DOI 10.51558/2303-5161.2025.13.13.101 Scientific paper

# PROPOSAL OF MEASURES TO MITIGATE ENVIRONMENTAL IMPACTS ON THE AREA OF ABANDONED VAREŠ MINE

Abaz Velić[1], Zvjezdan Karadžin[2]

[1]*Faculty of Mining, Geology and Civil Engineering Tuzla, abaz_velic@hotmail.com*
[2] *Faculty of Mining, Geology and Civil Engineering Tuzla, zvjezdan.karadzin@gmail.com*

**Summary**

The negative impacts of the old mining operations both in our country and throughout the world represent one of the biggest environmental problems.
The analysis of the previous practice in Bosnia and Herzegovina regarding the closure of mines in the past decades lead to the conclusion that very few were closed in accordance with the regulations. The problem was further complicated by the war that took place in our country from 1992 to 1995 which in certain number of cases led to the sudden stoppage of mine operations, many of which did not continue to operate even after the cessation of war activities. In the period 2013-2014 the Japanese Agency for International Cooperation (JICA) did an initial analysis of black industrial spots (Hot spots) in the Federation of Bosnia and Herzegovina and 4 such locations were determined , one of which was the former mine in Vareš. The mine consisted of several units at different locations where various types of raw mineral materials were exploited , which made reasearch even more difficult. This primarily refers to the location of surface mine (SM) „Smreka“, the ore processing and packing plant at SM „Veovača“ and the water accumulation with flotation tailings. For the mentioned sites, a field inspection and analyses of the existing condition were carried out to obtain results required to serve as a basis for proposal of measures to reduce the impact on the environment as well as the rough estimate of the relating remediation costs, which were done separately for each of the research polygon sites.
It should be emphasized that Bosnia and Herzegovina's accession to European Union implies significantly stricter environmental protection practices in the mining industry as well. Today, environmental protection in mining is an international standard and obligation. At the same time, the need should be pointed out to the contribution of each country in reducing the negative impact on the environment and climate changes.
**Key words:** abandoned mines, environmental risks, measures to reduce environmental impacts, remediation.

## 1. OVERVIEW OF MINING ACTIVITIES IN THE VAREŠ AREA

### 1.1. Iron ore mines

In the area of Vareš municipality in the period 1945-1990 intensive exploitation of iron ore and its processing, i.e production of hematite and siderite ore concentrates were carried out . Vareš mine and iron factory are the oldest units in RMK Zenica company. The industrial production

of this work organization dates back to the commissioning of the first blast furnace for the production of iron in 1981.
The labor organization Mine and Iron factory Vareš employed 3.350 workers, of which „Mining“ employed 1.180 workers. Surface exploitation was carried out at SM „Smreka“ and SM „Brezik“, along with underground exploitation carried out in „Droškovac“ mine. [6]

### 1.1.1. *Surface mine "Smreka"*

One of the largest iron ore deposits in Vareš is located in the central part of the metallogenic area of Vareš. This surface mine worked on the production of siderite and hematite raw ore, from which siderite and hematite concentrates were obtained after separation process. In addition to the mined ore that was transported to the heavy liquid separation unit, direct transport was also included for all tailings, transported to the landfill. Combined transport was also applied. Upon closure of activities at the surface mine „Smreka“ it was planned to start the underground exploitation of the deposit.
At „Smreka“ surface mine after the stoppage of mining activities in 1992, a lake with a volume of about 3,000.000 cubic meters of water was formed in the crater. The lake is surrounded by hills with the height of 1100 and 1350 meters above sea level (Kota and Veokovac). The surface of the lake was 125.000 cubic meters , length 610 m and depth 107 m. [6].

### *1.1.2 Surface mine "Brezik"*

SM „Brezik is located about 10 km away from Vareš, east of the town near the village of Pržići.This surface mine worked on the production of siderite and hematite raw ore, from which their concentrate was obtained after separation process. Distribution of concentrate was ensured to Zenica iron factory and in the smaller quantities to Smederevo iron factory.
Overburden was transported to the external disposal site by trucks. The transport of ore from the mine to the preparation/separation plant „Smreka“ was carried out using combined transport, trucks-chute-pit locomotive in the pit „Droškovac“ . The SM „Brezik is of the deep type of surface mines (open pit). It is not flooded due to existance of the pipe that connects it to „Droškovac“ undeground mine. The preparation of the pit ore was carried out at heavy liquid separation plant located within the SM „Smreka“ area.

### *1.1.3 Underground mine "Droškovac"*

„Droškovac“ deposit is located in the central part of the metallogenic area in Vareš, in the valley of Ruda stream, the right tributary of the Stavnja river, south of the town of Vareš. It is a deposit where underground mining was carried out. This mine served for production of siderite and hematite ores, from which after separation process, siderite concentrate was obtained,
Distribution of concentrate was carried out to Zenica iron factory, and to Smederevo iron factory but to a smaller degree. Preparation of raw ore, i.e. production of concentrate was carried out using heavy liquid separation method performed in the plant on SM „Smreka“. [6]

### 1.2 "Veovača" lead, zink and barite mine

„Veovača“ deposit is located on the slopes of Zvijezda mountain in the immediate vicinity of the villages of Daštansko and Tisovci. Exploitation from this area, namely overburden removal operations were started in 1979 by „Energoinvest“ Sarajevo. Ore exploitation was carried out using the surface mining method, performing excavation in the south-north direction, so that the progress of the excavation was in the north direction, and the overburden and tailings were deposited in the south side of the mine area. The exploitation of complex lead, zink and barite ore at this mine was interrupted in 1987 and 1988 due to instability of dam of water accumulation containing flotation tailings. In 1989 the mine continued production, only to stop production again in 1990 due to the imposibility of selling sulphide concentrates due to presence of mercury and the financial over-indebtness. [6]

### 1.3 „Tisovac“ ore preparation/processing plant

The process of preparing the ore and obtaining a useful product was carried out at the plant located three km southwest of the surface mine near the settlement of Tisovac.
The technological process of preparation consisted of crushing, separating, grinding, flotation and depositing lead and zinc concentrates, either as separate or collective concentrates, then followed by drying, depositing and packing of the product. Ore exploitation from Veovača mine commenced in June 1990 while the flotation unit began operating in mid-1982 and by the end of 1985 870,955 tons of ore with an average content of Pb-0,95 %, Zn – 1,66 % $BaSO_4$-17,40 %. had been processed . The operation of the plant was stopped in 1990. [6]

## 2. THE RESEARCH POLYGON- BRIEF REVIEW OF THE CURRENT STATUS

Based on previously conducted research in the Federation of Bosnia and Herzegovina, it was established that there are environmental hotspots contaminated with hazardous substances, These localities represent a negative legacy from the time of former SFR Yugoslavia and then from the period of war, when they were abandoned and left unattended. The research carried out as a part of the subject research includes one of the established hotspots- the former Vareš mine.
Metal mines, mostly destroyed in the previous war period in BiH were not the object of interes of domestic or foreign investors until recently. Many are not adequately closed, so an thorough inventory of abandoned metal mines is necessary to define hotspots, environmental hazards and risks, as well as a preconditions to set priorities for remediation. The problem also present undefined successors to the mine property, because the companies that managed the mines mostly no longer exist in the mining sector. [7]
The unsetlled situation in the sphere of interrupted surface exploitation is evident in the subject research area. Namely, operation on the last surface mine was stopped in 1992, and to this day the situation is only getting worse. It concerns the abandoned iron ore mine SM „Smreka“ and SM „Brezik“, as well as polymetallic lead-zin-barite deposit at SM „Veovača. Also during the operation phase of the mine an underground iron ore mine „Droškovac“ was also functioning.

Apart from the surface mines where no form of land reclamation was performed, the same unsetlled situation is present at other mine facilities and objects. [3]

*The subject research polygon includes:*

- SM "Smreka" – a lake formed at the abandoned iron ore
- SM "Veovača" and abandoned lead, zink and barite processing plant, and
- Water accumulation with flotation tailings. [6]

Figure 1. Water accumulation at SM "Smreka"

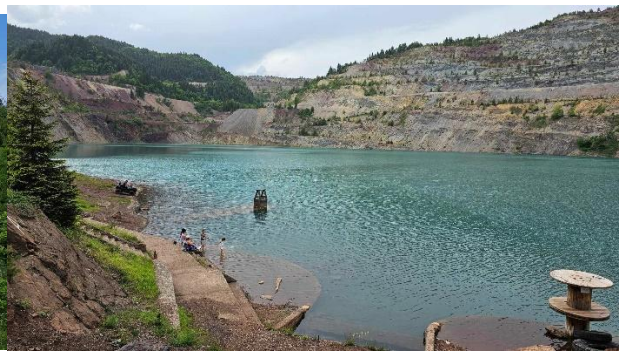

Figure 2. Water accumulation with flotation tailings

Figure 3. SM "Veovača"

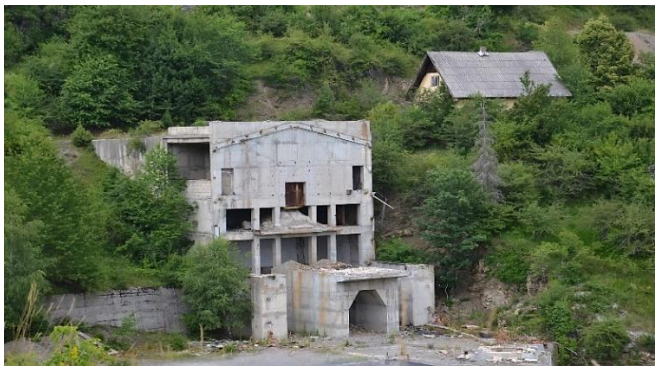

Figure 4. Remnants of the preparation/processing plant

## 2. ASSESMENT OF THE ENVIRONMENTAL IMPACTS ON THE RESEARCH POLYGON

### 3.1 Proposal of criteria for assessment of related environmental impacts

Criteria for assessment of impacts caused by the subject mining operations are shown in Table 1. Numbers in parenthesis relates to rating for subject sites. SM „Smreka (1), SM „Veovača“ (2), and water accumulation with flotation tailings (3)

***Table 1.*** *Criteria for assessment of environmental impacts* [6]

**A – Exploitation of processing of mineral raw materials**

| | POINTS |
|---|---|
| Existing | 20 |
| Recently completed | 15 |
| Production stopped several decades ago or long ago (1,2,3) | 10 |

**B – Usage of chemicals in the technological process**

| | POINTS |
|---|---|

| | |
|---|---|
| Chemicals or toxic substances were (are) used to a great extent | 20 |
| Chemicals or toxic substances were (are) used to a limited extent (2,3) | 15 |
| Chemicals or toxic substances were not used (1) | 0 |

**C – Land subsidence caused by mining activities, collapses, old works, land slides**

| | POINTS |
|---|---|
| Significant impacts (over 10 ha, at the depth of more than 40 m) and established on the basis of detailed research, endangering people, settlements and property to a significant extent | 20 |
| Less pronounced impacts (bellow 10 ha, shallower works, endangering people, settlements and property on a local scale or isolated zones, possibility of occurrence and extent of damage must be investigated in more details (1, 2) | 10 |
| Insignificant impacts, area of impact and impacts are small or non-existent (3) | 1 |

**D – Slope deformations and other geodynamic phenomena** (erosion, abrasion, atmospheric influence, volume changes, floods, karst phenomena, inundation, liquefication

| | POINTS |
|---|---|
| Pronounced impact (large areas, destruction of many buildings of various purposes), defined on the basis of detailed research, jeopardizing people, settlements and property to a significant extent | 20 |
| Geodynamic phenomena that threaten the environment to a lesser extent with low intensity (local impact, individual residential buildings, minor damage to property (1,2,3) | 15 |
| Geodynamic phenomena that threaten the environment to an insignificant extent with low intensity (local impact, individual residential buildings, minor damage to property | 1 |

**E – Negative changes in relief or terrain** (collapses of an older date, old mining works, places were ore was mined, long-initiated landslides, pits, etc.)

| | POINTS |
|---|---|
| Regional and pronounced influence (over 10 ha of area ) | 20 |
| Local impact (limited in the field of operations) (1,2,3) | 15 |
| Minor changes | 1 |

**F – Hydrogeological condition and impacts on water supply**

| | POINTS |
|---|---|
| Pronounced impact on sources of drinking water of regional character, pronounced impact on hydrological conditions | 20 |
| Impact on local sources of drinking water of regional character, pronounced impact on hydrological conditions (1,2,3) | 15 |
| Minor impact on drinking water sources and water courses | 1 |

**G – Mine waters**

| | POINTS |
|---|---|
| The quantity and quality of mine waters that produce impacts on the environment that are potentially regional in scale (disruption of hydrogeological structures and flow patterns, emission of metallic and toxic elements into surface waters at a critical level (1,2,3) | 20 |
| The impact on surface waters and hydrological conditions is of medium value, several mine rooms where mine waters in drained, local disruption of hydrogeological structures, local impacts due to the emission of mine water) | 15 |
| Minor changes or no hazardous mine water is created | 1 |

**H – Hydrogeochemical anomalies (geogenic or anthropogenic contamination of water)**

| | POINTS |
|---|---|
| Geogenic or anthropogenic contamination of water is potentially regional in nature (1,2,3) | 20 |
| Local extent | 15 |
| Minor extent | 1 |

**I – Lithogeochemical anomalies** (geogenic or anthropogenic contamination of soil and river sediments , mainly with Cu, Pb, Hg, Sb, Cd, Cr, pH values changes)

| | POINTS |
|---|---|
| Potentially of regional character (1,2,3) | 20 |
| Potentially of local character | 15 |
| Minor extent | 1 |

**J – Biogeogenic anomalies** (Geogenic or anthropogenic impact on vegetation)

| | POINTS |
|---|---|
| Potentially of regional character | 10 |
| Local extent (1,2,3) | 5 |
| Minor extent | 1 |

**K – Depots of materials** (overburden dump sites, dumped piles of materials, disposed tailings material from mineral processing plants, disposed hips of rock materials, ore disposal site)

| | POINTS |
|---|---|
| Active process | 20 |
| Recently completed or long overdue disposal process (1,2,3) | 15 |
| No landfill/dumps present | 0 |

**L – Tailings from processing plants** (overburden dumps, hydraulic dumps, settling tanks, precipitators)

| | POINTS |
|---|---|
| Active and with monitoring, remediation must be included | 20 |
| Out of use or currently inactive, no remediation performed, no monitoring plan (1,2,3) | 15 |
| Old tailings, fully or partially remediated or not at all, without significant impact on the environment) or there is no tailings disposal site from processing plants | 0 |

**M – Method of land use** (aspect of population density, infrastructure, industry, agriculture, arable land, zones under forests)

| | POINTS |
|---|---|
| Contact with settlements, urbanized zones industrial zones, zones where construction works are carried out, commercial zones, communications | 20 |
| Agricultural land, arable land, meadows, pastures, no-arable land, artificially modified green zones | 15 |
| Forests (1,2,3) | 10 |

**N – Monitoring**

| | POINTS |
|---|---|
| Systematic monitoring of the environment is inevitable, but it was not carried out despite the fact that it was an legal obligation, or the monitoring is not carried out in a satisfactory manner. Partial, did not cover all aspects of potential impacts (1,2,3) | 20 |
| Monitoring is carried out , the scale and frequency is satisfactory, the risks refers only to rapid changes in the transition period (for example, a change of owner) with the possibility of being interrupted in a transition period, or monitoring is not carried out in an adequate way after that. | 10 |
| Monitoring is not required. Some environmental aspects are satisfactory covered with the established state/local environmental monitoring network | 0 |

Based on the criteria scoring system, the impacts are divided into three categories, Table 2.

Table 2 – Ranking system by impact categories

**I. Category (more than 150 points)**

| |
|---|
| Locations or mining zones where remediation is required as an acute step in the prevention of possible negative impacts on human health, the environment (water, air, biota) and property. The impacts have been registered, documented and are of significant proportions. |

**II. Category (100-150 points)**

| |
|---|
| Locations or mine zones with a transition period (in the midst of activities) where the impacts are partially defined as well as their scale, but as a result of specific factors (such as type of ore and natural conditions, changes in technology applied, cessation of exploitation of mineral materials) at the present the threat of damage is either not so critical or requires additional research to clarify the situation (with the possibility of changing category for the mine site) |

**III. Category (under 100 bodova)**

| |
|---|

Locations or mining zones with an apparently low impact on human health, the environment and property due to various factors, such as long-finished mining operations, temporarily interrupted exploitation operations, etc. Monitoring systems are sufficient to identify the impact or special conditions for accident management are already set there (old-new mine)

Based on results of the analysis three locations have been identified and rated as priority where environmental remediation measures have to be implemented.

1. SM "Smreka 190 points
2. SM "Veovača 205 points
3. Flotation tailings lake 181 points

### 3.2. Assesment of the subject locations using Preliminary Hazard Analysis method (PHA)

The authors of the paper within the subject research carried out preliminary hazard analysis (PHA) [3]

Table 3. Hazard identification and probability of risk occurences and consequences

| Rb | HAZARD | PROBABILITY | CONSEQUENCES | RISK |
|---|---|---|---|---|
| 1. | Health consequences of consuming fish from lake at SM Smreka | Small | Medium | Small |
| 2. | Sliding of the western and southern slopes of SM "Smreka" | Small | Medium | Small |
| 3. | Displacement of a large amount of water due to sliding and flooding downstream area | Small | Medium | Small |
| 4. | Pollution of watercourses by acid water streaming out of the mine audit connected to SM "Brezik". | Medium | Small | Small |
| 5. | Pollution of watercourses by washing out ore deposits from benches of SM "Veovača". | Medium | Small | Small |
| 6. | Pollution of surface and ground waters by toxic materials from abandoned surface mines | Medium | Medium | Medium |
| 7. | Pollution of soil and air by dust from tailings disposal sites and surface mines | Medium | Medium | Medium |
| 8. | Soil pollution by leachate at overburden and tailings disposal sites. | High | Medium | High |
| 9. | Further impact on the flora and fauna at the location of the breakage of the transport troughs and spillage of flotation waste | High | Medium | High |
| 10. | The destruction of aquatic life, and the impossibility of using watercourses for water supply and recreation, which is associated with the change in water color due to the introduction of iron hydroxide salts and others. | Medium | High | High |
| 11. | Health problems caused by the intake of heavy metals into the organisms. | Small | High | Medium |
| 12. | Wind carrying toxic dust from the dam along the lake towards the settlements | High | Small | Medium |
| 13. | Soil pollution with heavy metals, such as: Cu, Pb, Cd. Ni and As on the site of abandoned processing plant of lead, zinc and barite, due to leaching and transport down the slope | High | High | High |
| 14. | Risk of landslides and destruction of tailing dam. | Medium | High | High |
| 15. | Pollution of watercourses in the case of the dam breakage and spillage of water and sediment for the tailing pond due to toxicity from copper, zink, led, cadmium, arsenic and nickel. | Medium | High | High |
| 16. | Raise of water level and overflow of water across the tailing dam in the case of clogging of vertical shafts for intake of water that stream down into the tailing pond. | Medium | High | High |

## 4. PROPOSAL OF MEASURES TO REDUCE ENVIRONMENTAL IMPACTS ON THE RESEARCH POLYGON

Results of the given analyses clearly indicate the locations with pottentially greatest environmental impacts [6]. It concerns SM „Smreka“, SM „Veovača and water accumulation with flotation tailings. The situation at the sites, the key results of the research, the proposed remediation plan and the estimated costs of remediation are given in Tables 4, 5 and 6. Taking into account that the situation at the research polygon is complex and a comprehensive approach requires the readiness of institutions, the involvement of experts from various disciplines and a financial support, the proposed remediation plan, aimed at mitigating environmental impacts, authors also took into account the findings of previously conducted research including the master plan of the Japanese International Cooperation Agency (JICA) related to hotspots in the Federation of Bosnia and Herzegovina [7].

### *4.1 . The lake at SM „Smreka“ PK "Smreka"*

Table 4. Status and proposed solutions -SM „Smreka“

| Category | Summary |
|---|---|
| *Status of the site* | The 116 m deep lake was formed in the crater of the abandoned surface mine, as an accumulation of rainwater and undergorund water<br>The surface of the lake is about 132.000 $m^2$.<br>After the site was abandoned no rehabilitation measures were taken.<br>Mining machines were abandoned within the mine area, which were then submerged after the formation of the lake. Around the lake there are several abandoned buildings and some equipment that were used during the mine operation. |
| *The main findings* | *Water quality:*<br>- Concentration of heavy metals are high in some places, but not higher than those found in the close vicinity.<br>*Sediment quality:*<br>- Concentration of some heavy metals are higher than Canadian PEL values (Probable Effect Level), but analysis of samples taken from the local environment exceeded PEL. [11] |
| *Proposed remediation plan* | The proposed measures consist of (I) Development of a detailed project (II) Biological remediation. It is possible that a technical remediation would be required before the biological. In addition a regular monitoring is suggested. In the period ahead it will be neccesary to carry our regular visual control of the benches at surface mine and waste dumps in order to detect in time possible deformations (cracks, local separation of rock massifs, landslides, etc) and other potential hazards. The rough estimate of remediation costs is 350.000 KM. [6] |

### 3.3. SM "Veovača" lead, zink and barite mine

Upon cessation of work operations, both, at the surface mine „Veovača“ and preparation/processing plant the facilities and equipment were left unattended. As the result of exploitation interruption open benches remained at the surface mine, and the ores from the deposit are exposed to erosion, washing, consequent dust dispersion, etc.

The facilities and equipment at the "Tisovci" processing plant were abandoned without implementing required cleaning, conservation and preparation measures for such a long stoppage in production. During the war, part of the equipment was stolen and in the post war period , the remaining equipment was scrapped and sold as scrap metal.
At the same time, a certain amount of finished products (lead, zinc and barite concentrates in bulk or packed in paper packing) and raw materials remained in the warehouse and at the depot.
At the time of the research, the surface soil at the site of the abandoned factory for processing of lead, zinc, and barite was heavily contaminated with heavy metals, namely: Pb, Cd, Ni and As even though most of the dangerous substances were previously removed from the site. [6]

Table 5. Status and proposed solutions -Ore processing plant site

| Category | Summary |
|---|---|
| *State of the site* | The parts of the plant have been partially or completely demolished, water is still present in several settling tanks, and they can be used if needed in future in case of reinstatement of production process.<br>There are some remains on the plateau of the plant (uselles waste) and part of the products, exposed to washing and carrying/draining down the slope. |
| *The main findings* | *Surface soil:*<br>- Cd max. 27,3 mg/kg (Maximum allowed concentration MAC - 10 mg/kg).<br>- Pb max. 3.005 mg/kg (MAC - 500 mg/kg).<br>- Concentrations of Ni, Zn, Mn i As are above permissible levels as well. [3] |
| *Proposed remediation plan* | Proposed measures include: (I) development of the remediation plan, (II) decommissioning and demolition of the remaining buildings, (III) extraction and disposal of contaminated land.<br>The rough estimate of remediation costs - 920.000 KM. [6] |

Given that the exploitation and processing operations were stopped but that there is an intention to reinstate the production it would be necessary to:

- Analyse posibilites for future ore exploitation/production,
- Create project documentation for the continuation of exploitation and/or rehabilitation of the existing parts of the processing plant, along with technical and biological reclamation of the devastated area of the surface mine and the external disposal site. [10]

The site has recently been taken and operated by a mining company, and there is a possibility that the contaminated land could be processed if the processing plant is rehabilitated. Since then certain activities were carried out including: demolition of the remaining facilities for ore processing, removal of construction waste materials, new processing plant was built. Future plan should include technical and biological reclamation with a special attention paid to water protection.

### 3.4. Accumulation with tailings from flotation process

An earthen dam for tailings from the processing plant of lead, zink and barite ores was used to retain tailings generated during the flotation operations. It concerns a lake with a significant volume of accumulated water separated after the setlling process. Upon the cessation of

concentrate production, it represents a potential environmental threat especially for water courses belonging to Bosna river basin. The crown of the dam is damaged by wind erosion. In addition to surface erosion, traces of furrow and ditch erosion are evident, see figure 7. [6]

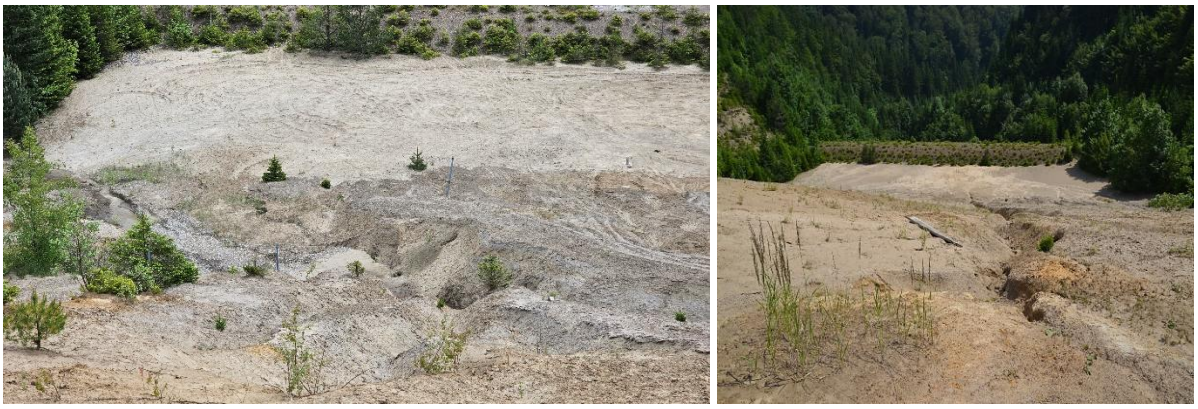

*Figure 7. Ersion on the flotation tailings dam*

Table 6. Status and proposed solutions – Water accumulation with flotation tailings

| Category | Summary |
|---|---|
| *State of the site* | The dam was designed and built as a homogenous dam, constructed with a 15 m high centered core made of clay and filled with stone.<br>The crown of the dam is damaged by wind and water erosion. [6] |
| *The main findings* | *Water quality:*<br>- Concentration of Cd, Pb, Cu and Zn exceeded the quality criteria for surface waters in FBiH, but are still close to acceptable limits, and it is assumed that these concentrations are caused by natural phenomena, and the deposition of constituent particles.<br>*Soil and sediment on the dam:*<br>- Concentration of Cd, Pb, Cu, Zn and As exceeded maximum allowed concentrations several times. [3] |
| *Proposed remediation plan* | The proposed measures consist of : (I) geotechnical examniation, (II) detailed project, (III) construction and related works, and other measures required for rehabilitation of the dam along with constrcution of two peripheral water draining channels<br>The rough estimate of remediation costs is 570.000 KM. |

The earthen dam is considered the greatest threat therefore its rehabilitation is required urgently.

## CONCLUSION

The focus of the research paper is on the environmental impacts of mining activities in Vareš area interrupted by the previous war in BiH, and further taking into account post-war unsettled state in the entire country and a noticable tehnical-technological legging behind the world trends. A wider area of polymetallic deposits, with underground and surface exploitation

facilities was determined to be the research polygon primarily due to interest in state of environment affected by the mining oeprations.

Based on the previosly conducted analyses by the authors of the paper that included status of remaining facilities, surface mines, undeground mine, then the degree of water and soil pollution as well as the assessment of environmental risks [3], the paper presents a proposal of measures to reduce environmental impacts, whereby special attention is directed to several key locations as follows: SM „Smreka and the lake created in the crater of the mine, SM „Veovača and the relating plant for ore processing and packing, and water accumulation with flotation tailings.

As for the results concerning the SM „Smreka, concentration of heavy metals in the lake formed in the crater of the surface mine, as well as in the sediment is high at certain spots . Rough estimate of remediation costs for this location amounts to 350.000 KM. The research results relating to the location of the ore processing and packing plant at SM "Veovača" show that the content of heavy metals in the soil exceed the permitted limits many time over, especially when it comes to cadmium and lead contents. For the proposed remediation measures it would be necessary to alocate 920.000 KM. The analysis of water in the water accumulation with flotation tailings shows that the concentration of certain heavy metals exceeded the maxium permitted limits, while their value on sediment in the sediment samples taken from the dam of the water accumulation was exceeded several times. The approximate costs of remediation are estimated at 570.000 KM.

Test results with significantly exceeded limit values of certain parameters indicate that dangerous sites require urgent remediation measures. Rehabilitation of the dam at the flotation tailings water accumulation is considered the most urgent measure to be taken, since in the case of the dam collapse the consequences could be catastrophic possibly endangering some water courses that are in the catchment area of drinking water for Breza town.

European legislation set ambitious goals for environmental protection, and requires harmonization of domestic legislation with related EU legislation. The EU legislation is flexible in terms of the way to achieve the set goals as well as in terms of the organization and ownership of assets and financing of the necessary activities. The positive aspects of EU legislation are also reflected in the provision of a solid basis for long-term planning at the technical, financial and political level. Also, the positive side is the increased degree of civil society involvement, which provides a „living" example of good european governance.

Much more attention must be paid to environmental management, since it represents the key to transition to sustainable development.

## REFERENCE

[1] Begić S, Kurtanović R, Omerhodžić N.: *Napušteni kopovi i ekološka problematika Općine Vareš*, VII Naučni/stručni simpozij sa međunarodnim učešćem "Metalni i nemetalni materijali", Zenica, 2008.

[2] Karadžin Z., Šišić, R.: *Uvod u geookolinski inžinjering*, Tuzla, 2020.

[3] Karadžin Z., Velić, A.: Assesment of environmental risks at an old mining site, International Engineering Conference, Novi sad, 2024.

[4] Operta M.: *Olovo, cink i barit u metalogenetskoj zoni Borovica-Vareš*, VI Naučni/stručni

simpozij sa međunarodnim učešćem "Metalni i nemetalni anorganski materijali", Zenica, 2006.
[5] Salihović S, Selimbašić V, Simičić H.: *Hemijska karakterizacija degradiranog tla na području Bosne i Hercegovine*, VI Naučni/stručni simpozij sa međunarodnim učešćem "Metalni i nemetalni anorganski materijali", Zenica, 2006.
[6] Velić, A., *Mogućnosti ublažavanja okolišnih uticaja napuštenih rudarskih radova na području općine Vareš*, doktorska disertacija, 2025
[7] Japan International Cooperation Agency (JICA): *Master Plan for Remediation of Hotspots in Bosnia and Herzegovina*, Sarajevo, 2014.
[8] UNEP, UNDP, NATO, OSCE - EnvSec initiative, *Mining for Closure* - Policies and quidelines for sustainable mining practice and closure of mines, , Beč, 2005.
[9] *Plan upravljanja zemljištem, zagađenim zemljištem i kontrolom erozije,* ESIA, Eastern Mining, 2021.
[10] *Procjena uticaja na okoliš, Poglavlje 5*, ESIA, Eastern Mining, 2022.
[11] *Threshold Effect Level (TEL), the Probable Effect Level (PEL)*, Canadian Council of the Ministers of the Environment, McDonald, Canada, 2002.