# Analysing a major risk factor for the quality of the Bistrița River: mining activities in the Suceava County

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**ABSTRACT:** Mining has been one of the main drivers of the economy in the Suceava County. However, both during and after the cessation of mining activities, in addition to incorrect or incomplete closure procedures, pollution events have been recorded, as mine waters continue to be discharged into the dense hydrographic network around the Bistrița River. The Bistrița River, the most important watercourse along the mining perimeters analysed, collects all the waters that cross the contaminated sites and carry along pollutants that not only affect the water quality, but also the aquatic ecosystems and, indirectly, human health. The present paper sets out to analyse the influence of the polluted waters carried by the Puciosu, Crucea, Isipoaia and Neagra Șarului creeks based on a quantitative evaluation of specific indicators and a qualitative risk evaluation matrix.

KEY WORDS: water quality, mine waters, mining sites, risk evaluation matrix, water pollution.

## 1. Introduction

According to current legislation, water is considered a *"strategic resource for the national security and defence"* (Legea Apelor no. 107/1996). Any given destabilizing factor affecting the quality of the surface waters can unfold negative repercussions not only for the aquatic and riparian ecosystems but also, through the services they provide, for human health. According to a Report of the World Bank, despite water consumption dropping substantially since 1990 (an effect mostly due to the industrial collapse and the significant reduction of irrigations in agriculture) and due to the climate change effects on water resources, Romania can potentially suffer a water deficit (World Bank Group, 2018). It is therefore important to identify and monitor the anthropic pollution sources that affect water bodies, as a first step towards implementing optimal measures.

Following this line of thought, the paper proposes an analysis, albeit not exhaustive due to the subject matter's complexity, of the ways in which the quality of the Bistrița River within the territory

of the Suceava county can be affected by one considerable factor- the impurified waters from the numerous mining perimeters, abandoned or active, along its course.

Regardless of the type of ecosystem service considered, the quality of the waters of the Bistrița River are of utmost importance, beyond what is stated in the legislation. The Bistrița Aurie River springs from Rodna Mountains and ends on the confluence with Dorna River. It has a length of about 70 km, 19 tributaries on the right side and 19 on the left side, and crosses localities as Cârlibaba, Ciocănești, Iacobeni and Vatra Dornei (Donisă and Poghirc, 1968). The age of the Bistrița valley is Pliocene-Quaternary (Donisă and Poghirc, 1968). Maintaining a favourable conservation status for the riverain species and habitats included in the natural protected areas *Natura 2000, namely* ROSCI0010 *Bistrița Aurie* and ROSCI0196 *Pietrosul Broștenilor - Cheile Zugrenilor*, is a process strongly dependant on the river water's quality. Even though the practice of traditional rafting is almost completely extinct, the Bistrița River still hosts a series of special events for tourism and leisure, most of them in the month of August: *River Rafting Week* (beginning with the 25$^{th}$ of August), *National Trout Festival* (when fries are released into the river for artisanal use) and river rafting in the Zugrenilor Gorge. The first two events are organized by the Ciocănești Town Hall.

## 2. Study area

The Bistrița River belongs to the hydrographic basin *Siret* and is characterized by a series of superlatives: it is the most important tributary of the Siret River; it has the longest mountain course in Romania and is considered a pioneer river in ecological research. It springs from the Rodnei Mountains, separating from the upstream downward the Suhardului Mountains from the Obcina Mestecănișului (NW-SE), turning north-east toward the Giumalău Massif and the Bistriței Mountains and, south-east, between Stânișoarei Mountains and Bistriței Mountains. The Bistrița River, also known as the *Golden Bistrița (Bistrița Aurie)* from its spring to its confluence with the Dorna River, enters the Suceava County through Cârlibaba and crosses through Ciocănești, Iacobeni, Vatra Dornei, Dorna Arini, Crucea, exiting the county through Broșteni.

The nature of the geological substrate crossed by the Bistrița River has determined through time the development of industrial mineral resource exploitation. Mining has since become the engine of social and economic growth of the mountain communities of Bukowina. However, the secondary effects are manifested through the deterioration of the environmental factors. The dense hydrological network facilitates the transport of pollutants in addition to the deterioration of the water quality.

For the area of study (Figure 1), of great importance are the manganese reserves located in black quartzites from the base of low-grade metamorphic rocks belonging to Crystalline-Mesozoic Zone (CMZ) of the Eastern Carpathians. The manganese deposits are grouped in several sectors: Cârlibaba (Dadu Deposit); Ciocănești (Tolovan, Oița); Iacobeni (Arșița, Nepomuceni, Argestruț, Căprăria); Șaru Dornei (Dealu Rusului); Dorna Arini (Ulm Quarry). Except for the Ulm Quarry, all other mining perimeters are closed. On the Cârlibaba - Argestru segment of the Bistrița River, polymetallic and pyrite-copper mineralization, found in a series of quartz-silica shales that make up the Mănăila Deposit are being exploited and mechanically and chemically prepared at the Iacobeni Unit. The compact pyrite mineral, exploited at the Mestecăniș mining perimeter is found in the low-grade metamorphic crystalline of the Obcina Mestecănișului. Downstream, on the Crucea - Broșteni sector, on the left bank of the Bistrița River, there is a dense network of mining exploitations with ceased activity: areas with intense complex sulphur and copper mineralization in Crucea, Ursului Creek, Isipoaia (Bistrița Mountains). Uranium ore used to be exploited in Crucea, baryte from

Holdița-Casei Creek (Broșteni). On the upper course of the Neagra Șarului River, right-side tributary of the Bistrița River, in the Călimani Massif, between 1970 and 1997 one of the most pollutive activities in the country was undertaken: the exploitation and preparation of sulphur.

Along the Bistrița River, within the study area, on the narrow mountain valley, several rural settlements developed urban characteristics due to the intense mining during the Austro-Hungarian Empire (e.g., Iacobeni). During Communism, the pressure for the exploitation of mineral resources led to the construction of mining colonies. Despite the existing water supply network and sewage, dysfunctionalities occurred and so the rural population from the hydrographic basin Bistrița could benefit thereof (e.g., Iacobeni, Crucea, Șaru Dornei, Broșteni).

Along the watercourse there are several aquatic ecosystems of community importance, stated in the Law no.5/2000 concerning the *management of the national territory, 3rd Section Protected Areas* with subsequent modifications in the areas of community importance ROSCI0010 *Bistrița Aurie* and ROSCI0196 *Pietrosul Broștenilor - Cheile Zugrenilor.*

The tributaries of the Bistrița River cross the mining sites and transport pollutants into the main stem river. The degree of pollution is influenced by the morphological, hydrogeological, and even climatic characteristics of the riverbanks. The Bistrița River shapes the mountainous relief characterised by complex geological structures, hard rocks, and a predominantly arboreal vegetation. The climate in the Bistrița valley is temperate continental, categorized as a humid area (Ujvari, 1972), with average multiannual precipitations of over 777.6 mm in Cârlibaba and 569 mm in Broșteni (Cojoc, 2016), facilitating a relatively constant water flow, sufficient for ensuring the self-cleaning capacity of the river. The average multiannual temperature of the Bistrița River is 6.3˚C at the hydrometric station Cârlibaba and 8.2˚C at the hydrometric station Broșteni.

The tributaries with polluting potential of the Bistrița River, from upstream downwards are:

- Valea Stânei Creek, collecting the waters crossing the copper mine Mănăila.
- Oița Creek that crosses the manganese mining perimeter with the same name, together with its own tributary, the Colacu Creek, that can collect tailing waters released accidentally.
- Puciosu Creek, in which mine waters from the copper ore mining perimeter Mestecăniș are released after they pass the wastewater treatment plant.
- The effluent evacuated from the technological water treatment plant at the Preparation Unit for Cu-Zn concentrates Iacobeni.
- Fierului Creek that collects mine waters, together with the creeks that wash the tailing deposits from the mining perimeter Nepomuceni - Arșița - Căprăria (manganese deposits).
- Neagra Șarului River, severely affected by the sulphur exploitation and preparation activities from the Călimani Massif.
- Crucea Creek, crossing the mining perimeter with the same name (Uranium exploitation).
- Isipoaia Creek, collecting the waters from the mining perimeter Isipoaia - Ursului Creek (copper ore deposits).
- Holdița Creek, crossing the mining perimeter Holdița-Casei Creek (barytine exploitation).

Apart from the Neagra Șarului River, all water courses crossing mining areas are left-side tributaries of the Bristrița River.

The present paper sets out to analyse the influence of the polluted waters carried by the creeks *Puciosu, Crucea, Isipoaia* and *Neagra Șarului.*

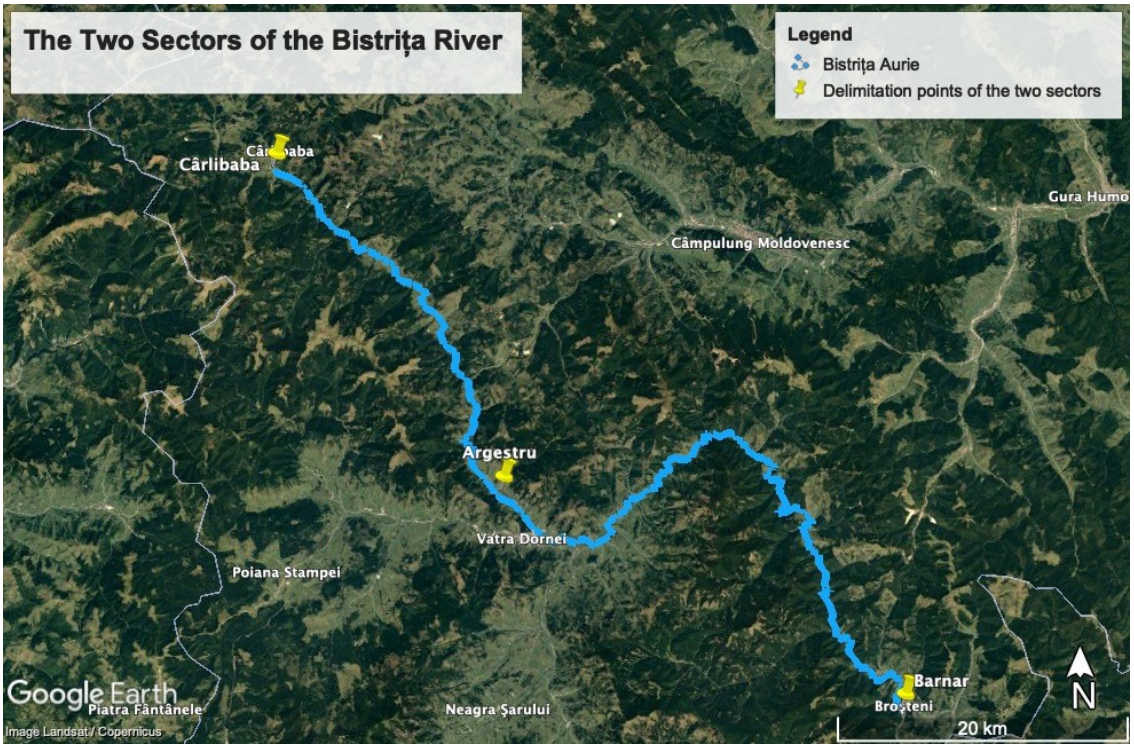


**Figure 1** Map of the Bistrița River with the two sectors Cârlibaba - Argestru and Argestru - Barnar (source: Google Earth Pro).

## 3. Methods

In evaluating the pollution risk of the waters of the Bistrița River and the degradation risk of aquatic ecosystems in the natural protected areas, two segments were established for the purpose of this study:

- The Câribaba - Argestru segment includes the natural protected area, integrated in the ecological network *Natura 2000*: ROSCI0010 Bistrița Aurie; polluted waters come mostly from the left-bank triburary - Puciosu Creek.
- The Argestru - Barnar segment, including the *Natura 2000* site ROSCI0196 Pietrosul Broștenilor - Cheile Zugrenilor; waters are collected from the Neagra Șarului River that crosses the National Park Căimani; polluted waters come from the Neagra Șarului river (right-bank tributary) and the Crucea and Isipoaia Creeks (left-bank tributaries).

The following research stages were followed:

- *Stage 1:* A quality evaluation of the tributaries of the Bistrița River, according to the legal norms for the period between 1997 (when all the above-mentioned mining sites were either active or undergoing closing procedures) and 2019 (when the only functioning units were the mine water treatment plant in Mestecăniș and the uranium mining exploitation in Crucea).
- *Stage 2:* An evaluation of the water quality classes for the Bistrița River on the two segments studied, based on the norms stipulated in the legislation (Order no. 161/2016).

All values utilised in the graphics represent annual averages for each physical and chemical parameter.

The data sources used in this research are presented in Table 1.

**Table 1** Data sources used in this research.

| Water course | Parameters evaluated | Data sources |
|---|---|---|
| Bistrița River | pH, dissolved oxygen, conductivity, radioactivity (β global activity) | Basinal Water Administration Siret Bacău, S CONVERSMIN SA, Environmental Protection Agency Suceava (EPA) |
| Puciosu Creek | pH, metals | S CONVERSMIN SA, EPA Suceava |
| Neagra Șarului Creek | pH, metals | SC CARTEL BAU SA, EPA Suceava |
| Crucea Creek | Radioactivity (β global activity) | EPA Suceava |
| Isipoaia Creek | pH, metals | S CONVERSMIN SA |

*Stage 3:* The evaluation of the quality degradation of the Bistrița River and its aquatic ecosystems. This stage implies an evaluation of the frequency and probability of occurrence of specific risk events and their consequences, which, together with other aspects analysed, are introduced into the qualitative risk and risk level evaluation matrix.

The small probability values are connected to the geo-morphological characteristics, local climate, and ecological rehabilitation measures in the mining sectors. **The effects on the Bistrița River and its aquatic ecosystems would be disastrous if a significant and simultaneous contamination of surface waters within the mining sectors.**

The risk was calculated according to the following equation (Order no. 184/1997):

$$R = P \times G$$

R= risk of occurrence of a certain event

P= probability of occurrence

G= the gravity of the danger

For the evaluation of the frequencies and probability of occurrence of risk events and their consequences, as well as for quantifying the risk level for each parameter analysed, the scales presented in Tables 2-4 were used.

**Table 2** The probability of occurrence of environmental risk events.

| Grade | Level of probability |
|---|---|
| 1 | Rare (improbable) |
| 2 | Unlikely |
| 3 | Possible |
| 4 | Probable |
| 5 | Almost certain |

**Table 3** Evaluation of the gravity of environmental risks.

| Grade | Gravity (consequences) |
|---|---|
| 1 | Insignificant |
| 2 | Minor |
| 3 | Moderate |
| 4 | Big |
| 5 | Major |

**Table 4** Quantification of risk levels.

| Grade | Risk level |
|---|---|
| 1-4 | Low |
| 5-9 | Minor |
| 10-14 | Moderate |
| 15-19 | Significant |
| 20-25 | Major |

## 4. Results and discussion

### 4.1. An evaluation of the water quality of the Bistrița River and of the species of conservative interest on the Cârlibaba - Argestru segment

The quality of the waters crossing the mining perimeters is primarily affected by the following factors:

- mine waters, which are meteoric waters combined with subterranean waters and infiltrate the subterranean mining infrastructure; their chemical composition is, to a large extent, determined by the mineralogy and petrography of the rock packs they cross.
- rainwaters percolating the extractive waste deposits that cause the phenomenon called *acid rock drainage* (ARD); ARD causes the formation of sulphuric acid and the solubilization of metals.

**The Puciosu Creek** receives mine waters from the mining perimeter in Mestecăniș, Iacobeni Commune. The mining in Mestecăniș focused on the extraction and preparation (at the Preparation Unit Fundu Moldovei) of compact pyrite ore. Once mining became unprofitable, the perimeter was closed. Both before and after the closure, highly acidic mine waters would be evacuated through the gallery situated at the lowest elevation (+935 m). The mine water flow would average at 3.2 l/s, whereas the emissary water course, the Puciosu Creek, would have an average flow of 15 l/s. This prompted S. CONVERSMIN SA a society responsible for the conservation and closure of mining sites - to upgrade and modernize the wastewater treatment plant during the period between 2001 and 2005. The high yield of the decontamination station adjusted the water pH and lowered the heavy metal concentration in the Puciosu Creek (Figures 2-3).

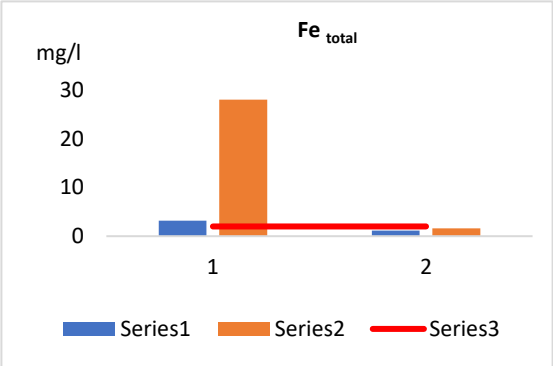


**Figure 2** Total Fe ion concentration in the Puciosu Creek, upstream and downstream of the decontamination station.

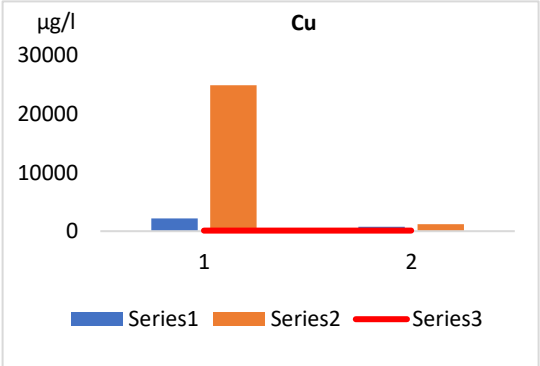


**Figure 3** The Cu concentration in the Puciosu Creek, upstream and downstream of the decontamination station.

Nevertheless, a study from 2001 (Ionce and Florea, 2020) emphasises the imperative need to continue to operate a decontamination station for the mine waters coming from Mestecăniș. This is due to the highly acidic pH of the waters that continues to be recorded, high concentration of copper ions that exceeds the legal limits by 70% and total iron ion concentrations also exceeding the maximum admissible limits by more than 60%.

Concerning the Bistrița River, the following observations can be made:

- The river section between the entry point into the Suceava County at Cârlibaba and the confluence with its left-bank tributary Puciosu Creek at Iacobeni, is considered to be a significant source of pollution due to the intake of mine waters from the Tolovanu Sector (subterranean exploitation and preparation through calcination of manganese ore); the high concentrations of manganese and iron ions required a mine water treatment plant that would evacuate the treated waters into the Tolovanu Creek, a left-bank tributary of the Bistrița River. The treatment plant was located 60 m away from the creek's confluence with the Bistrița River. However, after the permanent cessation of the mining activities in Tolovanu through the Government Order no.1846/2004 and the finalization of all mine gallery closure procedures, mine water evacuation stopped, and the treatment plant was disused.
- The placement of the Preparation Unit Iacobeni (mechanical and chemical preparation of polymetallic ore from the Mănăila Quarry) on the left bank of the Bistrița River, approximately 65 m away from the water course and 60 m away from the *Natura 2000* site ROSCI0010 *Bistrița Aurie*, makes it an important source of pollution. Used technological waters with high concentrations of Zn, Cu and Pb are run through a decontamination station. Any error or sign of negligence can result into the contamination of the Bistrița River.

The data provided by the Basinal Water Administration Siret Bacău for the monitoring sections Cârlibaba and Argestru, show that the water of the Bistrița River can be categorised in the quality class I according to the legal norms (Order no.161/2006).

Considering the relevance of the conservation state of the habitats and species of conservative interest along the water course, the evolution of the conductivity parameters was analysed to see the degree of mineralization and the concentrations of salts and metal ions released into the river from the mining areas, and the dissolved oxygen, an important indicator for the quality of aquatic life. For practical purposes, the indicators are represented together for all three sections of the two segments analysed.

For the Cârlibaba section the waters close to the spring and far from anthropic influences belong to the quality class I. In the monitoring section Argestru, the conductivity grows, however not significantly, a trend registered both during the time mining activities and after the closure of the mining sites. This is primarily due to the intake of waters with high concentrations of dissolved salts and metals. There is however no maximum admissible limit for this specific parameter in the legislation (Order no. 161/2006), making solely the observation of positive or negative trends relevant. The average multiannual values for conductivity are over 10 mg/l, suggesting optimal conditions for the development of aquatic ecosystems (the minimum value for life to exist is 2 mg/l). This is represented in Figures 4- 5.

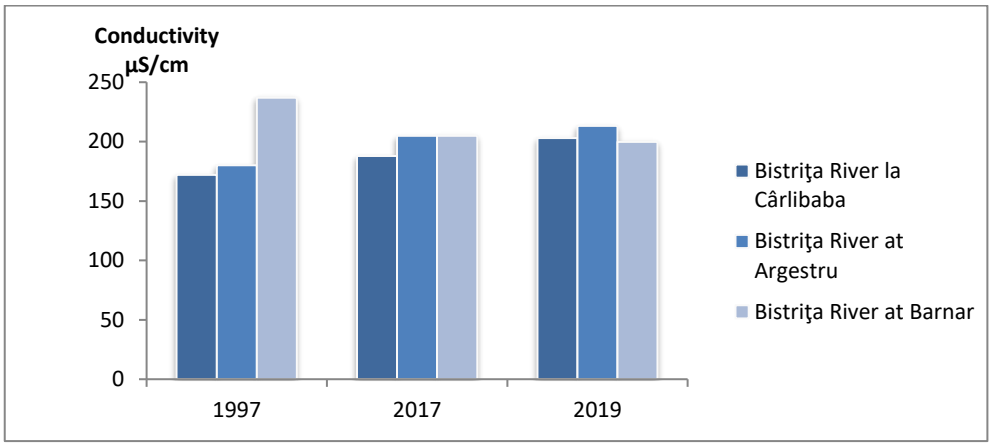


**Figure 4** Conductivity values for the monitoring sections on the river Bistrița.

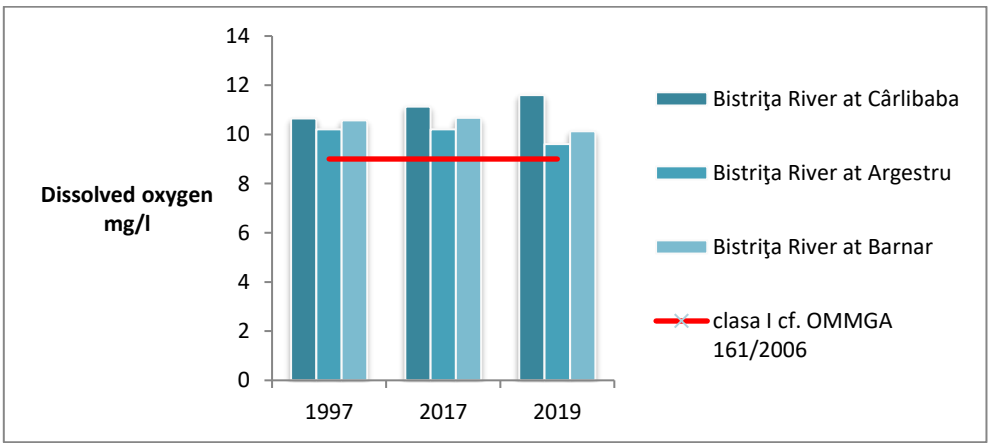


**Figure 5** Dissolved oxygen values in the monitored sections of the Bistrița River.

An analysis of the quality of the river Bistrița around the Preparation Unit Iacobeni in 2018 shows that the water belongs to the quality class III due to the manganese concentrations. Manganese is transported into the water from the storage from the industrial platform (the platform was functional until 1993 as a unit for mechanical and chemical preparation to obtain sulphates, technical crystallized manganese carbonate and manganese oxides.

According to the official Management Plan (Order no. 1118/2016), the following observations can be made concerning the *conservation state of the species of conservative interest* in the natural protected area of community interest ROSCI0010 *Bistrița Aurie:*

- For the species *Hucho hucho* (huchen), only the segment Cârlibaba - Ciocănești can constitute a favourable habitat, as it is less impacted by the sewage and no traces of industrial pollution; even though the conservation state of the habitat is considered favourable, the huchen's state of conservation is considered unfavourable, mainly due to poaching and the low water flow relative to the width of the river.

Based on the data provided by the Basinal Water Administration Siret Bacău, the saprobe index for phytoplankton- essential food source for fries- grows from Cărlibaba (where the water quality belongs the quality class I) to Argestru (where the water belongs to the quality classes II and III).

### 4.2. The evaluation of the quality of the Bistrița River and of the species of conservative interest under the influence of the tributaries crossing the mining perimeters in the Argestru - Cârlibaba section

The Neagra Șarului River collects all contaminated waters from the mining perimeter Călimani, where intense mining activities, specifically the exploitation and autoclaving of sulphur had a severe polluting impact. Before the intake of contaminated waters, the river pH used to be around 5.2- 5.9. However, after the intake of acidic waters, with high concentrations of iron ions and sulphates from the Dumitrelu Creek, the river's pH lowers to 2.3- 4.5 (Figures 6- 7).

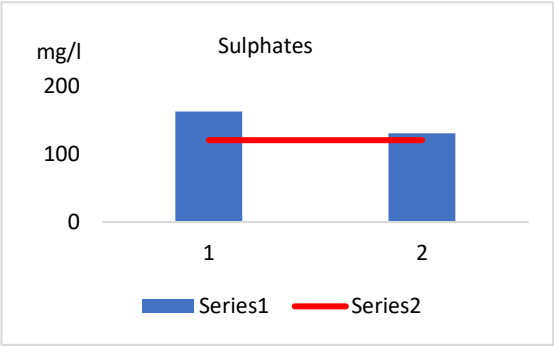


**Figure 6** Sulphates indicator for the Neagra Șarului River, upstream the confluence with the Bistrița River.

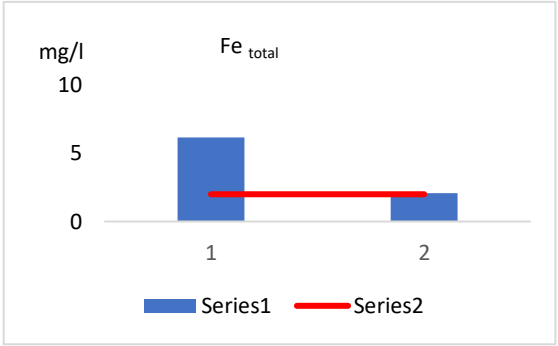


**Figure 7** Total iron ion concentration in the Neagra Șarului River, upstream of the confluence with the Bistrița River.

The Neagra Șarului River, after its confluence with the Bistrița River, registers waters belonging to quality class V. Even though there is a constant inflow of fresh, clean water from the tributaries coming from areas unaffected by mining and therefore a slightly higher pH and lower sulphate values, the Fe ion content is the main reason for this categorization. The high values for the previously mentioned parameters can be due to the existence of sediments in the riverbank,

gradually brought into the water stream from the mining area (Ionce et al., 2019). Not finalising the ecologic reconstruction works in the mining area Pietricelu - Călimani - Negoiul Românesc facilitates a continual degradation of the water quality of the Neagra Șarului, through a permanent intake of mining pollutants and abundant precipitations (the annual precipitation recording in Călimani in 2019 was 1000.8 mm).

The Crucea Creek collects the waters crossing the mining perimeter Crucea, as well as the decontaminated waters (from uranium precipitation, retained by the ion changing mine waters through washing with sodium hydroxide). The measurements performed by the Radioactivity Monitoring Station (part of the county's Environmental Protection Agency) reveal no concerning values which are under the warning limit of 5 Bq/l (Order no.1978/2010), indicating a high efficiency of the decontamination station.

The Isipoaia Creek crosses the mining perimeter with the same name, its confluence with the Bistrița River being about 1000 m away from the access gallery to the pyrite ore deposit. Since the cessation of the mining activities, the flow regime towards inferior horizons, with once active pump stations, changed, causing the mine to flood in these areas. The base horizon, where waters are freely evacuated, is situated at +740 m (Isipoaia gallery) and used to receive waters from the upper horizons. Mine waters in Isipoaia have a flow of 8- 12 l/s and are acidic, have high concentrations of Fe, Zn, Mn and Cu. Due to the high concentration of water contaminants (heavy metals, sulphates, salts), their evacuation directly in the natural emissaries lead to the pollution of surface and/or subterranean waters, specifically the Isipoaia Creek and, through it, the Bistrița River. Incorrect closure works, not considering the subterranean conditions determined by a dense mining infrastructure, have not been successful in fixing the source of pollution. This led to an extreme pollution event, recorded on the 26$^{th}$ of August 2015, when, due to an accumulation of a considerable volume of subterranean mine waters (from rain infiltrations and springs), the waters overflew through the gallery with a rate of cca. 150 l/s for almost 2 hours. The analyses performed in the accredited laboratory of S CONVERSMIN SA (the society operating within the framework of the Ministry of Economy and responsible for the closure of mining perimeters with ceased activity) showed significantly exceeding values for the quality indicators related to the norms imposed by the Government Decision no.352/2005- NTPA 001. Similar phenomena were recorded in 2016 and 2018 (Figures 8-9).

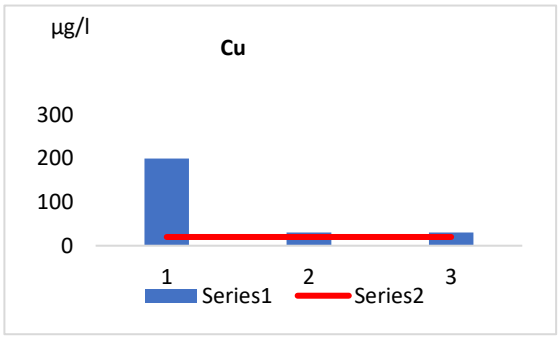


**Figure 8** The Cu concentration in the Isipoaia Creek.

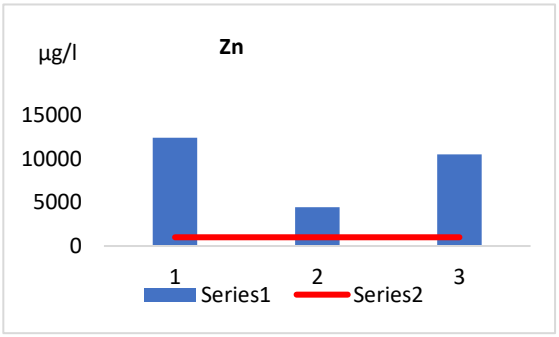


**Figure 9** The Zn concentration in the Isipoaia Creek.

The water quality for the Bistrița River, at the control section Barnar, can be categorised as quality class I. This is due to high flow tributaries (e.g., Dorna River, Bîrnărel Creek, Holda Creek, Neagra Broștenilor Creek) and to the dense hydrographic network supplying the river. The

negative trend of the conductivity indicator is visible from 1997 (when mining sites were still active) until 2019 in the section Barnar, as the content of salts and metals dropped.

However, subsequent parameter measurements performed due to accidental pollution events, reveal exceeding values downstream the confluence of the Neagra Șarului River with the Isipoaia Creek (contaminated watercourses from the mining activities). Therefore, for the indicators manganese, sulphates and total iron downstream the tributary Neagra Șarului, Bistrița River registers quality class II and sometimes III. Also, downstream the Isipoaia Creek, after the pollution event form 2015, the waters of the Bistrița River belong to quality class II and III for the manganese indicator.

In this segment (Argestru-Barnar), approx. 20 km away from the Vatra Dornei municipality, within the administrative jurisdiction of the Dorna Arini and Crucea communes, the natural protected area ROSCI0196 *Pietrosul Broștenilor - Cheile Zugrenilor* is located. Amongst the species of conservative interest, *Hucho hucho* is mentioned. The huchen is a highly sensitive to any alterations in the water quality. According to the management Plan of this natural protected area, the conservation state of the huchen is unfavourable- inadequate.

### 4.3. Risk evaluation concerning the quality of the Bistrița River and its aquatic ecosystems due to the mining activities in the Suceava County

In the evaluation process of the degradation risk of the Bistrița River waters across the Suceava County, several types of dangers relevant to the subject of this paper were identified, whose probability of occurrence was estimated based on the history of negative impact events (Table 5).

**Table 5** The evaluation of the contamination of waters and aquatic ecosystems in the Bistrița River.

| Type of the danger | Probability | Gravity | Risk level |
|---|---|---|---|
| Technical errors or interruptions in the financing for the decontamination plant Mestecăniș | 3 | 4 | 12 moderate |
| Accidental pollution caused by malfunctions of the decontamination station or by the intake of tailings or raw materials during abundant rainfall from the Preparation Unit Iacobeni's platform | 2 | 3 | 6 minor |
| Intake of tailings containing sediments from the Călimani Mining Exploitation into the Neagra Șarului River | 4 | 4 | 16 significant |
| Water quality degradation of the Neagra Șarului and Bistrița rivers, directly caused by the sludge discharge from the retention basin of the micro hydro-power plant based on the Neagra Șarului River; indirectly, this can be caused by the flotation tailings accidentally spilled into the Neagra Șarului River | 4 | 3 | 12 moderate |
| Cessation of the uranium ore exploitation without post-closure mine water decontamination solutions | 3 | 4 | 12 moderate |
| Permanent discharge of mine waters from the Isipoaia perimeter into the watercourse with the same name and no decontamination solutions | 5 | 3 | 15 significant |

The risk level is minor for the accidental pollution events from the industrial platform Iacobeni. The probability of this kind of events is reduced, mainly due to the permanent presence of the staff from the Preparation Unit, ready to intervene in case of need. The decontamination station is partially automatized and rainwaters washing the platforms are collected and chemically treated before they are evacuated into the emissary- the Bistrița River.

There is a moderate risk level for the following scenarios:

- Malfunctions/cessation of financing for the decontamination plant in Mestecăniș. Previous interruptions have been recorded twice, as the plant required serious upgrading to function according to the optimal conditions imposed by the legislation. However, relying on state budget, the decontamination plant suffered from the lack of finances.
- Sludge discharge from the basin of the micro hydro-power plant on the Neagra Șarului River.
- Closing the exploitation unit of radioactive ore (an undergoing procedure), without continuing the decontamination procedures of mine water plant, would lead to a high level of radioactivity in the Crucea Creek and, by consequence, the Bistrița River.
- The pollution of the Bistrița River with mine waters is highly probable given the permanent mine water evacuation with high heavy metal content and the recorded events from 2015, 2016 and 2018.

## 5. Conclusion

Corroborating the data on the water quality of the Bistrița River with the studies for the Management Plan of the two natural protected areas: ROSCI *Bistrița Aurie* and ROSCI0196 *Pietrosul Broștenilor - Cheile Zugrenilor*, the following conclusions can be made:

- The Bistrița River, between Cârlibaba and Broșteni, due to the local geomorphology and high flow maintained by over 20 tributaries, belongs to the quality class I according to the indicators for dissolved oxygen and mineralisation. However, the intake of metallic ions and other pollutants from different sectors of the river can severely affect the habitat of the huchen.
- The samples from the monitoring sections of the Basinal Water Administration Siret only generally indicate the ecological state of the river. However, analyses show local negative impacts after the intake polluted waters from tributaries, an effect that is later mitigated through the self-cleaning capacity of the river. This raises the question, whether a small particle of a give pollutant can reside long term and great its impact could be during periods of drought and low flow rates.
- According to previous studies, habitat fragmentation seems to be another major issue, affecting the conservation status of the species of conservative interest from the natural protected areas. This is mainly caused by urbanisation of the riverbanks, transport infrastructure consisting of European and national roads, and the intensely trafficked railways.

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