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Дигитални репозиторијум Рударско-геолошког факултета Универзитета у Београду

[ДР РГФ]

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Underground mining engineering ;Podzemni radovi | 2022 | |

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Review paper

REDUCING ENVIRONMENTAL IMPACT CAUSED BY MINING ACTIVITIES IN LIMESTONE MINES

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Received: May 01, 2022

Accepted: May 30, 2022

Abstract: Mining and its related activities have always resulted in changes in the environment and these changes can vary from one area to another. As a result of mining, several types of changes can be distinguished: destruction of land and existing vegetation, changes in terrain topography, modification in air quality, changes in surface and groundwater quality, as well as change geotechnical conditions of the rock. Environmental impact of mining has been a public concern. There is widespread global interest in mining and its sustainability, and it is focused on the need to shift mining industry to a more sustainable framework. This article describes the possibilities of how to reduce the environmental impact of limestone excavation. Successful closure must consider medium to long term post mining land use and land capability, as well as minimizing environmental impact.

Keywords: environmental impact, mining, degraded surface, sustainability, reclamation

1 INTRODUCTION

Over the last two centuries, the Earth's surface has changed significantly due to the human activities. Several factors such as ecological crises, governmental decisions, and local authorities, affect land use changes. Land use/land-cover changes might have positive or negative effects on natural resources at local and global scale (Mialhe et al., 2015; Mousivan and Arsanjani, 2019).

One of the most important and basic foundations of any country's economy is its mineral resources (Sekerin et al., 2019). The role of mines in economic growth is very serious and strategic, and the exploitation of the country's mines is an undeniable necessity in economic development (Firozjarei, et al., 2021). Many people are working in this big industry, and it can be recognized that the mining industry in every country has a significant impact on social welfare. The adverse effects of mining on our environment are not hidden from anyone. However, to balance these three sectors, economic growth,

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social welfare and reducing environmental disorders, we are required to enter sustainable development in this industry.

Mining activity is such that it has externality effects (Papagiannis et al., 2014). These effects will arise when a company or individual engages in an activity that directly affects others, positively or negatively, but does not pay or receive money for it. This means that the individual or company creating the externality effect does not include the costs or benefits of doing so in its cost benefit calculations.

The mining industry uses many natural resources, such as water, soil and minerals. While it is a vital industry which contributes to the economy of many countries, it can be damaging to the environment. The first step in solving this challenge is to identify the adverse effects of mining activities on environmental conditions in surroundings and the social planner should try to make the level of activity of the company at the optimal level of society.

In some studies, satellite images have been employed to monitor and assess the effects of anthropogenic activities on surface biophysical characteristics state (Estoque and Murayama, 2017; Moghaddam et al., 2018). Satellite data offer several advantages, such as being multi-temporal and multi-spectral, and cover extensive areas, that make them suitable to study and explore dynamic phenomena. With the advent of Geographical Information System (GIS), many mining activities (from exploration to stope development, and production to mine recultivation and rehabilitation) instead of old paper drawing now can create layers and composite images.

GIS replaced old map-analysis processes, traditional drawing tools, and drafting and database technologies.

Soil destruction and deforestation are two most crucial environmental impacts of open pit mining activities. Surface mining speeds up erosion and sedimentation and short duration, high intensity storms can be a violent force moving thousands of tons of soil. Physical characteristics of the overburden, degree and length of slope, climate, amount and rate of rainfall, type and percentage of vegetative ground cover affect the vulnerability (Goldan et al. 2020).

The environmental problems facing mankind in the 21st century are global climate change, natural resources depletion and also ecosystem degradation (Kittipongvises and Polprasert, 2016).

Despite the growing importance of mineral extraction and mining production, there has been an increasing concern over environmental impacts associated with the exploration, extraction and use of mineral product (Norgate and Haque, 2012; Liu et al 2015; Morrow et al 2014). This makes environmental sustainability in the mining decisive (i.e. economic, environmental and social dimensions).

2 A BRIEF OVERVIEW OF CLOSURE PRACTISE

Serbian legislation governing mine closure, Act of Mining and Geology "Official Gazette RS", 101/2015, 95/2018 and 40/2021 requires mitigation of both biophysical and socio-economic impacts.

„The holder of exploitation is obliged to recultivate the land in the course of and after the completion of works on exploitation, and no later than one year from the day of completion of works on the areas where mining works have been completed, according to the technical project of technical and biological reclamation“.

Act of Land Protection (112/15), „Land reclamation is carried out on polluted and degraded surfaces for re-formation of the soil layer and establishment plant communities on the areas where the exploitation took place mineral resources, failed afforestation, as in the case of elemental disasters, fires and other anthropogenic influences“.

Post-mining regeneration priorities in Serbia include:

- restoration of land surface of sufficient quality to support pre-mining land use potential,
- restoration of the ecological function of mined land and in the case of previously degraded land, the ecological function must be improved,
- efficient alternative use of mine infrastructure should be encouraged where this can be economically justified; where no economic alternative uses exist, mine infrastructure must be removed and the site rehabilitated to pre-mining condition,
- Minimization of current and potential future impacts on water quality and supply,
- development projects to enable equitable participation in post mining economies by all members of the community, especially marginalized groups,
- enhancement of leadership capacity within the community and local government.

As the process of environmental degradation approaches a critical point, it is necessary to increase the efficiency and quality of work on the protection, restoration, and improvement of the environment.

3 IMPACT IDENTIFICATION

Identification of possible impacts of the limestone exploitation project is an analysis of the relationship between surface mining - environment and is based on knowledge of the characteristics of the selected technology of surface exploitation of mineral resources and knowledge of the basic ecological potentials of the analyzed area (Figure 1.)

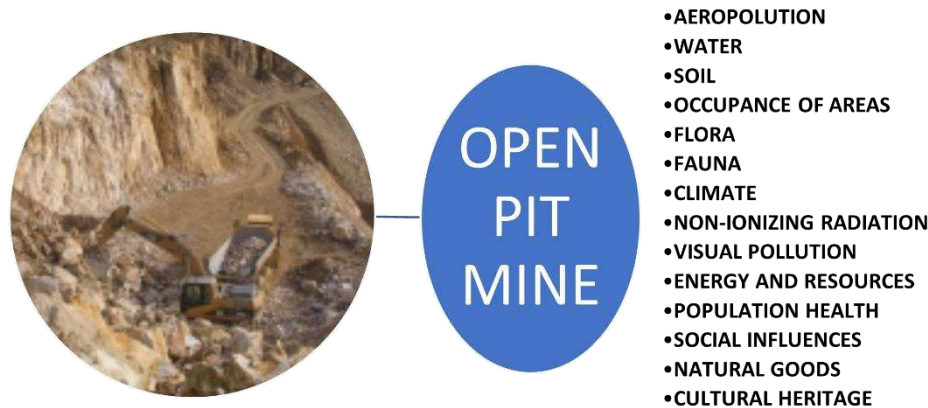


Figure 1 Relationship between the open pit and the environment

3.1 The Matrix of environmental impacts in the pilot site

Programs that address the reduction and control of environmental impacts in small scale mines generally rely on the experience and expertise of a project manager in order to identify the most important variables to be controlled and set objectives.

This Matrix method of evaluation as selecting objectives and goals, and giving relevance for different environmental impacts, improving reducing the level of subjectivity, and through the promotion of local stakeholder participation.

Table 1 Mining environment categories and impact factors

	Limestone Mining Environment	Impact factors
1	Health of humans	Land dispossession and potential funds
2	Social quality of life	Exposure, visibility of open pit
3	Air pollution	Atmospheric release of gas and dust
4	Water pollution	Above and underground water pollution
5	Soil Erosion	Increase in vehicular traffic
6	Loss of Biodiversity	The livelihood of the local workers
7	Aesthetic degradation	Vibration of ground
8	Noise pollution	Level of Noise
9	Economy	GDP Contribution

Every activity needs to be classified according to parameters with the summation indicating its significance for the environment. Variables with higher likelihood to cause environmental impact thus were given a higher priority. Every variable (mining activity) carries a potential environmental impact. To compose the matrix, a flowchart of the mining process in the area needs to be evaluated step by step. A summary of the variables is given in Table 2.

Table 2 List of mining activities with potential impacts on environment

#	Activities	#	Activities(continuation)
1	Surveying of deposit	9	Preparation refilled pit for revegetation
2	Removal of vegetation	10	Drainage of the mine
3	Transportation of equipment	11	Waste disposal
4	Installation of generator and motors	12	Revegetation
5	Excavation	13	Fertilization of vegetation
6	Drilling and Blasting	14	Fighting against pests and diseases
7	Preparation of limestone	15	Infrastructure objects (roads)
8	Backfilling old pits	16	Motors and pumps maintenance

4 LAND REMEDIATION

Land use must be decision to be made by society. Society can decide to change the land use on a rehabilitated area to housing or industrial estates, but mines have an obligation to ensure that no net loss in land capability occurs. This is primary objective in rehabilitating exploited land. Society is deprived of choice where land capability is not preserved, degraded lands can potentially support less land uses.

Agreements with communities regarding land use can be made prior to rehabilitation whereby a lower quality of rehabilitation is acceptable. For example, if the pre-mining land capability is tillable land, but the community is satisfied with grazing as a post-mining land capability. Such decisions do not promote sustainability even when are based on community preferences. Ground formation takes thousands of years and restoring a fraction of the original land capability, future generations are left of no choices that are available to this generation.

Remediation does not necessarily mean restoring the area to its original conditions. Rather is aimed at redeveloping the area to make it available for public use (naturalistic, sports purposes, educational or even scientific) or for other uses, yet with the focus always on sustainable development. Extraction operations in limestone open pit mines are the means to promote industrial activities for which social progress is an indispensable necessity.

5 CONCLUSION

In general, exploitation of limestone can cause serious damage to the environment near a mine area. Therefore, activities such as research, planning, design, and exploitation of surface mines are of exceptional importance from the aspect of preservation and protection of the environment.

Effects of mining on the environment are usually noticed after some years. Many environmental challenges such as land degradation soil erosion, noise, dust, toxic gases, and pollution water are created as result of the exploitation of the mine. Open pits affect

local biodiversity, changing topography and vegetation. Drilling and blasting operations as well as application of heavy vehicles are very important to environmental effects because these operations generate noise, vibration, and dust.

Depending on the technology used and the mining methods adopted, mining activities can have significant consequences on environmental degradation and industrial pollution. Mining dumps of overburden are frequently the principal source of solid waste and can cause the contamination of ground and surface waters with toxic chemicals.

Workings performed for extracting limestone in open pits are small-scale developments but can lead to significant degradation of the surrounding terrain and waste dumps resulting from this activity.

Our research indicates a significant and negative impact of the mine activities up to the present time and how it will be continued in future. In last ten years, significant parts of natural areas were converted to mine lands and mining activities that reduced vegetation cover and increased land surface temperature. Combination of information obtained from satellite images increases the accuracy of modeling the soil characteristics and the impact of mining activities on the surface biophysical characteristics. In the other hand, predicting the effects of mining activities can significantly affect alter the surface biophysical characteristics. The application of predictive models has insights about the future changes in the ecosystem and taking protective measure against the unplanned and undesirable situations.

To lessen their impact on the environment, mining companies should look into using sustainable equipment and waste disposal procedures, implementing pollution control measures. They should also consider replenishing the local environment as often as possible, which will make the surrounding area habitable and able to return to a natural state once the mine has closed. Reducing both input and output of the mining process can also help to reduce the negative impact that mines have on the environment and local neighboring community.

There is need to furtherance environmental awareness and/or education in mining ambience and ensuring sustainable use of the environment in the face of on-going mining activities. This will create certain balance between development/economic growth and environmental requisites for community livelihoods.

The most important thing is to understand the system requirements and specifications and to address human interface issues to improve component and system reliabilities and minimize the occurrence of environmental negative impacts.

The above recommendations will help reducing and prevent the environmental impacts that disturbs the sustainability of the mining and environmental policies towards achieving environmental sustainability in Serbia.

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