ANALYSIS OF THE STATE OF SUSTAINABLE MANAGEMENT OF RAW MINERALS IN THE REPUBLIC OF CROATIA WITH REFERENCE TO THE CONSTRUCTION INDUSTRY

Melita Srpak[1]*, Darko Pavlović [2], Hrvoje Meaški [3], Sanja Kovač [3]
[1] *Institute for Spatial Planning, Mali plac 1a, Varaždin, Republic of Croatia*
[2] *Plinacro Ltd. Savska cesta 88a, Zagreb, Republic of Croatia*
[3] *Faculty of Geotechnical Engineering University of Zagreb, Hallerova aleja 7, Varaždin, Republic of Croatia*
*E-mail of corresponding author: melita.srpak@gmail.com

Abstract: *Mining activity in the Republic of Croatia has its own legislation harmonized with EU regulations and market economy principles appropriate for Europe. Mineral raw materials are important for starting the economy of a particular country, and their use depends on the demand for energy, supplies, assumptions about the economic growth of certain regions and the state of the environment. The goal of the research is based on the research of strategic planning documents and studies that provide data on exploitation fields and exploration areas of mineral resources in the territory of the Republic of Croatia. The results of the research are based on previous knowledge about the exploration areas/exploitation fields and the data obtained from the research, which were determined on the basis of the resource base of mineral raw materials, i.e. mining-geological studies. In conclusion, the exploitation fields of mineral raw materials in the Republic of Croatia statistically do not cover large areas and it is possible to plan and produce them only in places where they exist, because the locations for exploration and exploitation depend on the geological composition of the area. Mining activity can disrupt the natural balance of the environment and space. In such situations, it is important to establish a balance between the market's (economy's) need for mineral raw materials and society's tendency to maximize environmental protection. The construction industry in the Republic of Croatia is an important factor that determines the need for the exploitation of technical construction stone, gravel and sand, as well as brick clay.*
Keywords: *exploitation, mineral raw materials, mining activity, fees, Republic of Croatia*

Received: 25.07.2024. / Accepted: 09.10.2024.
Published online:

Professional paper

1. INTRODUCTION

Mineral raw materials are important for starting the country's economy, and their use depends on the demand for energy, supplies, assumptions about the economic growth of certain regions and the state of the environment. Vrkljan (2021) points out that mining is a fundamental economic activity that deals with the exploration and exploitation of mineral raw materials, which also includes rehabilitation (recultivation) of the excavated area after the exploitation is completed. Mining supplies raw materials to many industrial branches, and includes a set of works on finding and extracting (obtaining) mineral raw materials. The importance and contribution of mining to the economy of the state is observed by recognizing and valuing the fact that mining as an activity creates new values, encourages and supports the work of a whole series of other production activities of the economy (energy, construction, processing industry). Krasić et al. (2005, 2006) point out that the underground exploitation of mineral raw materials in the Republic of Croatia has practically disappeared and currently only architectural and building stone is exploited underground, however there are numerous surface mines. There is no doubt that the exploitation of mineral resources creates prerequisites for the development of civilization, so today we are faced with the fact that, on the one hand, the desire for an increase in the material standard of living prevails, and on the other hand, this can be achieved with the ever-increasing mining activity of the exploitation of mineral resources, which means that mining activity it is not a matter of choice, but of inevitability. At the same time, it should be emphasized that at the end of the second decade of the 21st century, humanity is at a kind of time-resource turning point: will it find effective answers to the global challenge of preventing disastrousclimate changes caused by will disappear (Pavlović et al. 2018). The purpose of the research of this paper is based on the research of strategic planning documents and studies that provide data on exploitation fields and exploration areas of mineral resources in the territory of the Republic of Croatia. By researching published works in the field of mining and life cycle assessment of individual mineral raw materials, it was observed that the majority of published works deal with studies of the life cycle of different metals on a global or regional level: copper (Memary et al. 2012; Giurco and Petrie 2007; Suppen and et al. 2004), base metals (Norgate and Haque 2012), zinc (Suppen et al. 2004; Stewart et al. 2003), coal (Mangena and Brent 2004; Babbit and Lindner 2004), copper mine tailings and zinc (Reid et al. 2008), gold (Norgate and Haque 2012; Mudd 2007). However, Grbeša (2014) points out that such studies in the mineral raw materials sector usually cover part of the life cycle from the extraction of the raw material to the entry into the

industrial production process, and their purpose is to show the environmental impacts per unit mass of the raw material produced. A frequent response to the demands of mining activity is the rational management of mineral raw materials in the context of sustainable management of the entire area, where the main goal of this paper is to show the satisfaction of the needs for raw materials with a constant effort to make mining activity a positive, not a negative factor at the same time with regard to its overall impact on the environment and other contents in the space. Norgate and Haque (2012) believe that in the future there will be an increase in the energy and greenhouse footprint, i.e. that the exploitation of ores (metals) will become an increasingly important subject of study of life cycle analysis of mineral raw materials. Following this thinking, Liu and Müller (2012) in their studies focus on energy econometrics and greenhouse gas emissions, rather than considering impacts such as land use due to exploitation, emissions to water, soil and air. Giurco and Cooper (2012) believe that to generate more value, materials can be obtained from raw materials in easily accessible and easily developed deposits, without limiting conventional ore deposits, but including deep-sea deposits as well as recyclable waste.In the Spatial Development Strategy of the Republic of Croatia from 2017, it was recorded that mineral raw materials are exploited in 670 locations, and 40 types of mineral raw materials were discovered, of which 15 are constantly or occasionally exploited. Permits, approvals and concessions for the exploration and exploitation of mineral resources, as well as the prescribed procedures for assessing the impact on the environment and nature, as well as the information system on the exploration and exploitation of mineral resources are coordinated in the prescribed manner by the competent state bodies for mining, spatial planning, as well as environmental protection and nature protection (Srpak and Pavlović 2020). Based on data from the Ministry of Economy and Sustainable Development, the Mining Administration, the number of active exploitation fields of mineral resources in the Republic of Croatia in 2022 was 334, while the number of fields for which exploitation concessions were obtained was 278. The number of inactive exploitation fields of mineral resources on which the performance of mining works was permanently suspended, and on which measures to prevent the occurrence of dangers for people, property, nature and the environment were not implemented, there were 144, and the number of deleted exploitation fields of mineral resources from the Register of Mineral Resources was 332.

2. MATERIALS AND METHODS

2.1. Economic benefit and significance of mineral raw materials in the construction industry

The development of the mining economy is possible with respect for the principles of sustainable development and environmental protection in terms of maximum protection of natural resources and other economic resources, protection of nature and monumental heritage, principles of energy efficiency and principles of rational use of mineral raw materials (Srpak 2022). Unfortunately, the Republic of Croatia is not particularly rich in mineral resources, but their exploitation, as the primary activity in the economy of every country, is of great importance for the State. In terms of the amount of extracted mineral raw materials and the number of economic entities in the Republic of Croatia, the most significant exploitation of architectural-building stone, technical-building stone, construction sand and gravel and brick clay is the most significant. The results of the research are based on previous knowledge about the exploration areas/exploitation fields and the data obtained from the research, which were determined on the basis of the resource base of mineral raw materials, i.e. mining-geological studies. Evaluating the significance of mining and its contribution to the overall economic activity of the state, one must take into account and correctly evaluate the fact that mining is an economic branch that creates new values, and encourages and supports the work of a whole series of other productive economic branches such as energy, construction, processing industry (Krasić 2011). Based on the research, **Tables 1** show the exploitation fields of architectural-building stone (block) and (slab) in the Republic of Croatia in 2022 by county.

Of the total number of exploitation fields of mineral raw materials for construction sand and gravel in the Republic of Croatia (**Table 2**) and **Table 3** shows the exploitation fields of technical-building stone in the Republic of Croatia in 2022 by county.

Table 4 shows the exploitation fields of brick clay in the Republic of Croatia in 2022 by county.

2.2. Structure of the processing industry and fee for the concession for the exploitation of mineral raw materials in the Republic of Croatia

Mineral raw materials are important for starting the economy of a particular country, so they should and must be disposed of properly and efficiently. Investing in sustainable mining undoubtedly creates demand, creates new jobs and achieves economic progress, but it must also ensure socioeconomic and environmental improvements based on socially responsible business. Therefore, the decision on the exploration and exploitation of a particular type of mineral raw material is not determined only on the basis of spatial planning conditions, local community initiatives, environmental impacts and exploitation costs, but also depends on the actual economic state of the country (Srpak 2022).

Table 1 *Exploitation fields of architectural and building stone (block stone) in the Republic of Croatia in 2022*

Ef architectural-building stone		
County	Number of active exploitation fields	Number of active exploitation fields with terminated concessions
Dubrovačko- neretvanska	3	3
Istarska	12	7
Splitsko-dalmatinska	42	36
Šibensko-kninska	8	6
Zadarska	4	2
TOTAL	69	54
Ef architectural-building stone		
County	Number of active Exploitation fields	Number of active exploitation fields with terminated concessions
Splitsko-dalmatinska	1	1
Zadarska	25	22
TOTAL	26	23

Table 2 *Exploitation fields of construction sand and gravel in the Republic of Croatia in 2022*

Ef of building sand and gravel		
County	Number of active exploitation fields	Number of active exploitation fields with terminated concessions
Karlovačka	1	1
Koprivničko - križevačka	17	16
Ličko- senjska	3	3
Međimurska	10	9
Osječko- baranjska	1	0
Primorsko- goranska	1	1
Varaždinska	9	7
Virovitičko-podravska	2	2
Zagrebačka	8	7
TOTAL	52	46

The overall economic benefit and importance of the exploitation of mineral raw materials is manifested through the impacts: transport infrastructure, energy renovation of buildings, increased use of forms of energy that reduce greenhouse gas emissions (production of electricity and heat), general consumption (households and services), industry, agriculture, land use, land use change and forestry, waste management, transition to clean energy and development of products and services in the field of new technologies required for low-carbon energy. The structure of the manufacturing industry in the Republic of Croatia, where the largest share of the total industry belongs to the production of food products (19%), followed by the production of metal products (30%), the production of non-metallic mineral products (8%), pharmaceutical products (7%), etc. Pursuant to the provisions of the Law on Mining and the Regulation on Fees for Concessions for the Exploitation of Mineral Resources (Official Gazette No. 31/14 and No. 57/20), mining economic entities are required to pay a fee for the concession for the exploitation of mineral resources, which consists of a fixed part and a variable part. part. The fixed part of the monetary compensation for the area of the exploitation field determined by the entry in the Register of approved exploitation fields of mineral resources is the income of the state budget of the Republic of Croatia, and it is given in its entirety to the local self-government unit on whose territory the approved exploitation field of mineral resources is located. The variable part of the compensation for solid non-energy mineral raw materials is also the revenue of the state

budget of the Republic of Croatia, and it is divided as follows: 30% to the local self-government unit, on whose territory the mineral raw material is mined, 20% to the regional (regional) self-government unit, on whose territory it is mined mineral raw material 50% to the state budget of the Republic of Croatia. The importance of mining economic activity is reflected in the contribution to the growth of the gross social product of the economy as a whole, the growth of employment and the contribution to the increase in the income of the state budget.

Table 3 *Exploitation fields of technical and construction stone in the Republic of Croatia in 2022*

Ef technical-building stone		
County	Number of active exploitation fields	Number of active exploitation fields with examined concession
Bjelovarsko-bilogorska	6	4
Brodsko-posavska	4	4
Dubrovačko-neretvanska	8	7
Istarska	26	20
Karlovačka	17	13
Koprivničko-križevačka	1	1
Krapinsko-zagorska	5	4
Ličko-senjska	7	5
Osječko-baranjska	3	3
Požeško-slavonska	5	6
Primorsko-goranska	8	7
Sisačko-moslavačka	5	5
Splitsko-dalmatinska	18	13
Šibensko-kninska	4	4
Varaždinska	5	6
Virovitičko-podravska	6	6
Zadarska	13	10
Zagrebačka	5	5
TOTAL	145	123

Table 4 *Exploitation fields of brick clay in the Republic of Croatia in 2022*

Ef brick clay		
County	Number of active exploitation fields	Number of active exploitation fields with the resulting concession
Karlovačka	1	1
Koprivničko - križevačka	1	1
Međimurska	1	1
Osječko - baranjska	4	3
Sisačko - moslavačka	1	1
Varaždinska	2	2
Vukovarsko - srijemska	2	2
Zagrebačka	1	1
TOTAL	13	12

3. RESULTS AND DISCUSSION

In conclusion, we can state that the sector of the production of other non-metallic mineral products is based on the activity of mining, i.e. the use of mineral raw materials in the production process, directly 26%, and indirectly, when we take into account that our own products are also based on the use of mineral raw materials, and significantly more. The exploitation of mineral raw materials represents a respectable economic activity in the Republic of Croatia in a direct and indirect way as a significant economic and financial share in the GDP and contributes to the increase of the state budget (Mikulić 2015). This is supported by the fact that the share of mining in the total GDP in the Republic of Croatia is several times higher than the share of the production of textiles, tobacco, pulp, paper and paper products, and is also higher than the share of economic branches (production of machinery, furniture, rubber and plastic products, communication devices). The growth of the gross national product and the exploitation or consumption of mineral raw materials are mutually related, so the exploitation and consumption is part of the overall economic activity of the country and thus contributes to the overall growth of the GDP. At the same time, GDP growth requires an increase in the consumption of certain types of mineral raw materials, therefore the sustainable management of mineral raw materials and the overall economic benefit in the management of mineral raw materials must be based on the established principles of sustainable development.

4. CONCLUSION

The development of mining and its contribution to the overall economic activity of the state must be viewed and evaluated in the fact that mining is an economic branch that creates new values, and encourages and supports the work of a whole series of other productive economic branches such as energy, construction, and processing industry. Sustainable development in the management of mineral resources should mean balance, and by no means a conflict, so in the management of mineral resources, the principle of balance between economic and economic (rational exploitation, use of mineral resources, protection as well as rehabilitation in order to increase added value), spatial- environmental (less negative impact on the environment) and social interests (reflected in the exploitation of mineral resources in partnership and within legal frameworks). The construction industry is an important factor that determines the need for the exploitation of architectural-building stone, technical-building stone, gravel and sand, and brick clay. Mineral raw materials are a non-renewable resource, of importance for the Republic of Croatia, so that experts should be actively involved in spatial planning and point out potential locations of activation, so that, based on this, decisions could be made about the priorities of the purpose, rehabilitation or conservation of deposits, ensure the protection of mineral deposits for future generations, and achieve development that encourages humane, sustainable, economical and environmentally friendly production.

5. REFERENCES

Giurco, D., Petrie, J.G. (2007): Strategies for reducing the carbon footprint of copper: New technologies, more recycling or demand management? Minerals Engineering, 20/9, 2007, pp. 842-853.

Giurco, D., Cooper, C. (2012): Mining and sustainability: asking the right questions. Minerals Engineering, 29, 2012, pp. 3-12.

Grbeša, A. (2014): Analiza ciklusa eksploatacije kvarcnog pijeska u Hrvatskoj. Doktorska disertacija. Zagreb: Sveučilište u Zagrebu, Rudarsko-geološko-naftni fakultet.

Jolliffe, L. i Conlin, M. (2011): Lessons in transforming mines into tourism attractions. In Mining Heritage and Tourism. A Global Synthesis. Routledge Advances in Tourism. Oxon, New York: Routledge.

Jones, C., Munday, M. (2001): Blaenavon and United Nations World Heritage Site Status: Is Conservation of Industrial Heritage a Road to Local Economic Development? Regional Studies, 35(6), pp. 585-590.

Krasić, D., Vidić, D., Mikulić, A. (2005): Rudarska djelatnost u Republici Hrvatskoj. Klesarstvo i graditeljstvo, (1-2), pp. 6-15.

Krasić D., Vidić D., Mikulić A. (2006): Rudarska djelatnost u Republici Hrvatskoj - zakonska regulativa (Mining operation in the Republic of Croatia - Legal regulations). Međunarodni rudarski simpozij: Istraživanje i eksploatacija čvrstih mineralnih sirovina, 8-10.11.2006. Dubrovnik, pp. 338-352.

Liu, G., Müller, D.B. (2012): Addressing sustainability in the aluminum industry: a critical review of life cycle assessments. Journal of Cleaner Production, 35, 2012, pp. 108-118.

Mangena, S.J., Brent, A.C. (2004): Application of a Life Cycle Impact Assesment Framework to evaluate and compareenvironmental performances with economic values of supplied coal products. Journal of Cleaner Production, 14/12-13, 2006, pp. 1071-1084.

Memary, R., Giurco, D., Mudd, G., Mason, L. (2012): Life cycle assessment: a time series analysis of copper. Journal of Cleaner Production, 33, 2012, 97-108.

Mikulić, A. (2015): Održivi razvoj rudarske djelatnosti u Republici Hrvatskoj. Doktorski rad. Zagreb: Sveučilište u Zagrebu, Rudarsko-geološko-naftni fakultet.

Mesec, J. (2009): Mineralne sirovine, vrste i način dobivanja. Sveučilište u Zagrebu, GFV.

Mudd, G.M. (2007): Global trends in gold mining: Towards quantifying environmental and resource sustainability. Resources Policy, 32/1-2, 2007, pp. 42-56.

Norgate, T., Haque, N. (2012): Using life cycle assessment to evaluate some environmental impacts of gold production. Journal of Cleaner Production, s 29-30, 2012, pp. 53-63.

Nacionalna klasifikacija djelatnosti (NN br. 58/2007).

Pavlović, D., Banovac, E., Vištica, N. (2018): Defining a composite index for measuring natural gas supply security - The Croatian gas market case. Energy policy, 114, 30-38. https://doi.org/10.1016/j.enpol.2017.11.029

Srpak, Melita; Pavlović, Darko (2020): Sanacija zatvorenih i napuštenih eksploatacijskih polja mineralnih sirovina na prostoru Varaždinske županije//Naftaplin, 40 (2020), 165; pp. 63-72.

Srpak, M. (2022): Nova metodologija izračuna modela agregiranoga kompozitnoga indeksa za održivo gospodarenje mineralnim sirovinama na primjeru Varaždinske županije, Doktorski rad, Varaždin.

Stewart, M., Basson, L., Petrie, J.G. (2003): Evolutionary Design for Environment in Minerals Processing. Process Safety and Environmental Protection, 81/5, 2003, pp. 341-351.

Suppen, N., Carranza, M., Huerta, M., Hernández M.A. (2004): Environmental management and life cycle approaches in the Mexican mining industry. Journal of Cleaner Production, 14/12-13, 2006, pp. 1101-1115.

Uredbe o naknadi za koncesiju za eksploataciju mineralnih sirovina (NN br. 31/14 i br. 57/20)

Vrkljan, D. (2021): Rudarstvo. Leksikografski zavod Miroslav Krleža, Portal hrvatske tehničke baštine, Hrvatska tehnička enciklopedija. Zakon o rudarstvu (NN br. 56/13, 14/14, 52/18, 115/18 i 9