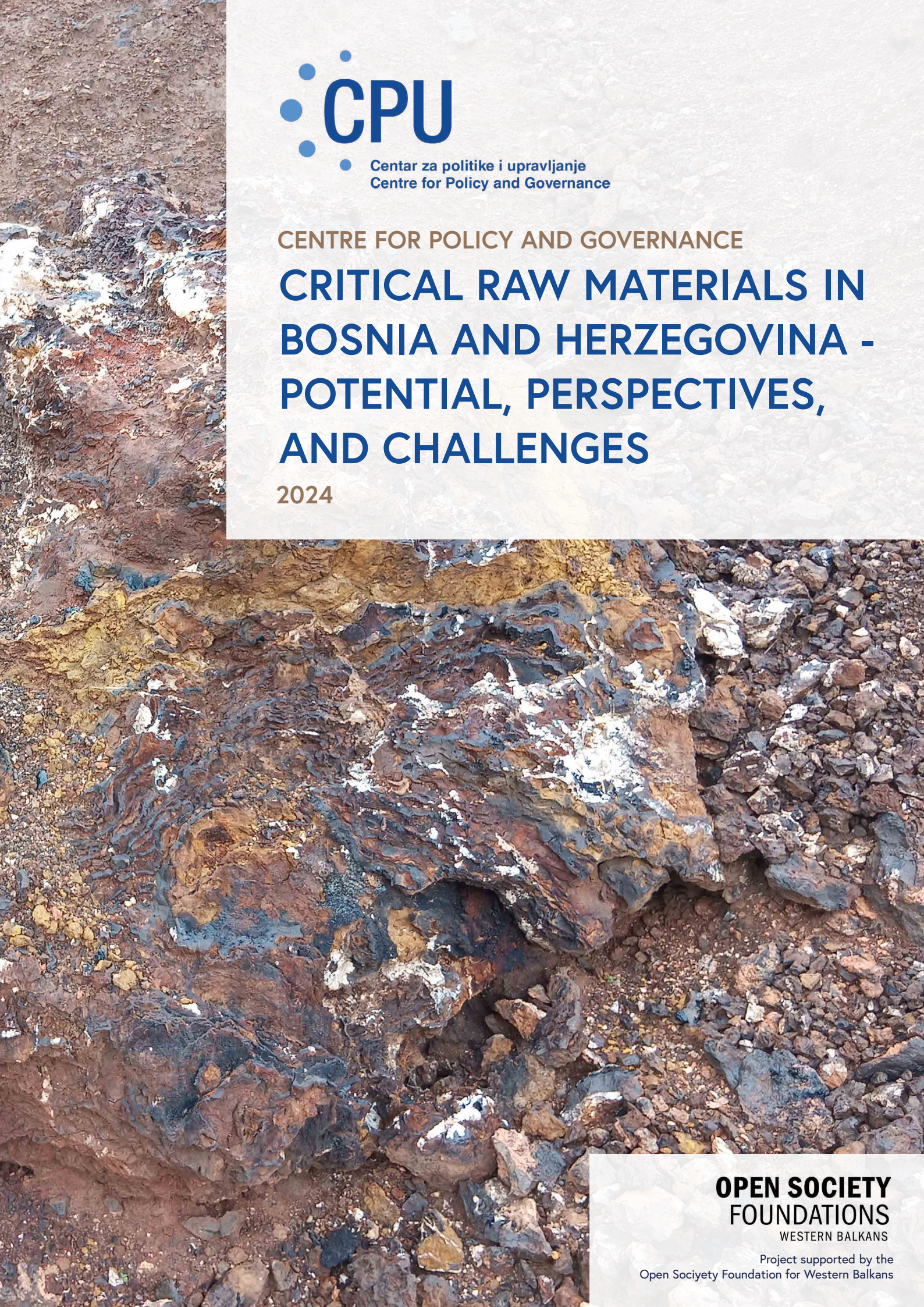


CPU

Centar za politike i upravljanje
Centre for Policy and Governance

CENTRE FOR POLICY AND GOVERNANCE

CRITICAL RAW MATERIALS IN BOSNIA AND HERZEGOVINA - POTENTIAL, PERSPECTIVES, AND CHALLENGES

2024

OPEN SOCIETY FOUNDATIONS
WESTERN BALKANS

Project supported by the
Open Sociyety Foundation for Western Balkans

Title

Critical Raw Materials in Bosnia and Herzegovina – Potential, Perspectives, and Challenges

Publisher

Centre for Policy and Governance

Year

2024.

CONTENTS

SUMMARY

The growing global demand for key raw materials such as lithium, cobalt, copper, nickel, or rare earth elements (REE) positions Bosnia and Herzegovina (BiH) as a potential strategic partner to the European Union (EU), particularly in the context of the 2024 Critical Raw Materials Act. Additionally, Bosnia and Herzegovina is a signatory of the Green Agenda for the Western Balkans, committing to sustainable mining-metallurgical and energy practices.

While much of Bosnia and Herzegovina's mining sector faces challenges in adapting to global, especially EU decarbonization requirements, the country holds significant reserves of critical materials (CRM) for the EU, such as bauxite, magnesium, manganese, cobalt, antimony, lithium, and others. Some of these materials, like bauxite, have already been extensively exploited, the reserves of some are well-known, while others, like lithium, require further exploration.

The aim of this document is to assess the potential, perspectives, and risks related to the exploitation of critical materials in Bosnia and Herzegovina, with a focus on alignment with European Union policies and global green transition trends. It also seeks to explore the challenges and opportunities in the sector, including environmental, economic, and governance aspects.

According to data from the BiH Agency for Statistics, the mining sector directly contributes 1.3% to the gross domestic product, but its role in related industries, especially in the production of base metals and energy, is far more significant. New projects, such as the opening of silver, zinc, lead, and gold mines in Vareš, lead mines in Olovo, and upcoming projects in Lopare and Fojnica, as well as numerous geological explorations, indicate significant dynamism in this sector. Additionally, Bosnia and Herzegovina has considerable potential for the extraction of secondary materials from the former mining dumps and tailings of waste material.

These projects present an opportunity to strengthen the economy, particularly at the local level, but they also require appropriate environmental and social standards to ensure sustainability. From an economic perspective, it is crucial for Bosnia and Herzegovina to align its processing industry with the needs of green technologies and the use of critical materials, allowing the country to participate in all stages of EU value chains. Furthermore, it is necessary to consider improving the concession system in the context of enhancing transparency, competitiveness, and efficiency in selecting concessionaires, as well as the adequacy of fees and their collection.

Environmental challenges are significant. Mining contributes to significant surface alterations, biodiversity loss, water pollution, soil erosion, and CO_2 emissions, while abandoned mines pose a long-term environmental risk if not closed in accordance with environmental protection program. Bosnia and Herzegovina currently lacks a comprehensive and up-to-date registry of former mining sites and dumps and tailings, which hinders planning. It is necessary to identify locations with strategic potential based on existing data. Additionally, aligning with EU environmental standards should be prioritized, which includes introducing stricter regulations for pollution control and environmental risk management. A strategic environmental assessment of mining in BiH is recommended, as well as improving project-level impact assessment standards. Identifying locations with strategic potential in this area should also be a priority.

Bosnia and Herzegovina needs to improve the application of international standards in sustainable mining, including ensuring adequate public participation under the principle of free, prior, and informed consent (FPIC) from indigenous and local populations before the start of mining projects. It should also implement best practices for industrial mining, environmental protection, safe working conditions, and respect for human rights.

It is recommended that Bosnia and Herzegovina adopts a clear and sustainable strategy based on broad societal discussion about the role of extractivism in the country's strategic development, intending to exploit resources sustainably and ensure long-term economic benefits for the country and its citizens.

Additionally, it is necessary to intensify geological research, modernize and optimize mining infrastructure, and ensure that these resources support the processing and green industries in Bosnia and Herzegovina. It is also important to improve the education of technical personnel, enhance industrial value chains and increase transparency in the concession system. Taking advantage of opportunities for integration with EU policies is key to achieving economic sustainability and meeting environmental protection standards.

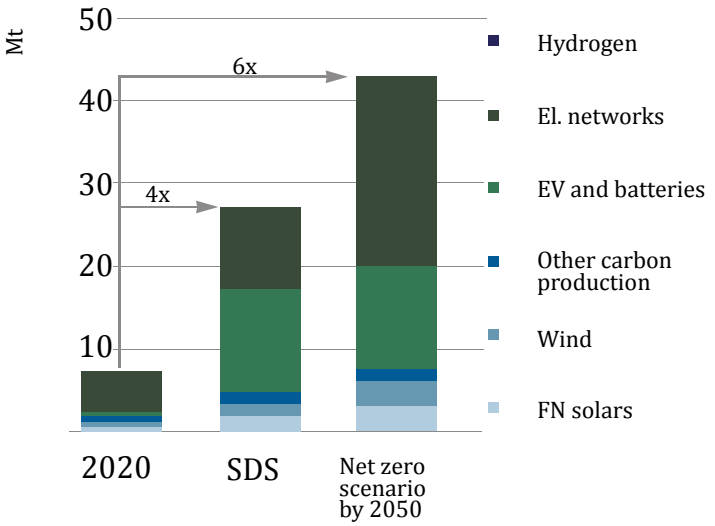
1. STRUCTURAL CHANGES AND TRENDS IN THE GLOBAL RAW MATERIALS MARKET

Global demand for critical raw minerals, such as lithium, cobalt, nickel, copper, and rare earth metals, is rapidly increasing due to the transition to green technologies and digitalization. This trend creates challenges regarding the long-term sustainability of supply and requires a strategic approach to resources. Most of the world's reserves of critical raw minerals come from a few geopolitically sensitive countries (e.g., Democratic Republic of the Congo, China, Bolivia), which increases supply chain risks. This dependency can lead to supply disruptions due to political or economic instability. The recycling of critical materials is still underdeveloped, adding further pressure on primary resources.

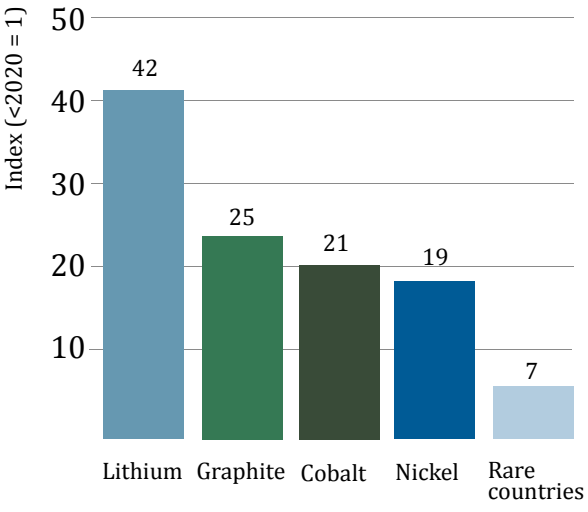
The potential for recycling these materials is significant, but current recycling levels do not meet global needs. Despite short-term fluctuations in the prices of critical materials, the International Monetary Fund (IMF) estimates that with rising prices, the economic significance of critical raw minerals will match that of crude oil over the next two decades. The table below presents projections of the growth in global demand for key technologies and the critical raw minerals required for these technologies and minerals.[1]

DEMAND FOR MINERALS FOR CLEAN ENERGY TECHNOLOGIES ACCORDING TO THE SCENARIO

Growth until 2040 by sector



Growth of selected minerals in SDS, 2040 in relation to 2020



1 Data from the International Energy Agency (IEA), The Role of Critical Minerals in Clean Energy Transitions, 2021, https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/executive-summary, processed by the European Bank for Reconstruction and Development (EBRD), Mining Sector Strategy 2024 – 2028, www.ebrd.org

Although long-term projections indicate significant growth, current prices of some minerals found in Bosnia and Herzegovina show considerable volatility. For example, the price of lithium has dropped by more than 67%, while the price of silver has increased, and magnesium has decreased by nearly 15%. The price of aluminum has fallen by 2%, while the price of coal has risen by 2%, and copper by 1.6%.

THE CURRENT MARKET VALUE OF SELECTED CRITICAL AND STRATEGIC MINERALS

MATERIAL	EU CLASSIFICATION	MARKET PRICE AS OF 30 JULY 2024	PRICE CHANGE (YOY)
ALUMINUM (BAUXITE)	CRITICAL	2.237 USD/t	-1,99%
COPPER	STRATEGIC	4,07 USD/lbs	1,61%
COKING COAL	STRATEGIC	140,10 USD/t	2,04%
MAGNESIUM	STRATEGIC	18.800 CNY/t (2.590,64 USD/t)	-14,74%
LITHIUM	CRITICAL/STRATEGIC	85.500 CNY/t (11.781,9 USD/t)	-67,67%
SILVER		28,368 USD/t.oz	14,53%

Source: *Commodities - Live Quote Price Trading Data (tradingeconomics.com)*

2. THE EUROPEAN UNION AND CRITICAL RAW MATERIALS – CHALLENGES AND POLICIES

Although the EU has ambitious goals for reducing emissions and developing a green industry, its reliance on importing critical materials from third countries poses a significant vulnerability for EU supply chains, especially in strategic sectors such as electric mobility, renewable energy, and digital technologies.

The EU currently has modest capacities for the extraction and processing of critical raw minerals, accounting for only 2% to 15% of global production in key technologies.[2] These limitations hinder the achievement of strategic autonomy.

The European Union Critical Raw Materials Act[3] adopted in 2024, aims to ensure a secure, sustainable, and resilient supply of critical materials for Europe's high-tech industries. The Act seeks to establish a stronger and more autonomous supply chain for these vital resources. It outlines goals, policies, and a comprehensive set of measures to secure the sustainable procurement of materials for the European economy while minimizing environmental and social impacts during the extraction, processing, use, and recycling stages. The Act sets quantitative targets for domestic EU capacities across the supply chain for strategic materials and for diversifying EU supply sources by 2030.

Although the EU aims to meet 40% of its demand for green technologies by 2030, its current share in key stages of production, particularly in extraction and processing, is insufficient to achieve this ambition without significant investments in expanding both domestic EU capacities and those in third-party partner countries. The European Commission has been regularly updating its list of critical and strategic materials for the EU since 2011, and in 2023, the list includes 34 raw minerals.[4]

2 European Commission, https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en

3 European Commission https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan/european-critical-raw-materials-act_en

4 Ibid

A LIST OF CRITICAL AND STRATEGIC MATERIALS FROM THE EU LIST IN 2023

STRATEGIC RAW MINERALS	
Bismuth	Manganese - battery class
Boron- metallurgic grade	Natural graphite - battery
Cobalt	Nickel - battery class
Copper	Rare earth elements for magnets (Nd, Pr, Tb, Dy, Gd, Sm and Ce)
Gallium	Metal silicone
Germanium	Titanium metal
Lithium-battery	(Wolfram)Tungsten
Metal magnesium	

CRITICAL MINERALS			
Antimony	Coking coal	Heavy REE	Phosphorus
Arsen	Copper	Light REE	Platinum group metals
Bauxite	Feldspar	Lithium	Scandium
Baryte	Fluorspar	Magnesium	Metal silicone
Beryllium	Gallium	Manganese	Strontium
Bismuth	Germanium	Natural graphite	Tantalum
Boron	Hafnium	Nickel – battery class	Metal titanium
Cobalt	Helium	Niobium	Tungsten
		Phosphate rock	Vanadium

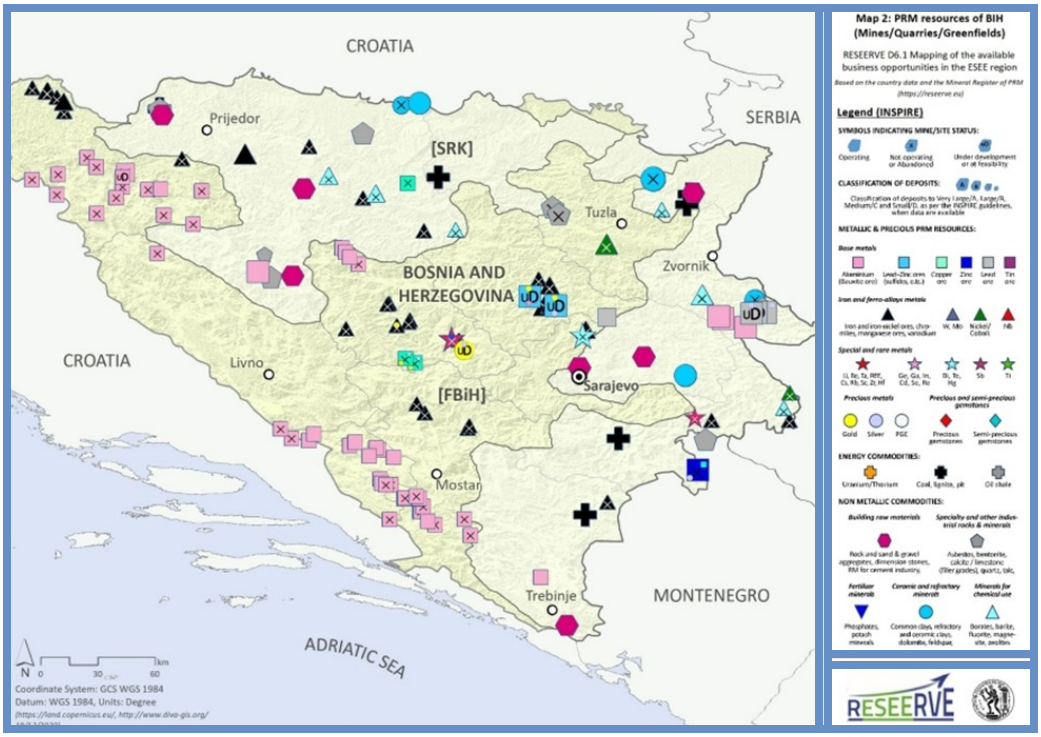
In this context, **the EU's strategic partnerships with third countries are expected to ensure responsible mining and exploration practices**, with respect for human rights and environmental standards, inclusion of local communities in decision-making processes, and support of local industry and green technology development in partner countries. This aims to ensure participation in all stages of value chains, contributing appropriately to industrial development in those countries. While the EU advocates for sustainable extraction and processing of critical materials, challenges related to environmental standards, human rights, and transparency remain, especially in partnerships with non-EU countries. The recent signing of such a partnership with Serbia has sparked considerable controversy.

The Western Balkans possess significant resources of critical materials, which can contribute to the production of components for electric vehicles and the battery industry. By adopting the Green Agenda, countries in the region have committed to a more sustainable approach to primary production and the circular economy, in line with the EU's climate ambitions. However, implementing these goals requires stronger cooperation between the region's countries and the EU, as well as concrete measures to develop sustainable value chains. Additionally, most countries are in the early stages of adopting EU legal frameworks and meeting EU environmental standards, which poses a challenge to ensuring sustainable mining in the region.

3. GEOLOGICAL POTENTIAL OF BOSNIA AND HERZEGOVINA

Bosnia and Herzegovina holds significant reserves of coal, iron and aluminum. Coal reserves amount to approximately 5 billion metric tons, and in 2022, 6.6 million tons of brown coal and 7.1 million tons of lignite were produced, primarily used for electricity generation. Of the 14 active coal mines, 10 are majority state-owned, while 4 are privately owned. In April 2024, operations at the Zenica Coal Mine (RMU Zenica) were halted based on the mine's technical and economic indicators. In addition to coal, total iron reserves amount to 653 million tons[5], and in 2022, iron ore and concentrate production reached nearly 1.3 million tons. From the perspective of critical and strategic raw minerals, Bosnia and Herzegovina has the most promising potential in the supply of manganese, aluminum, barite, silicon, antimony (critical), and iron, zinc, and lead (strategic).

PRIMARY DEPOSITS OF MATERIALS ON THE EU LIST OF CRITICAL AND STRATEGIC MATERIALS



Source: EU RESEERVE Project, *https://reseerve.eu/upload/files/D.6.1_RESEERVE_website%20version_FINAL_MR.pdf*

5 Trade.gov. Bosnia and Herzegovina - Mining. https://www.trade.gov/country-commercial-guides/bosnia-and-herzegovina-mining (2022), official statistics

Significant bauxite reserves are estimated at 120 million tons. Bosnia and Herzegovina has 53 bauxite deposits, of which only 7 are currently listed as active mining sites, although production has significantly decreased. It is estimated that at deposits where exploitation has ceased, such as the abandoned mines in Bosanska Krupa and Sanski Most, approximately 15 million tons of bauxite remain in resources. The production of aluminum ore and concentrates reached 1.3 million tons in 2022. [6]

Zinc and lead reserves, each totaling 56 million tons, are distributed across geographically widespread occurrences and established deposits. Operational mines are in Srebrenica (Republic of Srpska) and Olovo (Federation of Bosnia and Herzegovina), with development projects in Rupice and Veovača in Vareš.[7] In 2022, lead ore and concentrate production amounted to a modest 9,000 tons, while zinc ore and concentrate production was 15 tons. Given the established and potential reserves, there is substantial potential for the development of these raw minerals.

Potential lithium deposits are located in northern, central, and eastern Bosnia and Herzegovina, but further research is needed to assess the concentration and continuity of the ore body.[8] Arcore AG conducted research and estimated reserves of 1.5 million tons of lithium carbonate in the areas of Lopare and Ugljevik (alongside 94 million tons of magnesium sulfate and 17 million tons of boron). Exploration of lithium and other related critical raw minerals are also conducted as part of preliminary geological surveys in Čajniče, Jezero, and Šipovo, with interest expressed in other municipalities such as Ugljevik, Bijeljina, Zvornik, and Brčko.[9]

Magnesium resources in Bosnia and Herzegovina are found in small and abandoned deposits in Republic of Srpska, such as Čelinac, Teslić, and Rudo. Detailed research is required to make more precise assessments of their potential. The company BH Magnezij i Minerali d.o.o., a member of the MFE 'Magnesium for Europe' group, has launched a project to extract magnesium from dolomite rock, which has already been exploited in the Kupres area from the nearby Grguljača quarry.[10]

Manganese resources and occurrences are distributed throughout the country, with several small deposits, including locations in Banja Luka, Čelinac, Rudo, and Gacko in Republic of Srpska, as well as Bužim, Velika Kladuša, Čevljanovići, Konjic, and Vareš in the Federation of Bosnia and Herzegovina. The Popović Polje mine is currently operational on a limited basis. Noteworthy are the manganese deposits in Velika Kladuša and Čevljanovići, with potential reserves of up to 9,000,000 million tons, making them valuable due to their high manganese content.[11]

Antimony reserves are estimated at 200,000 tons, with primary deposits in Čemernica (Fojnica municipality) and associated occurrences alongside the exploitation of lead, zinc, and silver in Srebrenica and Vareš (Rupice mine).[12] There is also significant potential for precious and rare metals, including gold, nickel and cobalt. Established reserves of gold are found in Fojnica, Kreševo, Gornji Vakuf and in the river basin of the Lepenica, Lašva and Fojnica rivers.[13] Potential nickel and cobalt reserves amount to around 3 million tons near Živinice as well as the northern slopes of Mount Ozren.[14]

---

6 Official statistics

7 EU RESEERVE Project, https://reseerve.eu/upload/files/D.6.1_RESEERVE_website%20version_FINAL_MR.pdf

8 Sibila Borojević Šoštarić and Tomislava Brenka, The Miocene Lithium-Boron Metallogenic Zone in the Western Balkans, https://www.researchgate.net/publication/365343911_The_Miocene_Western_Balkan_lithium-boron_metallogenic_zone, The Faculty of Mining and Geology in Tuzla

9 EU RESEERVE Project, https://reseerve.eu/upload/files/D.6.1_RESEERVE_website%20version_FINAL_MR.pdf

10 Radio Slobodna Evropa, 30.09.2024. https://www.slobodnaevropa.org/a/izgradnja-fabrike-magnezija-kupres/33125132.html

11 Šostarić Borojević, S., Markelj, A., Jašarević, E. i Haindl, The potential of antimony, bauxite, fluorspar and magnesite in Bosnia and Herzegovina, 2022, https://hrcak.srce.hr/280004

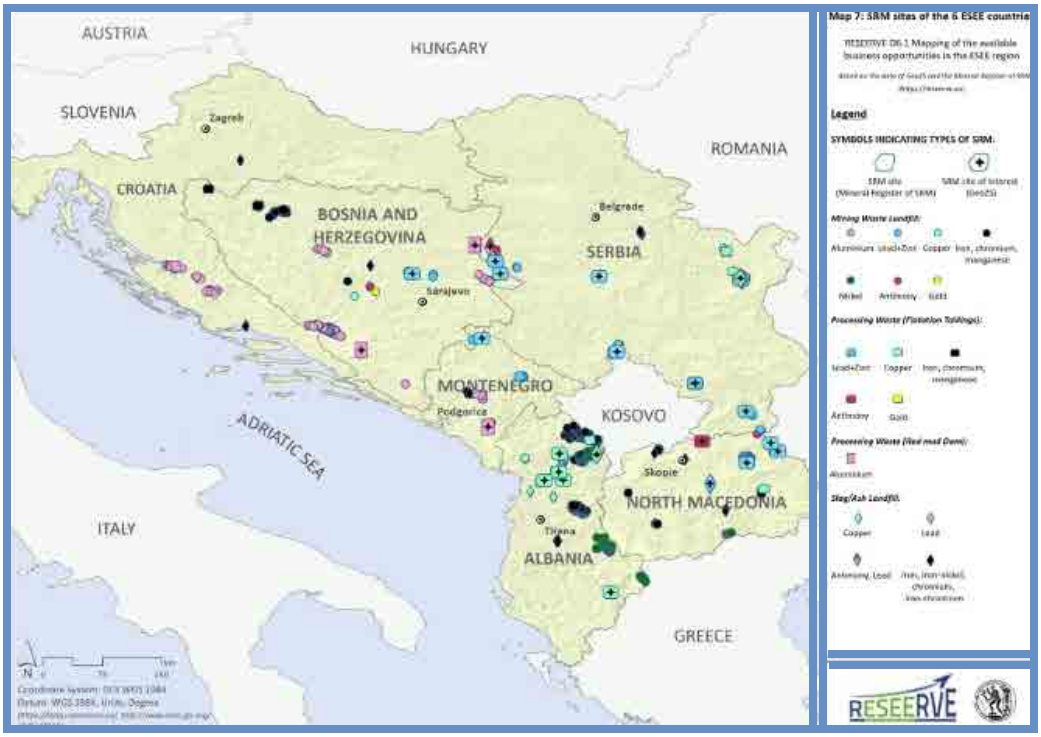
12 Ibid

13 Jurkovic, I. 1995. Bakovici the biggest gold deposit of Bosnia and Herzegovina. Rudarsko-Geolosko-Naftni Zbornik, Zagreb. Vol 7. I.1. pp1-15.

14 Smailbegovic, A. I Serifovic, E. 2023. Pojave mineralizacije kobalta u ofiolitskim zonama sjeverne Bosne I Hercegovine. 3. Kongres Geologa BiH. https://www.researchgate.net/publication/374675518_OCCURRENCES_OF_COBALT_MINERALIZATION_IN_THE_OPHIOLITIC_ZONES_OF_NORTHERN_BOSNIA_AND_HERZEGOVINA

Bosnia and Herzegovina has significant potential for extracting secondary materials from mining waste, which not only reduces the need for new mining activities but also helps preserve the environment by reducing waste. Among the metals that can be extracted from deposits or tailings, silver stands out as the most promising, while zinc, gold, and copper also show considerable potential. Rare earth elements, though in smaller quantities, also contribute to the overall value of these waste deposits. The most promising are former flotation tailings (Ljubija, Vareš, Srebrenica), which make up 43% of the total potential, followed by red mud deposits (Mostar and Zvornik) with 33% and slag heaps (Zenica, Ilijaš, Vareš) with 24%. These deposits are often part of active or abandoned/closed mining sites, meaning that infrastructure and logistical capacities for their exploitation already exist. For example, deposits such as Đulići (Birač) and Dobro Selo, containing aluminum, and Sase – Srebrenica and Vareš - Mala Rijeka, containing lead, zinc, and silver, represent significant resources for potential future projects.[15]

THE SECONDARY DEPOSITS OF MATERIALS FROM THE EU LIST OF CRITICAL AND STRATEGIC MATERIALS



Source: EU RESEERVE Project, https://reseerve.eu/upload/files/D.6.1_RESEERVE_website%20version_FINAL_MR.pdf

15 EU RESEERVE PROJECT. List of Potential Secondary Sources of Raw Materials with Economic Value (D5.5). (2021). Official statistics

There has been an increase in the scope of new projects focused on the exploration and extraction of critical minerals in Bosnia and Herzegovina, including the recently opened silver, zinc, lead, and gold mine in Vareš, as well as the lead mine in Olovo. Several companies are currently exploring various minerals in Bosnia and Herzegovina. Lykos Metals Limited, an Australian company, is actively exploring minerals such as lead, zinc, copper, barite, and related metals in the municipalities of Jezero, Šipovo, and Mrkonjić Grad in Republic of Srpska. They are also exploring copper, lead, zinc, and lithium in the municipality of Čajniče, as well as nickel, copper, cobalt, zinc, lead, silver, and gold in the municipality of Petrovo. In addition, Canadian company EMX Royalty is conducting preliminary geological surveys across Bosnia and Herzegovina, Seven Plus Sarajevo is exploring chromium occurrences in the municipality of Vareš, Terra Balcanica is interested in lead occurrences in the Foča region, while BBM Sarajevo is aims to conduct the exploration of silver and gold in the municipality of Fojnica. Arcore Ltd from Switzerland has completed the lithium exploration phase in the municipality of Lopare.[16]

16 EU RESEERVE Project, https://reseerve.eu/upload/files/D.6.1_RESEERVE_website%20version_FINAL_MR.pdf

4. ECONOMIC CONSIDERATIONS

Given the scale of mining activities in Bosnia and Herzegovina, the direct contribution of this sector to GDP is limited, while its more significant impact comes through indirect contributions to economic activity via industrial value chains. In 2023, mining contributed 646 million BAM (1.3%) to the total GDP (0.80% from coal and lignite extraction, 0.30% from metal ore extraction, and 0.20% from other mineral extraction). Compared to 2016, this contribution has decreased by 0.53 percentage points, from 1.83% to 1.3%. The contributions to GDP from parts of the manufacturing industry that rely on mining resources are much more significant: production of basic metals – 1.20%, production of fabricated metal products, except machinery and equipment – 2.40%, and production and supply of electricity, gas, steam, and air conditioning – 33,68%.[17]

GROSS VALUE ADDED BY SECTOR, GDP OF BOSNIA AND HERZEGOVINA IN 2022, SELECTED SECTORS

SECTOR	GROSS VALUE ADDED (% OF GDP, 2022)
Mining and Quarrying	1,32
Manufacturing Industry, of which:	14,37
Production of coke and refined petroleum products	0,26
Production of chemicals and chemical products	0,70
Production of other non-metallic mineral products	0,64
Production of basic metals	1,20
Production of fabricated metal products, except machinery and equipment	2,40
Production and supply of electricity, gas, steam and air conditioning	3,68

Source: Agency for Statistics of Bosnia and Herzegovina (2023). Gross Domestic Product by Production, Income and Expenditure Approach. Thematic Bulletin ISSN 1840-104X.

The mining sector has a limited share in Bosnia and Herzegovina's overall trade, with exports of ores being significantly higher than imports. When considering the trade of goods produced from ores, the contribution of this sector to total trade increases substantially. In 2023, Bosnia and Herzegovina's total trade amounted to 44.47 billion BAM, with an export-to-import ratio of 60.1%. Exports of metal ores and scrap amounted to 519.7 million BAM, with exports of metal ores covering imports more than tenfold, while coal exports covered around 64% (exports of hard coal, coke, and briquettes amounted to 439.5 million BAM). The mining sector in Bosnia and Herzegovina significantly

17 Agency for Statistics of Bosnia and Herzegovina (2023), NAC_02_2023_Y1_0_BS.pdf (bhas.gov.ba).

contributes to industrial value chains, particularly in manufacturing and electricity production. Electricity, primarily generated in coal-fired power plants, was exported in the amount of 1 billion BAM, nearly five times more than imports. Additionally, metal products were exported of 1.7 billion BAM, with exports exceeding imports by 66.5%.[18]

TRADE OF BOSNIA AND HERZEGOVINA FOR 2023., SELECTED CATEGORIES (IN THOUSANDS OF BAM)

2023	Export	Import	Coverage of exports by imports
Mining products			
Metal ores and metal waste	519.679	50.905	1020,9%
Coal, coke, and briquettes	439.470	689.625	63,7%
Related activities			
Electrical energy	1.055.724	215.877	489,0%
Products from non-metallic minerals	312.381	620.495	50,3%
Iron and steel	497.222	1.303.497	38,1%
Colored metals	558.420	1.414.409	39,5%
Metal products, others	1.717.833	1.031.872	166,5%

Of the total post-war foreign direct investments in Bosnia and Herzegovina amounting to 19.42 billion BAM, 1.54% or 299 million BAM **was invested in the mining sector by the end of 2023** (227 million BAM in metal ores, 62.2 million BAM in other mining and quarries, and 8.9 million BAM in support services). These foreign direct investments include a recent investment from the United Kingdom, amounting to 204.6 million BAM in 2022 alone, and investments in projects to explore and exploit critical mineral raw materials, primarily in Vareš and Lopare. These are the first post-war foreign investments in this sector.[20] New projects attract interest, but limited **exploitation of critical minerals in Bosnia and Herzegovina is currently taking place in operational bauxite, lead, zinc, and associated copper and silver mines, through existing investments or potential revenue from the exploitation process itself.**

18 Ibid
19 Ibid
20 Ibid

Foreign direct investments in the manufacturing industry, supplied with raw materials from the mining sector, are much more significant. For example, the production of coke and refined petroleum products accounts for 3.8%, the production of other non-metallic mineral products for 2.2%, and the production of basic metals for 3.1%. Investments in the supply of electricity, gas, steam, and air conditioning amount to 1.26 billion BAM (6.5% of total foreign investments).[21]

Exploitation of mineral resources in Bosnia and Herzegovina is taxed through concession fees. Transparency International (TI) BiH has detailed[22] data on a total of 75.5 million BAM in concession fees paid from the exploration and exploitation of mineral resources in BiH in the period from 2014 to 2022, and they estimate that revenues from concession fees make up 0.9% of the total budget and that 47 % of all concessions granted in the field of exploitation of mineral raw materials. The highest realized revenues from individual concessions include 16.2 million BAM from the Banovići Brown Coal Mine and 12.8 million BAM from the "Kreka" Tuzla Mine. The level of concession fees varies significantly. For example, fees for coal exploitation range from 0.5 - 1 BAM per ton to 3.6%-5% of annual income, while for bauxite exploitation they amount to 1.50 BAM/t + 100 BAM/ha, 40 BAM/ t, up to 3.6%-5% of the annual income. This data indicates a significant potential for collecting public revenues from the exploitation of critical and strategic mineral raw materials, but also the need for a more transparent and efficient concession management system.

Mining in Bosnia and Herzegovina has traditionally employed a significant number of workers, but today, under the pressure of decarbonization policies and the green transition, it faces major challenges that are affecting employment in the sector. At the end of 2023, the mining sector in the Federation of Bosnia and Herzegovina (FBiH) had 11,119 employees, a decrease of 1,876 workers compared to 2018. This reduction mainly concerns coal and lignite extraction, while the number of employees in metal ore extraction increased from 433 to 892 during the same period.[23] In Republic of Srpska (RS), the number of employees in mining fell from 5,113 in 2018 to 4,688 in 2021.[24] According to World Bank estimates, around 18,600 workers across value chains in Bosnia and Herzegovina are at risk of losing their jobs in the event of mine and thermal power plant closures. On the other hand, the newly opened mine in Vareš employed 296 people at the end of 2023, 255 of whom are in Bosnia and Herzegovina. The project has an indirect impact on employment growth among subcontractors and related industries.

21 Ibid

22 Registar Koncesija u BIH - Registar koncesija u Bosni i Hercegovini (transparentno.ba)

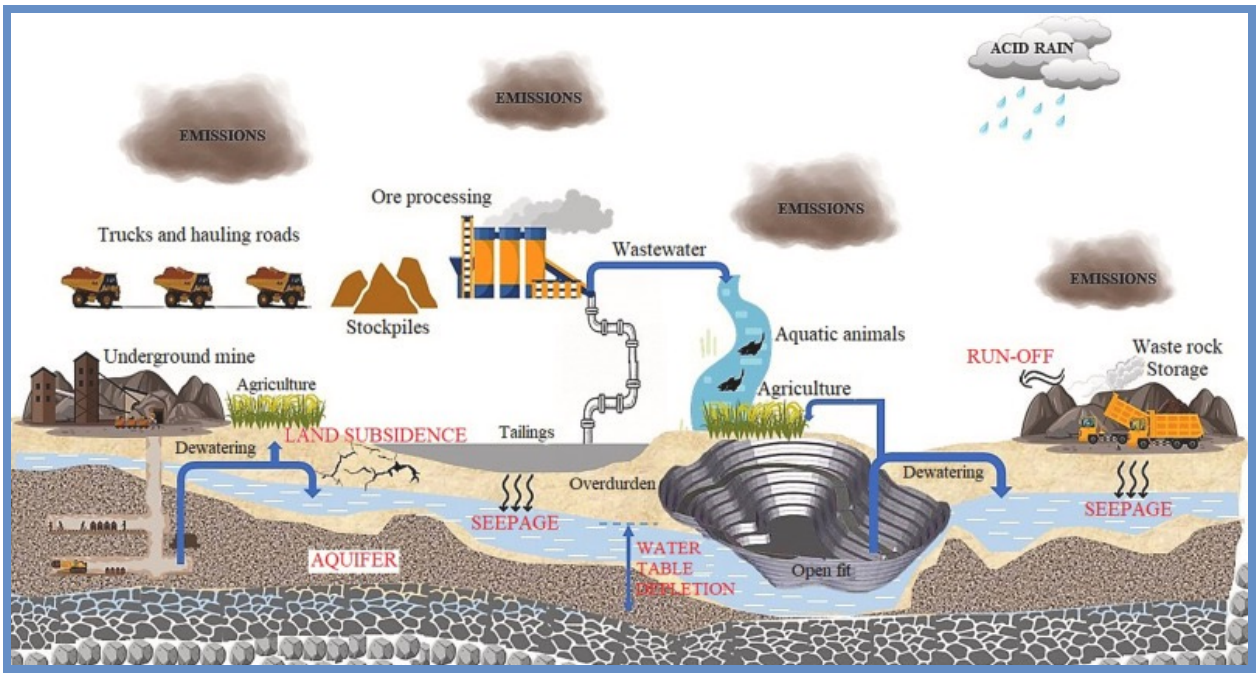
23 Federal Institute of Statistics FBiH

24 Republic Institute of Statistics, Republic of Srpska.

5. ENVIRONMENTAL CONSIDERATIONS

Mining projects have a significant direct and indirect impact on the environment, including potentially negative effects on land, water, air, and population. The impacts vary depending on local characteristics, the type of mining activities, geology, and the type of ore, as well as the application of monitoring elements for environmental protection. Each phase of the mining process, from exploration and exploitation to processing and waste disposal, has its environmental impacts that can be minimized through proper planning and monitoring of the entire lifecycle of mining activities.

OVERVIEW OF THE IMPACT OF MINING ON THE ENVIRONMENT



Source: Mardonova, M. & Han, Y-S. 2023. Environmental, hydrological, and social impacts of coal and nonmetal minerals mining operations. Journal of Environmental Management, Vol. 322.

Water pollution and excessive consumption are significant concerns. Wastewater from hydrometallurgical processes can contain chemicals such as cyanide, mercury, arsenic, lead, and zinc, along with high levels of acidity. Worldwide, nearly 650,000 km of river flows and channels are threatened by metal mining.[25] Approximately 23 million people, 6 million livestock, and 66,000 km^2 of irrigated land are directly exposed to dangerous concentrations of toxic waste in water. Sixteen percent of all critical mineral deposits are located in areas with high water scarcity, while half of the global production of lithium and copper occurs in regions with high scarcity, creating competi-

25 Madaka, H., Babitt, C. & Ryen, EG. Opportunities for reducing the supply chain water footprint of metals used in consumer electronics. Resour. Conserv. Recycl. (2022).

tion for water among mining, agriculture, population needs, and other uses.[26] Concerns about the risk of water pollution in the case of the Jadar lithium mine in Serbia, where the Drina River basin serves 2.5 million people, are among the key issues that have sparked massive protests.

Erosion, Soil Contamination, and Waste. Soil erosion occurs during the exploitation process (removal of material above deposits, blasting, and waste disposal). Erosion rates can increase by several hundred times compared to undisturbed areas. Soil contamination is a global problem caused by mining, particularly due to waste such as sludge, which contains heavy metals and acidic components. Abandoned mines generate acidity, metal solubility, and ecosystem degradation. Mineral extraction is the world's largest producer of waste. Approximately 1 million km^2 of global land area is covered by mining waste, and as ores with lower metal content are extracted, the amount of waste increases. Estimates of the deposit area of mining waste in Bosnia and Herzegovina are about 67.73 km^2 across 134 locations[27], posing a significant environmental risk while also representing the potential for recovering materials from secondary raw materials.

CO2 Emissions and Air Quality. Metal production consumes large amounts of fossil fuels. Emissions associated with the extraction of mineral resources account for about 10% of global CO2 emissions. More complex and advanced mining processes consume more energy. Mining also contributes to climate change through deforestation and ecosystem degradation. Globally, CO2 emissions vary depending on the type of mineral—mining one kilogram of diamonds can produce 0.8 tons of CO2, while producing one kilogram of iron generates about 2 kg of CO_2.[28] Dust from mining activities often contains toxic elements that threaten human health and pollute water sources. Even non-toxic dust can negatively impact health, while emissions from mobile sources, such as trucks and excavators, contribute to additional air pollution. The introduction of green energy networks and electrification are key steps toward more sustainable mining, while recycling is becoming increasingly important due to challenges in reducing emissions from rare earth metals.

Biodiversity. The mining industry has direct and indirect impacts on ecosystems. Globally, mining has caused the extinction of about 0.02% of species, with metals such as nickel, bauxite, and iron responsible for 76% of biodiversity loss related to mining.[29] Since 2000, industrial mining has led to the loss of approximately 8,500 km^2 of tropical and subtropical forests, with the highest shares in Indonesia, Brazil, Ghana, and Suriname. In the Amazon, mining can cause deforestation within a 70 km radius of mining sites, while indirect deforestation can be up to 12 times greater than direct deforestation.[30]

26 De Haes, S. & Lucas, P. ENVIRONMENTAL IMPACTS OF EXTRACTION AND PROCESSING OF RAW MATERIALS FOR THE ENERGY TRANSITION. (© PBL Netherlands Environmental Assessment Agency, 2024).

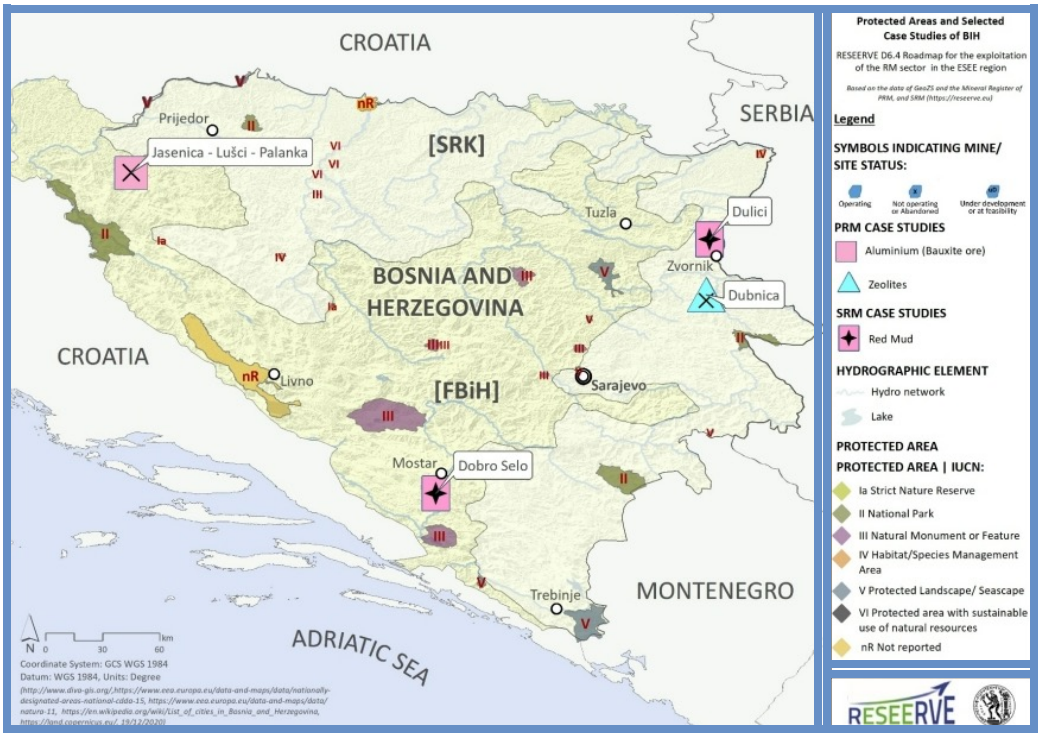
27 EU RESEERVE PROJECT. List of Potential Secondary Sources of Raw Materials with Economic Value (D5.5). (2021). Official statistics

28 European Environment Agency. Improving the Climate Impact of Raw Material Sourcing — European Environment Agency. https://www.eea.europa.eu/publications/improving-the-climate-impact-of (2021).

29 Ibid

30 Ibid

MAP OF PROTECTED AREAS AND PROSPECTIVE CRM DEPOSITS IN BOSNIA AND HERZEGOVINA



Source: EU RESEERVE Project, *https://reseerve.eu/upload/files/D.6.1_RESEERVE_website%20version_FINAL_MR.pdf*

Mining ores with lower mineral content significantly increases energy consumption and the amount of waste, leading to a higher risk of soil and water pollution. Open-pit mining causes significant ecological damage, while underground mines, although less destructive to the surface, require more energy. This dynamic highlights the **necessity of finding optimal mining methods that balance efficiency with environmental protection.**

OVERVIEW OF THE ENVIRONMENTAL IMPACTS OF MINING AND RISK MANAGEMENT APPROACHES[31]

IMPACT FACTOR	ELEMENTS	RISK LEVEL	MITIGATION STRATEGY
WATER	Water consumption Water pollution Reduction of water resources Management of waterways	HIGH	Planning / monitoring Well and spring capture Barriers (surface / underground) Drainage and water treatment New water treatment methods
AIR	Air pollution Dust emissions	HIGH	Use of filters / closed systems Establishing artificial and bio-barriers
SOIL	Soil contamination Soil erosion Material deposition Land subsidence Topographic changes	HIGH	Baseline recording Slope planning and control Physical barriers and treatment Use of waste material to fill cavities Recycling and treatment of tailings
ENERGY	Energy consumption	MEDIUM	Use of renewable energy sources (geothermal, solar)
COVER	Deforestation Excavation Construction sites Deposits	MEDIUM	Planning and baseline recording Reforestation Modular constructions Utilizing deposit materials
FLORA / FAUNA	Reduction of biodiversity Habitat destruction	MEDIUM	Creating buffer zones Reforestation and plant cultivation Maintaining wildlife corridors Waste management
NOISE	Noise Ground vibration	LOW / MEDIUM	Modular constructions Use of vibro-pads Reducing the use of explosives
GAS EMISSIONS	Ore processing Fuel combustion	LOW	Use of closed systems Use of filters
CLIMATE CHANGE	CO_2 emissions Increased temperatures	LOW	Reducing surface footprint Reducing CO_2 emissions through the use of electric vehicles or engines

31 Mardonova, M. and Han, Y-S. 2023. Environmental, hydrological, and social impacts of coal and nonmetal minerals mining operations. Journal of Environmental Management, V. 322.

A comprehensive assessment of the environmental impacts from mining activities has never been conducted in Bosnia and Herzegovina, although several targeted studies have been carried out.[32] The lack of an integrated approach to impact assessment is making effective planning and mitigation of negative environmental impacts challenging. Methods for life cycle assessment (LCA) and other environmental impacts of mining are not standardized, which prevents precise comparisons between different mining operations and metals.[33]

Bosnia and Herzegovina currently lacks a comprehensive registry of active, closed, and abandoned mines, complicating risk assessment and environmental protection planning. This gap creates barriers to the long-term sustainable management of mining resources. Generally, mining companies often do not provide sufficient data on the environmental impacts of their activities. The lack of transparency is particularly pronounced in middle and low-income countries, hindering the assessment of actual environmental effects.

32 UNEP, 2018. Mining and Environment in the Western Balkans; https://zoinet.org/wp-content/uploads/2018/02/MiningBalkans_screen_0.pdf IMPACTMIN, 2012. Impact Monitoring of Mineral Resources Exploitation. https://impactmin.geonardo.com/

33 European Commission, Annual report on Bosnia and Herezgovina 2023, https://neighbourhood-enlargement.ec.europa.eu/bosnia-and-herzegovina-report-2023_en

6. GOVERNANCE CONSIDERATIONS

Bosnia and Herzegovina has a complex legal and institutional framework for managing mineral resources and granting concessions, with key responsibilities resting at the entity and cantonal levels. The role of municipalities is crucial, as they oversee the implementation of spatial plans and environmental permits, but they face challenges due to limited administrative capacities. **BiH currently lacks a comprehensive strategy for the development of the mining sector**, although the FBiH is in the process of drafting a sectoral strategy. International obligations, such as the decarbonization outlined in the Draft National Energy and Climate Plan, include a gradual reduction in coal exploitation, which will lead to mine closures and the need to implement new solutions in both energy and staffing. Harmonizing laws and coordinating between the entity levels of government pose challenges to achieving effective mining regulation.

Bosnia and Herzegovina has a range of obligations in the process of joining the European Union, which touches upon the regulatory framework for mining. BiH must align its legislation with the Acquis Communautaire, including Chapter 27 on environmental protection and Chapter 20 on enterprise and industrial policy. Under Chapter 27, BiH is required to implement regulations related to sustainable resource management and reducing the negative environmental impact of mining activities. This involves modernizing industrial processes and applying environmentally friendly technologies to reduce harmful emissions and improve resource efficiency.

According to the 2023 annual report[34], of the European Commission on Bosnia and Herzegovina , the country is in the early stages of aligning its environmental protection framework with EU law. The report highlights the need for several improvements in areas such as environmental impact assessments and the reduction of harmful emissions. It also emphasizes the lack of coordination between the entities and the need for the modernization of industrial processes and the implementation of environmental standards.

The concept of responsible mining encompasses technical, environmental, and social aspects, including human rights and the active involvement of local communities in decision-making processes. It is essential to ensure free, prior, and informed consent (FPIC) of indigenous and local populations before the start of mining projects.[35] There are several international standards applied by international financial institutions (such as the World Bank, IFC, and EBRD) in ensuring environmental and social standards in infrastructure projects.

The Initiative for Responsible Mining Assurance (IRMA) has established widely accepted standards for responsible mining and supply chains. The standard for responsible mining defines best practices for industrial mining, environmental protection, safe working conditions, and respect for human rights. The standard requires environmental impact assessments, waste management plans, and biodiversity protection. It also ensures safe working conditions, and respect for workers' rights, and prohibits child labor. The involvement of local communities in decision-making processes and respect for the rights of indigenous peoples are key elements. Transparency and accountability are achieved through public reporting on environmental and social impacts, as well as independent audits. The economic impact is promoted through local economic development, fair wages, and other benefits. The IRMA Supply Chain Standard defines sustainable sourcing of mineral resources, reduction of emissions, and assurance of human rights compliance by suppliers. Transparency in the supply chain is ensured through regular reporting.

34 Ibid
35 https://www.ihrb.org/resources/what-is-free-prior-and-informed-consent-fpic

7. RECOMMENDATIONS

1. **Given the expected increasing demand for critical raw materials, data on the geological potential of Bosnia and Herzegovina indicate significant investment potential** in the critical and strategic mineral resources. It is necessary to initiate a broader societal discussion on the role of research and extraction of mineral resources in the future development of the country.

2. Bosnia and Herzegovina needs to **define strategic goals** in this sector aligned with the EU Critical Raw Materials Act and the requirements of the Green Agenda for the Western Balkans. Possible diversification of investments in mining would reduce dependence on coal and petro-derivatives and increase investment in critical raw materials as well as the development of alternative energy sources (e.g., geothermal, solar, etc.).

3. Although estimates indicate large reserves of critical raw minerals in Bosnia and Herzegovina, **further research is needed** to confirm the quantities and economic potential and justification and assess the eventual ecological risks in the context of exploitation of resources such as bauxite, gold, manganese, and lithium. It is recommended to intensify and streamline geological exploration research for better assessment of reserves and potential planning for future exploitation. A comprehensive analysis of the status of active closed, and abandoned mines, as well as waste deposits across the country, is necessary.

4. **The rehabilitation of abandoned mining sites** should become a priority to reduce soil erosion and environmental contamination. This process would involve the remediation of waste deposits and the restoration of land for use in forestry, tourism or agricultural projects.

5. **Optimization of the concession system:** It is essential to establish a transparent, competitive, and efficient system for selecting concessionaires and a fee system to ensure adequate revenues from the extraction of mineral resources. A review of existing rules and practices regarding the issuance of concessions and an enhancement of the assessments of the economic and environmental impacts of mining projects are recommended.

6. **Strengthening industrial value chains.** Given the connection between mining and the processing industry and energy sector, it is recommended to strengthen industrial value chains to maximize resource potential through the development of green technology industries and products in the context of participation in all stages of EU value chains.

7. **Environmental risk management:** It is necessary to identify and manage risks associated with mining activities, including environmental pollution and disruption of biodiversity. Bosnia and Herzegovina should adopt a national environmental protection strategy and a plan for adopting the environmental aspects of the EU legal acquis.

It is essential to align provisions for environmental impact assessments and strategic environmental assessments. Control of pollutants and the implementation of the "polluter pays" principle, as well as horizontal environmental directives such as the Environmental Liability Directive and the Environmental Crime Directive, are also priorities.

8. **Stricter regulations and oversight of mining operations** to reduce environmental impacts, particularly in areas with water scarcity and high biodiversity risks. Legal norms should be adopted to ensure the sustainability of water resources and reduce risks to ecosystems.

9. **Increasing recycling and reuse** of materials from waste deposits can significantly reduce pressure on natural resources and decrease the volume of mining waste. Recycling particularly critical materials, such as lithium and cobalt, has significant economic potential.

10. **Biodiversity protection** through establishing clear boundaries for mining operations in high-value ecosystems and protected areas. Comprehensive strategies should be developed to minimize habitat fragmentation and preserve forest ecosystems. Bosnia and Herzegovina should increase the percentage of protected territory from the current 4% to 17.8% following the Sofia Declaration, and in the long term to 33%, which is the desired threshold in the European Union.

11. **Investment in education, research and development of new technologies in mining** can increase the efficiency and sustainability of the sector. Support for initiatives to train personnel in geosciences, geotechnical engineering disciplines, innovation and technological advancement in mining and related activities is recommended. The use of renewable energy sources and electrification of mining operations is key to reducing the industry's carbon footprint.

12. **Development of infrastructure and local communities:** Projects in the mining sector can contribute to the development of local infrastructure, including roads, housing, utility services, schools, and kindergartens. Planning and implementation of infrastructure projects in mining regions are recommended. Special priority should be given to the least developed regions of the country, namely those with the lowest population density.

13. **Promote the application of international standards in sustainable mining,** including adequate public participation based on the principle of free, prior, and informed consent (FPIC) from indigenous and local populations before the commencement of mining projects, as well as best practices for industrial mining, environmental protection, safe working conditions, and respect for human rights.

ANNEXES

LIST OF ABBREVIATIONS

Abbreviation	Meaning
BAM	Bosnian Convertible Mark (currency)
BiH	Bosnia and Herzegovina
EU	European Union
EBRD	European Bank for Reconstruction and Development
FPIC	Free, Prior, and Informed Consent
FBiH	Federation of Bosnia and Herzegovina
GDP	Gross Domestic Product
IMF	International Monetary Fund
IRMA	Initiative for Responsible Mining Assurance
LCA	Life Cycle Assessment
RS	Republic of Srpska
TI	Transparency International
RMU	A type of mining operation (e.g., RMU Zenica)
REE	Rear Earth Elements

REFERENCES

1. International Energy Agency (IEA), The Role of Critical Minerals in the Transition to Clean Energy, 2021.

2. European Bank for Reconstruction and Development (EBRD), Mining Sector Strategy 2024–2028, 2024.

3. European Commission, European Critical Raw Materials Act, 2024.

4. EU RESEERVE Project, List of Potential Secondary Sources of Raw Materials with Economic Value (D5.5), 2021.

5. Trade.gov, Bosnia and Herzegovina - Mining, 2022.

6. Borojević Šoštarić, S., and T. Brenka, Miocene Metallogenic Zone of Lithium-Boron in the Western Balkans, Tuzla Mining and Geology Faculty, 2022.

7. Borojević Šoštarić, S., A. Markelj, E. Jašarević, and Haindl, The Potential of Antimony, Bauxite, Fluorite, and Magnesite in Bosnia and Herzegovina, 2022.

8. Radio Free Europe, Preparations Underway for the Construction of a Magnesium Factory on State Land in Bosnia and Herzegovina, 2024.

9. Jurković, I., Bakovići, The Largest Gold Deposit in Bosnia and Herzegovina, Mining-Geological-Petroleum Bulletin, 1995.

10. Smailbegović, A., & Šerifović, E., Occurrences of Cobalt Mineralization in the Ophiolite Zones of Northern Bosnia and Herzegovina, 3rd Congress of Geologists of Bosnia and Herzegovina, 2023.

11. Agency for Statistics of BiH, Gross Domestic Product by Production, Income, and Expenditure Approach, Thematic Bulletin ISSN 1840-104X, 2023.
12. EU RESEERVE Project, Mapping Available Business Opportunities in the ESEE Region (D6.1), 2021.

13. Registry of Concessions in BiH, Registry of Concessions in Bosnia and Herzegovina, 2023.

14. Institute for Statistics of FBiH, Federation of BiH in Figures 2023, 2023.

15. Republic Institute for Statistics of the Republic of Srpska, Statistical Data, Banja Luka, Republic of Srpska, 2023.

16. UNECE, Presentation of Bosnia and Herzegovina - Albania, Tirana, December 11, 2023, 2023.

17. Mardonova, M., & Han, Y.-S., Environmental, Hydrological, and Social Impacts of Coal and Nonmetallic Mineral Exploitation, Journal of Environmental Management, Vol. 322, 2023.

18. De Haes, S., and P. Lucas, Environmental Impacts of Extraction and Processing of Raw Materials for the Energy Transition, PBL Netherlands Environmental Assessment Agency, 2024.

19. Madaka, H., C. Babitt, and E. G. Ryen, "Opportunities for Reducing the Supply Chain Water Footprint of Metals Used in Consumer Electronics," Resources, Conservation and Recycling, 2022.

20. European Environment Agency, Improving the Climate Impact of Raw Material Sourcing, 2021.

21. European Commission, Annual Report on Bosnia and Herzegovina 2023, 2023.

22. UNEP, Mining and the Environment in the Western Balkans, 2018.

23. IMPACTMIN, Monitoring the Impact of Mineral Resource Exploitation, 2012

24. Institute for Human Rights and Business (IHRB), What is Free, Prior, and Informed Consent (FPIC), 2022.

Author of the photograph: Amer Smailbegović
Iron-berite ore, Ljubija, Republika Srpska