta$$

where:

- P – revenue from mining activity;
- T_{π} – costs of mining production;
- T_{ε} – costs of preserving the natural environment;
- T_{ρ} – costs of development of mining production;
- T_{Ω} – costs of sustainable development and
- δ – the rest of the revenue (profit).

The above formula means that the revenues generated by the mining industry should cover all costs, including the costs of sustainable development (creating a better resource base of the society for the period in which mineral resources will be depleted) with a certain remainder, i.e. the profit.

The seriousness of the mining companies in addressing the issue of sustainable development can be illustrated by the ICMM (International Council on Mining & Metals) organization⁴, which has established 10 principles for aligning the goals of mining with sustainable development:

1. implementation and maintenance of ethical business activity;
2. integration of sustainable development in the process of making business decisions;

⁴ <http://www.icmm.com/> (January 28, 2023.)

3. supporting fundamental human rights while respecting the culture, customs and values of employees and others who are affected by the mining activities;
4. implementation of a risk management strategy based on valid data and science;
5. permanent research on improving health and safety performance;
6. permanent research of environmental performance;
7. contribution to biodiversity conservation and integral approach to land use planning;
8. facilitation and encouragement of responsible product design, use, re-use, recycling and disposal;
9. contribution to the social, economic and institutional development of the communities in which we work and
10. implementation of effective and transparent engagement, communication and independent verification of reports with owners.

Each of these principles is further elaborated to the operational level, showing that even in specific cases, harmonizing the mining activity with the principles of sustainable development is a very complex process that requires considerable intellectual and practical efforts appropriate to each specific situation.

The importance of harmonizing the mining activity with the principles of sustainable development is also reflected in the fact that global organizations (UNDP - United Nations Development Programme and World Economic Forum) have mapped the mining activity within the framework of sustainable development goals defined by the United Nations⁵. In the mentioned document was concluded that six goals are directly affected by the mining activity in the following order:

- Goal number 9 - Industry, innovation and industrialization;
- Goal number 8 - Work and economic growth;
- Goal number 7- Access to energy and sustainability;
- Goal number 6 - Clean water and sanitation;
- Goal number 15 - Ecosystem and biodiversity protection and
- Goal number 13 - Climate action.

The first three goals represent an opportunity for the mining sector to contribute, while the remaining three require adaptation, mitigation and impact minimization strategies. The remaining eleven sustainable development goals are also systematized according to the degree of impact of the mining industry on indirect and intermediate effects. These goals are also classified according to the possibility of the mining industry's contribution to their improvement or mitigation of negative effects. At the same time, innovative meanings of the contribution to these goals are also being explored.

4. Conclusion

Mining activity has significant interactions with sustainable development. On the one hand, mining provides the raw materials necessary for development and for meeting the human needs, while on the other hand, environmental impacts, along with the limited availability of mineral raw materials, threaten the basic principles of sustainable development.

Solving this conflict of goals is given great importance both in academic literature and in the elaboration of business policies and strategies of mining companies and groups engaged in mining.

Complexity of the issue of relationship between the mining activity and sustainable development is reflected in different possible approaches based on detailed elaboration of general principles and definitions of sustainable development.

⁵ http://unsdsn.org/wp-content/uploads/2015/09/DRAFT-Final-ES_Mining-and-SDGs_v2.pdf (January 29, 2023.)

The economic principle of sustainable development indicates that, due to the limitation of natural mineral resources, the possibility of investing part of the mining industry revenue in other sources of economic growth and development of society has to be considered. In this way future generations would be compensated for the depletion of mineral resources at some future point in time.

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