



University of Belgrade, Technical Faculty in Bor
29th International Conference Ecological Truth
& Environmental Research



EcoTER'22

Proceedings



Editor

Prof. Dr Snežana Šerbula

21-24 June 2022, Hotel Sunce, Sokobanja, Serbia



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PREFACE

In today's world, the environment has been endangered by the use of outdated technology, fossil fuels and environmental law violations. Therefore, environmental and many other scientists all over the world have been concerned about finding sustainable technology in resolving these issues. That is why environmental research and ecological truth are at the focus of the 29th International Conference Ecological Truth & Environmental Research 2022 (EcoTER'22), which will be held in Sokobanja, Serbia, 21–24 June 2022. On behalf of the Organizing Committee, it is a great honor and pleasure to wish all the participants a warm welcome to the Conference.

We hope to convey the message of the conference, which is that a transformation of attitudes and behavior would bring the necessary changes. This is also an opportunity for the participants who are experts in this field to exchange their experiences, expertise and ideas, and also to consider the possibilities for their collaborative research.

The 29th International Conference Ecological Truth & Environmental Research 2022 is organized by the University of Belgrade, Technical Faculty in Bor, and co-organized by the University of Banja Luka, Faculty of Technology, the University of Montenegro, Faculty of Metallurgy and Technology – Podgorica, the University of Zagreb, Faculty of Metallurgy – Sisak, the University of Pristina, Faculty of Technical Sciences – Kosovska Mitrovica and the Association of Young Researchers, Bor.

These proceedings include 85 papers from the authors coming from the universities, research institutes and industries in 6 countries: Bulgaria, Italia, Albania, Bosnia and Herzegovina, Montenegro and Serbia.

As a part of this year's conference, the 4th Student section – EcoTERS'22 is being held. We appreciate the contribution of the students and their mentors who have also participated in the Conference.

Financial assistance provided by the Ministry of Education, Science and Technological Development of the Republic of Serbia is gratefully acknowledged by the Organizing Committee of the EcoTER'22 conference.

The support of the Platinum donor and their willingness and ability to cooperate have been of great importance for the success of EcoTER'22. The Organizing Committee would like to extend their appreciation and gratitude to the Platinum donor of the Conference for their donation and support.

We appreciate the effort of all the authors who have contributed to these Proceedings. We would also like to express our gratitude to the members of the scientific and organizing committees, reviewers, speakers, chairpersons and all the Conference participants for their support to EcoTER'22. Sincere thanks go to all the people who have contributed to the successful organization of EcoTER'22.

Prof. Snežana Šerbula,

President of the Organizing Committee

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IMPACT OF THE MINING ACTIVITIES IN THE GOLLIJA NATURE PARK AREAS SITUATED ON THE TERRITORY OF RAŠKA MUNICIPALITY

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Abstract

Traces of present or former mining activity in the Golija Nature Park areas situated on the territory of Raška Municipality are assessed and analyzed in terms of their impact on the environment and possibilities for remediation and reclamation. Active dolomite quarry "Lokve", closed magnesite mine „Trnava“, tunnel Brvenica – Trnava, scheelite deposit and undermining excavation site Jurija and other exploitation sites have left consequences to the environment, including localized pollution, altered hydrological regime and landscape degradation and fragmentation. Remediation scope, activities and types differ depending upon the exploitation and exploration methods, and include biotechnological approaches as well as contemporary category of mining geoheritage preservation.

Keywords: exploitation; reclamation; environmental impact

INTRODUCTION

Mining activities cause diverse environmental consequences, which are even more pronounced if the exploitation is undertaken within the protected area or in its immediate surrounding. Main types of such impact, according to [1] are: a) land and biota loss resulting from direct mining or associated impacts; b) pollution of environmental mediums, including water, soil and air; c) impact connected with infrastructure necessary for mine activities (roads, pipelines, transport tracks, power stations etc.) that are causing noise or habitat fragmentation; d) secondary effects on livelihood opportunities (migration of residents, shortage of water supplies, alien invasions etc.); e) Visual impairment due to mining and following activities (deposition of mine waste, transportation, habitat degradation or loss).

The area of Mt Golija was designated as a natural asset of exceptional importance [2], as well as a protected area of international, national or exceptional importance, with an established three-level protection regime [3]. Within this area, in 2001, the first biosphere reserve in Serbia "Golija-Studenica" was declared by the act of the UNESCO MAB programme. Due to the presence of numerous plant and animal species of national and international importance, and in order to protect priority habitat types, Golija has been identified as the international ecological network Emerald site, and internationally important area for plants (IPA), birds (IBA) and butterflies (PBA). It is considered as a center of genetic, species and ecosystem diversity in the Balkans and Europe. According to the landscape typization, Golija Nature Park is classified as a cultural landscape, a subtype of

cultural landscape close to nature, within which several biotope complexes with distinct representatives of species can be singled out [4]. Being poorly inhabited, distinct demographic aging is taking place within this area of broking type settlements, with cattle breeding as the main activity [5]. As cultural landscapes are hosting diverse traces of humans and nature interactions, that often includes historical or active mining sites, as is the case with Golija Natural Park.

The quality of water, soil and air in the Nature Park has been largely preserved, primarily due to the poor utilization of natural resources [6]. The land is endangered by erosion [4], and a certain degree of degradation is also present in the zones of mineral exploitation. Air pollution is considered to be mostly local; however, there are no measuring stations for monitoring of air quality in the area of the Nature Park. Pollution of water in this area originates both from uncontrolled waste disposal near watercourses and from the consequences of mining activities [7].

Golija Nature Park includes parts of municipalities Ivanjica, Sjenica, Kraljevo, Novi Pazar and Raška, out of which Raška municipality covers 12 623 ha (17% of the total territory). Within this area, two natural assets of the first degree of protection (sites Plakaonica and Ravnine) and two natural assets of the second degree of protection (sites Plakaonica 2 and Retko Bučje) are registered. Regarding the exploitation, coal, dolomite and construction stone are currently exploited in this territory or in its immediate vicinity (e.g. in quarries Biniće, Zvečarica, Biničko Polje and Luke). The consequences of mining works are still visible, most often in the form of landscape transformation or degradation. This paper analyses the current state, impact and possibilities of remediation of the consequences of former or current mine deposits as well as areas of exploitation of mineral resources within the investigated part of protected area.

OVERVIEW AND CHARACTERISTICS OF EXPLOITATION AND MINING SITES IN THE INVESTIGATED AREA

During the field activities carried out in August 2021 for the needs of "Zeleni putokazi Golije" project (<https://www.village.org.rs/zeleni-putokazi-golije/>), the terrain was reconnoitred and localities of present or former mining activities and their traces were identified (Figure 1).

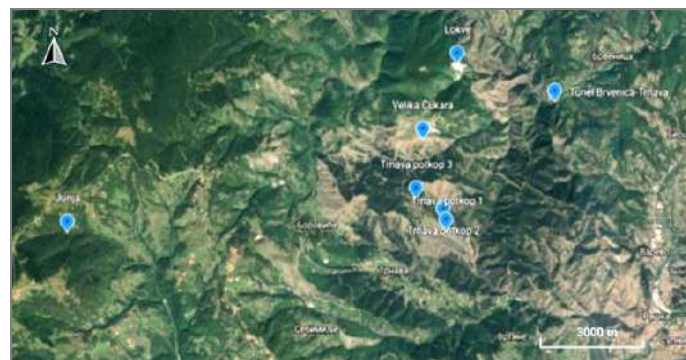


Figure 1 Locations of current and former mining activities in the area of the Golija Nature Park situated on the territory of Raška Municipality

Presentation of their main characteristics, dominant environmental hazards conditioned by their presence and adequate remediation measures were proposed for each case.

Dolomite quarry “Lokve”

Active exploitation of the dolomite stone in quarry ‘Lokve’ takes place within the third protection zone of the Golija Nature Park. Locality is surrounded by natural and artificial forests, as well as the degraded forest communities [8]. The consequences of the exploitation of dolomite on the environment are of local character. In addition to the destruction of landscapes in the area of exploitation and the devastation of the surrounding terrain, environmental disturbances are present in the form of dust and noise that impacts nearby areas and accompanying flora and fauna. Floating particles from the process of exploitation and preparation of raw materials and exhaust gases of machinery used in this process reduce air quality, while dust particles settle on plant leaves, interfering with the process of photosynthesis and physiological functions. These dust particles are also a source of soil pollution in the immediate vicinity of the place of exploitation. After the original ecosystems have been destroyed or devastated, they are replaced by other, initial communities and species or early vegetation stages. This can cause the emergence of invasive species, but also the emergence of potentially endangered species such as *Epilobium dodonaei* that, due to the threat to their natural rocky habitats, began to inhabit these anthropogenic areas, as the natural competition of other species is reduced. The described conditions of environmental disturbance are also present, to a lesser or greater extent, on the other quarry sites located in the study area, depending on whether is the case of active exploitation or an abandoned site.

Rehabilitation measures of the dolomite mine "Lokve" would imply the reclamation of the area, which is obligatory after the end of the exploitation period [9]. The project should include a plan which envisages stabilization and revegetation of the final terraces and plateaus, as well as the removal of ancillary facilities. The goal of reclamation in protected areas would be to integrate the area into the natural surroundings, striving to reach the state as close to the natural as possible. Modern trends in the reclamation of quarries include the use of targeted blasting of the final terraces to create cracks that would accelerate the development of the root system [10] and biological systems with high terrain coverage and initiation of pedological and biological processes are coming into use [11]. Additionally, it is possible to perform reclamation of the space for the recreational uses and tourism development [12].

Closed magnesite mine “Trnava”

In the peridotite massif located between Raška and the village of Trnava there are occurrences of magnesite deposits concentrated in several smaller units. The main and side ditches were opened at the location of the "Trnava" magnesite for the purpose of exploitation of the magnesite ore. Mining activities ended in early 1990s, and nowadays anthropogenic relief forms –partially exposed or totally exposed halds – are visible in the area. Halds are predominantly colonized by individual black pine trees (*P. nigra*) originating from nearby natural and antropogenically raised stands.

Traces of the forest fires are present in the immediate vicinity of the excavation sites. The whole landscape has undergone a certain degree of anthropogenic change. Presence of

surrounding forest ecosystems represents a favorable moment for the natural revitalization of the mining activities remnants in the area. On the other hand, the thinning of forest ecosystems, either by felling or due to natural disasters such as fires, reduces the degree of connectivity in the landscape and slows down the natural processes of colonization. Afforestation of halds with *P. nigra* trees would be a way for anthropogenically assisted rehabilitation of this area that would return the landscape to state close to the natural. In contrast, treating and protecting this part of the area as a kind of mining geoheritage that is a transitional category between geoheritage (natural) and industrial (cultural) heritage of an area [13], could represent potential for developing base for research, education and geotourism in in the municipality of Raška.

Tunnel Brvenica – Trnava

Right next to the river Brvenica, the most important water source for the municipality of Raška, there is deposited material from a tunnel built during the 70s of the last century in order to shorten the transport of magnesite from the Trnava mine to the processing plant in Bela Stena – Baljevac. Due to the collapse of water-tight layer of rocks in the tunnel Trnava, there was a gradual violation of the natural hydrogeological balance, i.e. drainage of surface and groundwater from the area of Zimovnik, Poljane and Breza in the tunnel Brvenica - Trnava. Due to the easier transport of ore by wagons, the tunnel was made with a slope towards Brvenica. For this reason, nowadays the water from the area of the Trnava mine flows through a tunnel towards Brvenica. That water is used to supply part of the Raška municipality with drinking water. On the other hand, due to the change of the hydrological regime, the wells and springs in Zimovnik have dried up.

The impact of deposited embankment made from the excavated material during formation of tunnel on the environment is relatively localized, but the place of disposal on the banks of the river Brvenica, between the zone of water sources and agricultural areas represents a potential risk to the quality of surrounding waters and soils, primarily due to the natural enrichment of serpentinite elements such as Ni, Cr, Co and others.

The process of primary and secondary colonization of embankment is underway (with predominant species being *Pinus nigra* and *Achnatherum calamagrostis*) and may represent a form of spontaneous reclamation which would eventually help to reach the state close to the surrounding area. On the other hand, the possibility of using crushed stone from the embankment for industrial or other purposes after examining its suitability would also be an adequate way to rehabilitate the terrain and remove these remnants of former mining activities in the municipality of Raška.

Scheelite deposit and undermining excavation site Jurija

The Golija ore region is located directly along the contact between the Dinarides and the Vardar zone. Within that region, there is significant ore field “Lisa - Crni Vrh”. Two basic associations of minerals are known in this ore field, with the dominant distribution of scheelite mineralization: (I) Skarns scheelite paragenesis that includes, in addition to scheelite, magnetite, quartz and calcite (II) High-temperature associations of scheelite with sulphides are much more common in this ore field, and larger than scheelite mineralization in skarns [14]. The Jurija deposit is the only tungsten / sheelite deposit that was explored in

more detail on Golija, during the 1950s. The location is placed near to the Ravnina site that is under the I level of protection within the Golija Nature Park.

Jurija site includes the former undermine excavation site and the hald, which consists of the deposits from excavation works. Hald is located on a slope at a height of about 100 m above Klisurski potok, and is completely bare as vegetation cover is missing. The entrance to the former trench is noticeable in the vicinity of halda, but also the water that flows out of the trench and flows down to the Klisura stream. This way, Klisura stream becomes a recipient of both water that flows out of the former undermining excavation site, and material that is washed out from the halda directly into the stream.

Preliminary water quality tests have not been performed at this location that would provide a basic insight into the extent of the impact of this former mining facility on the environment. It is necessary to perform sampling and analysis of waters that flow from the former undermining excavation site in order to determine their composition and quality, but also of the water from the Klisura stream at the locations before and after the inflow, in order to assess the possible environmental impact. Additional information about the long-term impact of these activities on the water quality would be provided by the study of biological parameters, such as the analysis of the status of aquatic biota. Partial remediation of this site is feasible by removing the material of the halda, after its mineral and chemical composition, the category of waste to which it belongs according to its characteristics, as well as the appropriate method of disposal have been determined.

CONCLUSION

The paper presents an analysis of the state of locations with former or ongoing mining activities within the Golija Nature Park in the municipality of Raška. Exploitation of mineral raw materials and mining explorations left several categories of consequences to the environment: a) Pollution of water, air and soil of predominantly local character; b) Change of groundwater regime in wider area c) Landscape change and landscape fragmentation. These activities disrupt the character and function of the Golija Nature Park landscape. Remediation types differ depending upon the exploitation and exploration methods, and include technical and biological reclamation, spontaneous and assisted recolonization of mine waste sites, potential use of waste as raw material in the construction industry, relocation of waste outside the Nature Park, but also the preservation of visible traces of mining activities as an inseparable part of cultural and geological heritage, in order to develop geotourism in this area.

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