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FOREWORD

The International Scientific and Professional Conference POLITEHNIKA 2023 represents the seventh edition of the POLITEHNIKA scientific and professional events, occurring biannually since its inaugural event in 2011. POLITEHNIKA 2023 upholds a distinguished tradition and commitment to integrating higher education and practical application across a diverse spectrum of disciplines represented by defined thematic scopes.

Organized with the patronage of the Ministry of Education of the Republic of Serbia, the Ministry of Environmental Protection of the Republic of Serbia, the Ministry of European Integration of the Republic of Serbia, the Directorate for Occupational Safety and Health, the Office for Dual Education and National Qualifications Framework, the Conference of Academies of Applied Studies in Serbia, the Chamber of Commerce of Serbia, the Chamber of Commerce of Belgrade, the Institute for Standardization of Serbia, the Association of Belgrade Architects, the City of Požarevac and the Tourist Organization of the City of Požarevac, POLITEHNIKA 2023 stands as a collaborative platform at the intersection of academia, governmental institutions and industry.

This year heralds a notable progression with its international status and the incorporation of 10 conference scopes. Expanding beyond the thematic domains featured in previous events, the Conference now encompasses Environment and Sustainable Development, Occupational Safety and Health and Fire Safety, Smart Management Systems, Graphic Engineering, Design, Traffic Engineering, Biotechnology and Healthcare, Mechanical Engineering, Ecotourism and Rural development, and Mechatronics. By engaging experts, emerging professionals, and practitioners from these domains, the conference unifies fields of study programs of the Academy of Applied Technical Studies Belgrade. The thematic scopes, coupled with the structure of the compiled papers in this Proceedings, exhibit a rich diversity and multidisciplinary approach, fundamentally contributing to a holistic examination and resolution of societal and scientific challenges.

Comprising over 220 peer-reviewed contributions, the Proceedings represent a substantial intellectual asset, aligning with the conference's overarching objective of fostering the exchange of knowledge, research findings, and professional experiences among experts from industry, research institutions, and higher education establishments.

The Proceedings of the International Scientific and Professional Conference POLITEHNIKA 2023 serve as a comprehensive snapshot of the current landscape within the thematic realms of the conference, offering both insights and directives for ongoing scientific and professional development. Moreover, they proffer concrete solutions to practical challenges grounded in contemporary trends and pertinent insights.

The Academy of Applied Technical Studies Belgrade extends its sincere appreciation to all conference supporters whose financial contributions played a pivotal role in its successful realization. Special acknowledgment is reserved for the authors of the papers, whose diligence and eagerness to present their work to a wider audience, alongside the reviewers and members of the International Scientific Committee, Program Committee and Organizational Committee, have collectively contributed to the triumph of the International Scientific and Professional Conference POLITEHNIKA 2023.

Belgrade, December 2023
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ENVIRONMENT AND SUSTAINABLE DEVELOPMENT

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Srećko Stopić, PhD, Bernd Friedrich, PhD, Process Metallurgy and Metal Recycling, RWTH Aachen University, Germany

Advances in understanding of a role of unit metallurgical operations for recycling

Svetlana Grujić, PhD, Faculty of Technology and Metallurgy, University of Belgrade
Emerging pollutants in the environment: contamination of the Danube river basin in Serbia

Marija Nikolić, PhD, Faculty of Technology and Metallurgy, University of Belgrade
Biodegradable polyesters – from ecology to medicine

DESIGN

INVITED PAPER

Jelena Ristić Trajković, PhD, Faculty of Architecture, University of Belgrade
Society, Ecology and Design Education: Transformative Learning for Future Sustainable and Healthy Environments

MECHANICAL ENGINEERING

INVITED PAPERS

Tamara Bajc, PhD, Faculty of Mechanical Engineering, University of Belgrade
Energy savings and CO₂ emission reduction potential through the existing building renovation

Marko S. Jarić, PhD, Innovation Centre of Faculty of Mechanical Engineering in Belgrade
Analysis of remediation of horizontal cylindrical tank for oil storage

ECOTURISAM AND RURAL DEVELOPMENT

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Marko Perić, PhD, Faculty of Tourism and Hospitality Management, University of Rijeka, Croatia
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Snežana Štetić, PhD, Balkan Network of Tourism Experts, Igor Trišić, PhD, Faculty of Geography, University of Belgrade
Selective forms of tourism and sustainable development of rural tourist destinations

INVITED PAPERS

Radomir Stojanović, PhD, Western Serbia Academy of Applied Studies
Education as a pillar of sustainable agritourism in Serbia

Jelena Premović, PhD, Faculty of Economics, University of Priština & Faculty of Economics and Engineering, University Business Academy in Novi Sad
Cultural heritage as a generator of sustainable development of tourism in local communities in the countries of the Western Balkans

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Analysis of the real number of tourist overnights based on the estimation of water consumption in Zlatibor

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MINING SOLID WASTE AROUND BOR, YESTERDAY, TODAY, TOMORROW

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Abstract: *Intensive exploitation and processing of copper ore in the area of Bor District has led to the degradation of large areas of land and the deposition of large amounts of solid waste (mining overburden and waste dumps, flotation tailings, smelter slag). The characteristic of these wastes is that they contain significant amounts of copper and other elements, but also permanently lead to soil, water and air pollution. The paper shows photos of the evolution of the appearance of mine solid waste landfills and provides data on sanation and recultivation and a plan for further activities. Conceptual solutions for sanation degraded areas created by hundred years of mining in Bor were also given.*

Keywords: Overburden, Flotation Tailings, Environment

1. INTRODUCTION

In the modern practice of producing non-ferrous, rare and precious metals, more and more attention is paid to the possibility of treating raw materials with low metal content, considering that they have disappeared, or the reserves of rich ores are very limited. At the same time, the intensive development of technology in the world leads to a higher consumption of metals, which results in a multiple increase in the price of metals in recent years [1]. The development of technological processes for recovering the low-percentage copper ore and complex raw materials, demands the massive production, which has got a strong negative effect on the environment, especially when such ore is mined in the open-pit mines. The harmful influence of mining operations has been reflected in the degradation of vast areas of soil (open-pit mines), then, dumping large volumes of solid wastes (mining overburden, waste rock dump and flotation tailing) as well as the occurrence of acid mining waters. During the metallurgical processes of polymetallic ores and concentrates, besides obtaining the basic metals, there have also been formed middlings (slag, dust, and mud-slurry) [2].

Some research has shown that today there are 3,500 active overburden dumps in the world and that 100 billion tons of mining waste are deposited there annually [3]. In the countries of the European Union, more than 5 billion tons of mining waste are disposed of, most often in Finland, Greece, Ireland, Portugal, Spain, Sweden and Great Britain [1].

In 2020, the equivalent of 4.8 tons of waste was produced per EU resident. This figure includes 3,080 kg of coarse mineral waste and 1,735 kg of waste from other sources. In other words, 64 percent of waste in the EU comes from mining. Figure 1 shows data on waste generation by individual countries in Europe [4].

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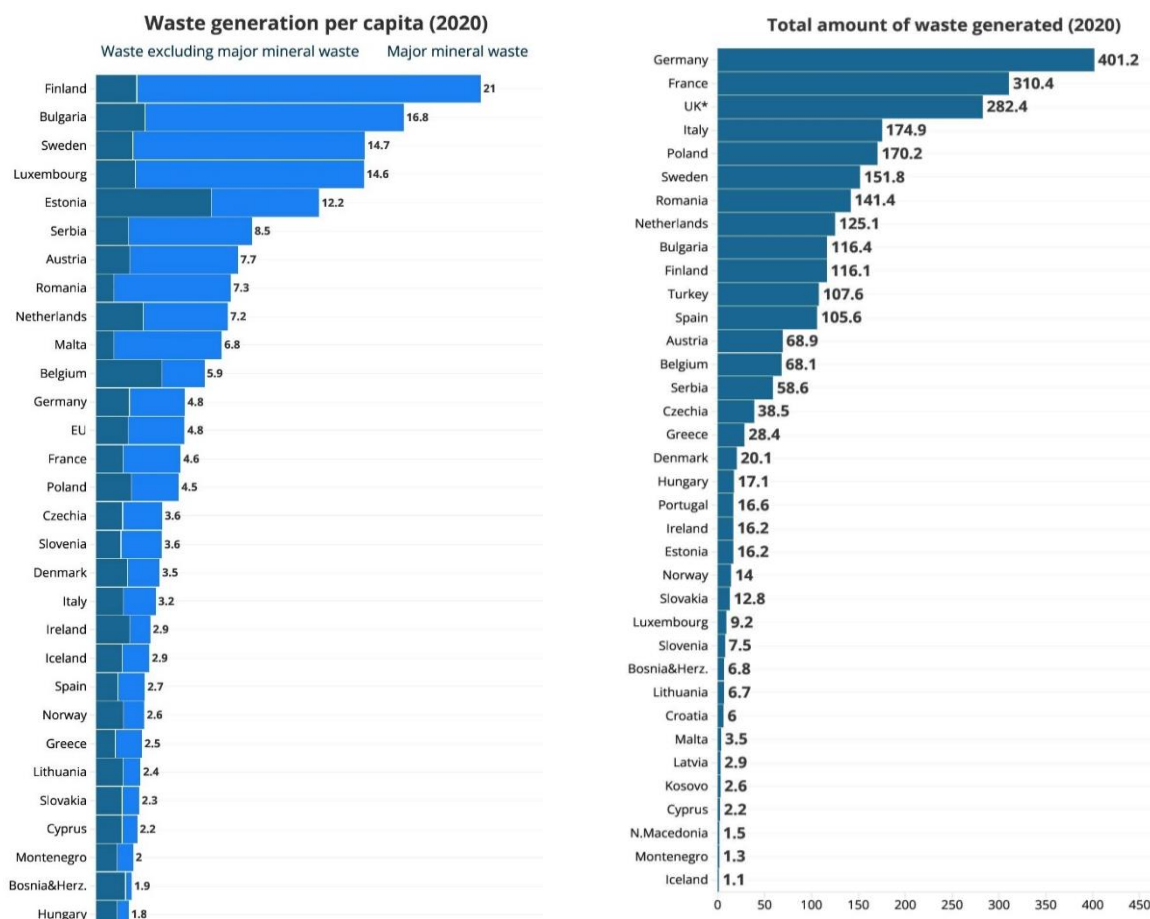


Figure 1. Data on waste generation by individual countries in Europe

Source: <https://sn.rs/c9ypb>

2. BOR YESTERDAY

Formerly RTB-Bor and today Zijin Copper represents one of the most important mining and metallurgical complexes in the Western Balkans. Mining production in Bor began in 1903, with underground exploitation. Surface mining in Bor began in 1912 and lasted until 1986. The two largest open-pit mines are Veliki Krivelj (opened in 1979) and Cerovo (opened in 1990).

Until 2001, the following were deposited on the territory of the municipality of Bor: 450 Mt of overburden, 207 Mt of flotation tailings and 23 Mt of smelter slag [5,6]. This waste represents a total of 99.95% of the total waste deposited on the territory of the municipality of Bor. Approximate quantities of deposited material in the vicinity of Bor are shown in Figure 2, and a schematic representation in Figure 3.

Mining has degraded 1198 ha of agricultural land, i.e. 0.02 ha per inhabitant. As a result of the discharge of wastewater from flotation and flotation tailings, 2,500 ha of land was destroyed, i.e. 0.4 ha per inhabitant [5,6]. The total area of the RTH tailings pond is 86.4 ha, and the area of the inactive "Visoki planir" mine disposal site is 302 ha with 177 ha of flat areas and 125 ha of sloping areas.

From the creation of the mining waste disposal site until 2019, technical and biological recultivation of degraded areas was carried out on several occasions. For example, in just one action in 1992, 190,000 acacia seedlings were planted on the flotation tailings of Bor and Veliki Krivelj, and 74 ha of degraded soil was filled with humus and grass was sown [7].

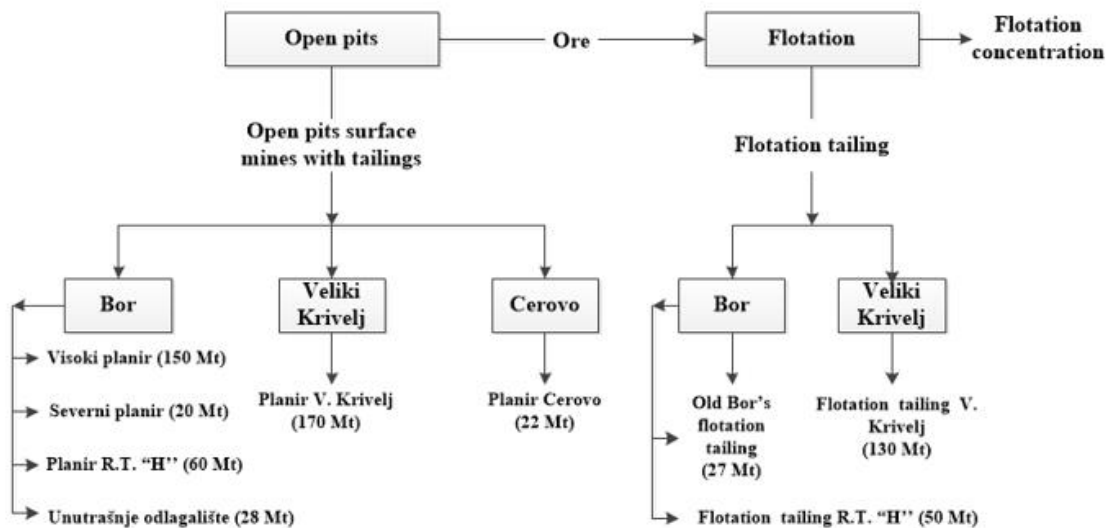
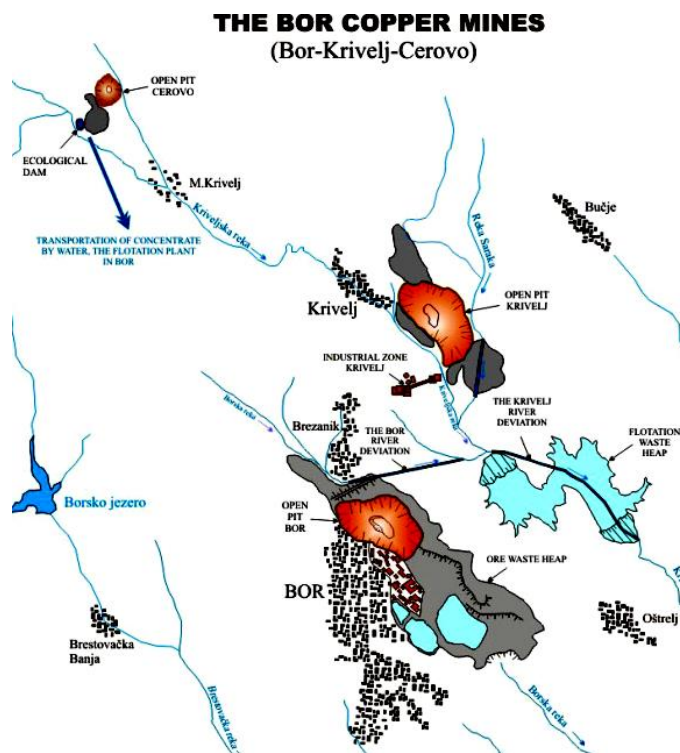


Figure 2. Graphic representation of the amount of waste materials until 2001
Source: [5]



Visoki planir and flotation tailing RTH



Lake Robule

Figure 3. Schematic representation of deposited overburden dumps around Bor
Source: [8]

3. BOR TODAY

Serbia Zijin Copper DOO is a company operating within the Zijin Mining Group. It was founded on December 18, 2018, on the day when Zijin and the Government of the Republic of Serbia signed the final documents, i.e. the contract on the acquisition of 63 percent of ownership in RTB Bor. Serbia Zijin Copper is committed to reducing the adverse impact on the environment and since taking over RTB Bor has invested considerable funds, among other things, in reculturing degraded areas. Table 1 shows data on recultivated areas and planted seedlings by location [7].

Table 1. The area that has been recultivated and the number of seedlings planted

Suorce: [7]

Location	Open-pit mine Veliki Krivelj	Veliki Krivelj Flotation Plant	Flotation tailings VK	Flotation tailings RBM	Flotation tailings RTH	Old Bor dumps	Open-pit mine Cerovo	Cerovo Flotation Plant	Kamenolom	Pit	Zagradje	Open-pit mine RBM	RBM Flotation Plant	TIR	Σ
Recultivated areas, ha	6.72	8.72	50.68	43.99	22.59	14.47	9.24	3.15	0.91	3.65	1.57	16.66	2.31	3.53	188.19
Planted seedlings	11,345	14,750	39,975	36,300	128,865	14,872	6,439	2,546	6,300	18,468	554	33,300	1,829	13,490	329,033

Figure 4 shows an example of two recultivated locations.

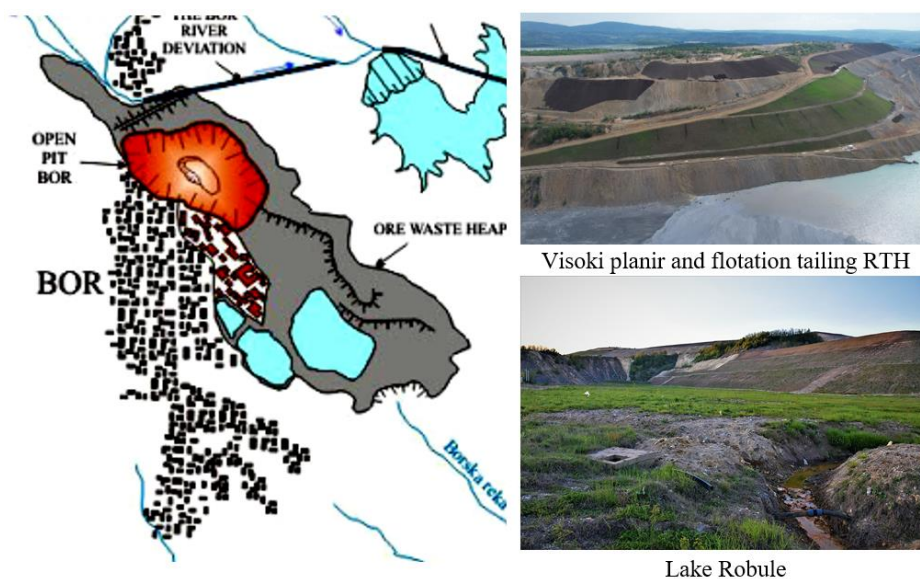


Figure 4. An example of recultivation (Bor today)

Suorce: [8]

4. BOR TOMMOROW

In the future, the company Serbia Zijin Copper DOO plans to continue activities on the recultivation and remediation of degraded areas, as well as the preparation of project documentation and the construction of solar power plants, which would meet part of the electricity needs from renewable sources. The use of renewable energy sources will significantly relieve the electricity grid of Serbia. The construction of solar power plants will be carried out in three phases, over the next 10 years, with the ultimate goal that in 2033 the production of electricity will be around 100 megawatts, while simultaneously reducing carbon emissions by 175,000 tons per year. The plan is that after the implementation of the project, the surroundings of Bor will look like the photos in Figure 5.



Figure 5. Forecasting the appearance of the around Bor in the future

Suorce: [8]

5. CONCLUSION

The constantly increasing development of human society is based on the development of industrial production and energetics imposing thus the necessity for larger exploitation of mining resources, that is, mineral raw materials. A long-term exploitation in Bor and its vicinity had a great influence on the environment through the degradation of large areas of soil (open-pit mines), then, the deposition of huge volumes of solid wastes (overburden and waste rock), next, forming waste waters and air pollution. How it was yesterday, how it is today, and how it will be tomorrow for the citizens of Bor, we leave it to the readers to answer for themselves, and we only give a couple of photos in Figure 6.



Figure 6. Past, present, future
Source: [8]

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