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ASSESSEMENT OF ACCIDENTAL WATER POLLUTION WITH MINE WATERS IN ROMANIA WITHIN 2017-2023

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ABSTRACT. – Assessment of accidental water pollution with mine waters in Romania during 2017-2023. Against the background of an increasingly restricted mining activity at the national level, due to the high economic costs, the active and conservation mining objectives sporadically register environmental incidents, which affects mainly the aquatic environment. Thus, in the context of excess rainfall, internal erosion processes associated with dikes and structures related to tailings ponds, poor management of the galleries under conservation can lead to the triggering of accidental pollution with mine waters and wastewaters from tailing ponds of the natural hydrographic network. The analysis of these events was done both from the perspective of spatial and temporal distribution, with a focus on the nature of involved polluting substances and the transfer of pollution waves on the local and regional hydrographic network system. The paper used information from the database of the Romanian National Water Administration, obtained as a result of the post-event investigations carried out through the Water Basin Administrations and their associated laboratories for the period 2017-2023,

Keywords: accidental water pollution events, spatial distribution, temporal analysis.

1. INTRODUCTION

Pollution means the direct or indirect introduction, as a result of human activity, of substances or heat into the air, water or land which may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems, which result in damage to material property, or which impair or interfere with amenities and other legitimate uses of the environment (WFD, 2000).

In Romania the subject of accidental pollution events affecting water network was documented in many studies focused either on single events: Baia Mare cyanide incident (Schwabach, 2000), mining spots from Apuseni Mountains (Bird, 2005), large watersheds: Arieș basin (Bătinaș, 2003). Accidental water pollution represents the discharge of pollutants from point sources, in high concentrations, unintentionally, due to an accident or under special circumstances, which leads to the impairment of water quality and causes damage to aquatic ecosystems. One of

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the important measures for maintaining the quality of water resources is the activity of preventing and combating accidental pollution.

The plan to prevent and combat accidental pollution is drawn up by each utility potentially polluting or where events may occur that may lead to accidental pollution a water resources.

Romanian network responsible for monitoring potential accidental pollution events for all components of the environment is coordinated by the Ministry of the Environment, through a wide spread centers located in every county, with special departments that are focused on these types of events. The basic legislation for evaluation/monitoring and specific interventions to diminish the effects of pollution events are presented in Environmental Protection Law no. 137 from 1995 and in Ministerial Order 2579 from 2012. The main authority on the national level is The National Environmental Protection Agency (NEPA) with is territorial county smaller agencies who are collecting the information regarding these events. Water pollution events are observed by Romanian Waters National Administration (RWNA) through a wide-spread monitoring stations connected into a controlled network.

Mine waters are usually treated in a sewage treatment plant where heavy metals are precipitated using an alkaline solution of calcium hydroxide. Treated waters are then discharged into the natural river network based on water management permit which can allow some loaded chemicals into the outflow source. Problems arise when the treatment plant suffers a failure or when a much higher flow of mining waters enters the system and they cannot longer be fully treated and all end up with a large load of heavy metals in the outfall. The best solution is to have alternative solutions available to stop pollution by using the ”dilution technique” with large volumes of waters from the nearby reservoirs. Another option is to quickly apply an alkaline solution to fast-precipitate the metals present in wastewaters. However, this alkaline solution must be applied responsibly because it may trigger, itself some effects on aquatic environment (Buz, 2017).

2. DATA AND METHODS

The raw data provided by the RWNA is expanded over eight consecutive years of monitoring (2017 - 2023) and contains information regarding the spatial distribution on the six large watersheeds – Water Basin Administrations, subsidiaries of RWNA. Data was collected by the local water management system offices spread around the country and correlated with information gathered by Regional Environmental Protection Agencies. In order to obtain the spatial distribution, we have used MS Excel and ArcGIS map software.

3. RESULTS

In the last eight years (2017 - 2023), Romania has experienced and registered 18 accidental water pollution events. The distribution of these events based on the recorded year and appearance in the WBA large watersheeds is presented in table 1.

Table 1. ***Pollution events with mining waters or sterile wastewaters within 2017-2023***

Water Basin Administration	Surface (km^2)	2017	2018	2019	2020	2021	2022	2023	Total
Crișuri	14941.8	0	0	0	1	2	0	0	**3**
Jiu	16579.7	0	0	0	0	0	0	1	**1**
Mureș	28532.2	1	0	0	1	0	0	0	**2**
Olt	24960.9	0	0	1	0	1	0	0	**2**
Siret	27944.2	0	2	0	0	0	0	1	**3**
Someș-Tisa	22450.6	1	2	1	1	1	1	0	**7**
Romania	**238831.6**	**2**	**4**	**2**	**3**	**4**	**1**	**2**	**18**

3.1. Spatial distribution

The most events of water pollution with mining waters or tailings waste were registered within Someș-Tisa Water Basin Administration, 7 events. Three events were registered at the Siret Water Basin Administration and also within Crișuri Water Basin Administration. Two events each were registered at the Mureș Water Basin Administration and Olt Water Basin Administration, and one event was registered within Jiu Water Basin Administration.

The locality most affected by mine water pollution was Valea Vinului village, Rodna commune, Bistrița-Năsăud County, which had three events in three consecutive years 2017, 2018 and 2019, and the Nucet locality in Bihor County which was affected by two times in September 2021.

3.2. Temporal analysis

In 2017, two events were recorded, a major incident at the tailings pond of Valea Șesii, Lupșa commune, Alba county, and a mine water pollution at the Valea Vinului mining perimeter, Rodna commune.

In 2018, two mining water pollutions were recorded at Valea Vinului, Rodna and Băiuț commune, Maramureș county, a minor incident at Tărnicioara pond, Tărnicioara village, Ostra commune, Suceava county and a water pollution from the Cacica salt mine, which polluted the Soloneț watercourse and caused fish mortality.

In 2019, two pollutions were recorded, one with mine waters at Valea Vinului, Rodna commune and one with wastewaters from the sterile tailings pond from the extraction of kaolin at Harghita Băi, Miercurea Ciuc municipality.

In 2020, two mining water pollutions were registered (one on the Cavnic river, Cavnic city, Maramureș county and one on the Crișul Alb river in Crișcior commune, Hunedoara county) and a minor incident at the Boița tailings pond, Boița village, Răchitova commune, Hunedoara county.

In 2021, four mine water pollutions were recorded, (two on the Crișul Băița river, Nucet town, Bihor county, one on the Olt river, Sândominic locality,

Harghita county, and one on the Băița creek, at the Câmpurele treatment station, Nistru mining perimeter, Maramureș county.

In the year 2022, a mine water pollution was registered on the Săsar river at the Săsar work point of CNMPN Remin SA, a small-scale pollution.

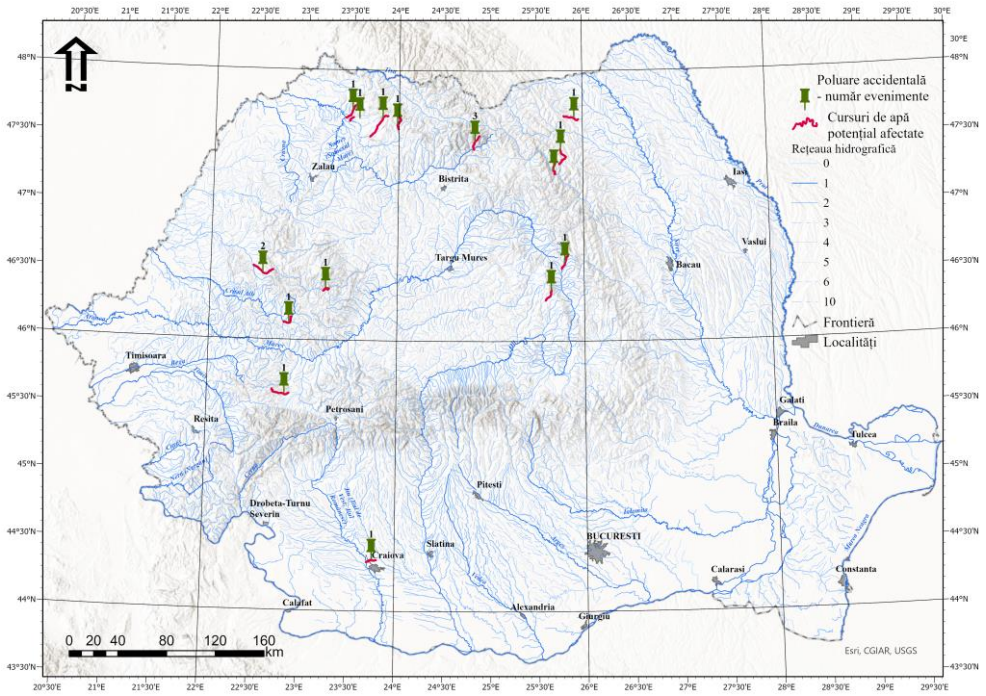

Fig. 1. ***Events of accidental water pollution (2017-2023)***

In 2023, a mine water pollution was recorded on the Bistrița river, Holda village, Broșteni city, Suceava county and a pollution with ash dust resulting from the burning of coal, on the Valea Mănăstirii stream, a tributary of the Amaradia river in the area of the town Albești, Șimnicu de Sus commune, Dolj county. This pollution was of small scale affecting only the Valea Mănăstirii stream locally.

Analyzing the nature of pollutants was the next criteria used to appreciate what are the most involved substances or process that have triggered the pollution events.

The main accidental water pollution sources are: wastewaters (with domestic and industrial genesis); hydrocarbons, acid mine waters, chemical substances, etc. An overview of the recorded values is presented in table below (Table 2).

Usually, the frame time when this kind of pollution occurs can developed within a few hours up to several days.

Table 2. ***Pollutant type involved in accidental pollution events (2017-2022)***

Pollutant nature type/ location/year	Fe mg/l	Cu µg/l	Pb µg/l	Zn µg/l	Mn µg/l	Cd µg/l	Cr µg/l
Rodna, Valea Vinului, 2018	Yes	Yes	Yes	Yes	No	Yes	Yes
Lupșa, Valea Șesii, 2017	Yes	No	No	No	Yes	No	No
Nucet, September 9th 2021	Yes	No	No	Yes	Yes	No	Yes
Nucet, September 30th 2021	No	No	No	No	No	No	Yes
Crișcior, Gurabarza mine, 2020	Yes	Yes	No	Yes	Yes	No	No
Broșteni, Holda, Isipoaia mine, 2023	Yes	Yes	Yes	Yes	Yes	No	No
Băița, Nistru mine, 2021	Yes	Yes	Yes	Yes	Yes	Yes	No
Ostra, Tărnicioara, 2018	Yes	Yes	Yes	Yes	Yes	No	No
Răchitova, Boița village, 2020	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sândominic, Bălan mine, 2021	Yes	Yes	No	No	Yes	No	No
Rodna, Valea Vinului, 2017	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Băiuț, 2018	Yes	Yes	Yes	Yes	Yes	No	No
Cavnic, 2020	Yes	Yes	Yes	Yes	Yes	Yes	No
Săsar, 2022	Yes	Yes	Yes	Yes	Yes	Yes	No
Rodna, Valea Vinului, 2019	Yes	Yes	Yes	Yes	Yes	Yes	Yes

3.3. Study cases

Tailing ponds incidents are mainly triggered by large rainfall amounts which are accumulated in the upper catchment of tailing ponds, fast-melting snow periods which generate huge water volumes to be handled to fit in tailings capacity, structural damages and cracks in pipeline system for wastewater from the processing ore plant towards tailing ponds, dam failure etc.

Valea Șesii is the main settling pond of the Roșia Poieni copper quarry mine, managed by SC CUPRU MIN S.A. Abrud. The tailings resulting from the technological process carried out at the processing plant from Dealul Piciorului are stored in this pond. The tailing pond was commissioned in 1986 and had a designed storage capacity of 12.5 million m^3 (Stematiu D, 2018). Earlier, in the 2000 years unfortunately some sever pollution incidents have been triggered within north part of Romania associated with some spilling of wastewaters from two toxic tailing ponds: Novăț and Aurul ponds. The two events were described as the worst in the modern history of nation-wide pollution events being characterized by wastewaters loaded with heavy metals that flowed through the large cracks in the dam's structures, which led in the end to create a cross-border incident pollution. Other similar events were prevented to happened in the case of Colbu tailing ponds system located in Borșa, Maramureș County which in September 2007, has under a severe threat due to large rainfall amounts. In order to avoid accidents, at the Colbu I pond, the decision was made to make a lateral breach in order to remove the water that endangered the central dike. These events were treated as an incident without polluting the Tisa river (Nacu S., 2009).

The April 2017 incident at the Valea Șesii tailing pond was due to an internal erosion phenomenon, cause by the blocking of the reverse well, used to evacuate the cleared water to river network. The initial/temporary system for evacuating the this water from the pond used the diversion works of the Valea Sesii stream during the execution of the priming dam. The initial system consisted of a clear water evacuation system with reverse wells on Valea Șesii and an evacuation system on Valea Cărbunarilor. The systems were made of *PREMO* Dn 800 mm pipes that connected downstream to the circular gallery with a diameter of 2.5 meters, made of reinforced concrete. The drainage system continued below the dam with a rectangular closed channel, also made of reinforced concrete, downstream up to the natural riverbed of Valea Șesii creek.

a) b)

Fig. 2. ***Valea Șesii tailing pond: a) internal suffusion cone in the stabilized area; b) temporary works downstream of dam to contain the pollution event (source: Ciungan, C., 2017)***

After the clear water discharge system was put into operation, the collector pipe from the provisional system of reverse wells failed in the dam undercrossing area. In the first phase the situation was remedied by closing downstream and stopping the flow of water and tailings. In 1998, the water intake, routing and evacuation system was decommissioned, the reverse wells were concreted, and the closed channel was blocked with a concreted metal gate over which a layer of earth and stone was deposited. In September 2016, at the Valea Șesii pond, traces of tailings were observed around a water source downstream of the dam, referred to by the exploitation staff as an outbreak. The source of the outbreak was the infiltration through the mass of tailings towards the gallery break, of rainwater and clear water. The hydrotechnical drillings carried out in the tailings beach revealed the fact that there was a wet area at a height of 1-2 meters under the surface of the beach, which explains the small flow rate of the outburst of about 3 l/s.

On April 3rd, 2017, the occurrence of a larger outbreak was observed, through which wastewater was discharged, the phenomenon was reported to the Alba Water Management System and further on the information flow to the Ministry of the Environment, Waters and Forests. The mining company has made several interventions to mitigate the pollution by building two temporary dams to keep the wastewaters from reaching the Arieș River and stopped the operation of the ore

preparation plant (Figure 2). The Alba Water Management System has decided to operate the reservoir of Mihoiești, in order to generate downstream a bigger flow to cope with the pollution events for dilution purposes. The monitoring campaign was focusing on collecting water samples from the affected area and from downstream collecting streams: Arieș and Mureș rivers.

The wastewaters collected in this tailing pond are characterized by a high content of suspended solids with low granulometry similar to a sludge and a high heavy metals ionic content.

The indicator of suspended matter (mg/l) was greatly exceeded in Valea Seșii creek immediately after the incident, 285197 mg/l on April 3rd, 2017 at 1:20 p.m., it decreased to 3862 mg/l on the same day at 6:50 p.m. The next morning, at 8:30 a.m. it was 782 mg/l and on the third day at noon it dropped to 31 mg/l within the acceptable limits. The maximum wave of tailings pollution at the Baia de Arieș hydrometric station was recorded on April 3rd 2027 at 7:40 p.m., when the concentration was reaching 10770 mg/l of suspended matter, at the Buru hydrometric station on April 4th, we have 700 mg/l, upstream of Turda municipality 330 mg/l was recorded, and 36 mg/l of suspended matter was recorded near the confluence with its collector, Mureș River. Analyzes of this indicator were also carried out on the Mureș River downstream of the confluence with the Arieș at 1 km (636 mg/l in on April 5th, 2017 at 10.30), and at Aiud town (57 mg/l on the same day at 13.25).

Similar exceedance for the same parameter was recorded at Harghita Băi tailing ponds, Albești ash pond, in Dolj county (figure 2), or on the incident reported at Broșteni, Holda village at Isipoaia mine.

The post monitoring actions associated with closed tailing ponds or waste dumps is lacking from a consistent strategy and in some cases these ”the no-man’s lands” can generate unpredictable pollution scenarios, which in some cases are difficult to be mitigate properly.

A different type of incidents may be triggered in abandoned old mine galleries that are fully filled with mining waters. When the pressure accumulates behind the concrete doors or blocks situated in the galleries, there a great chance that a pollution event is scheduled to happened in the near future. The failure of this blocking dams will generate a wastewater wave-flood event which cannot be mitigate on the treatment plant or other facilities in a short matter of time.

The pollution of the Cavnic river with mine waters discharged from the Ferdinand gallery started on November 15th, 2020 at 12.00 and ended on November 17th at 13.20. Concentrations of iron, manganese, zinc, cadmium, chromium, copper, nickel and lead were exceeding the approved limits thresholds validated in water quality permit. Pollution was monitored at the source, downstream of the pollution source, on the Cavnic river at Copalnic and at its confluence with Lăpuș river. The main collector was also investigated downstream of Cavnic river mouth and at Lăpușel village. Heavy metal concentrations immediately decreased by one order of magnitude downstream of the pollution source and by two orders of magnitude at Copalnic and by three orders of magnitude after the confluence with

the Lăpuș river. For example, the concentration of cadmium in the pollution source was 202.2 µg/l, it decreased to 35.44 µg/l at 50 meters from the pollution source, in Copalnic it was 7.49 µg/l and 0.742 µg/l in Lăpușel. On several sites along the path of pollution wave fish mortality has been recorded (Figure 3).

The pollution of the Lăpuș river with mine waters from the Breiner mining gallery, Băiuț commune, Maramureș county on March 27th, 2018 lasted for several hours. The monitoring of the events was done by collecting sample along the river length, both on Lăpuș river and on its collector, Someș river. The maximum iron concentration at the pollution source was 487.8 mg/l, it decreases to 1.989 mg/l at Rogoz, and in the Someș river after the confluence with the Lăpuș river it was 3.302 mg/l influenced by the iron concentration in the Cavnic rivers, Săsar, Baița and Nistru creek.

Fig. 3. ***Pollution wave caused by acid mining drainage from Băiuț mining site with confirmed fish mortality on Lăpuș River (source: Buda, M., 2020)***

The maximum concentration of manganese at the pollution source was 54.2 mg/l, it decreases to 2.79 mg/l at Rogoz, and in the Someș river after the confluence with the Lăpuș river it was just around 1.391 mg/l. The maximum concentration of zinc at the pollution source was 92.9 mg/l, it decreases to 3.73 mg/l at Rogoz, and in the Someș river after the confluence with the Lăpuș river it was 1.032 mg/l. The maximum copper concentration at the pollution source was 4.495 mg/l, it decreases to 0.12 mg/l at Rogoz, and in the Someș river after the confluence with the Lăpuș river it was 0.053 mg/l.

The pollution of the Săsar river in 2022 was due to a failure recorded at the mine water treatment station at the Săsar work point - Baia Mare municipality. Samples were taken from the pollution source, from the Săsar River, downstream of Baia Mare and from the Lăpuș River upstream of the confluence with the Someș River. The untreated waters were loaded with iron, manganese, zinc, cadmium, lead, nickel, chromium and copper. The maximum concentration of iron at the pollution source was 728 mg/l, it decreases to 0.438 mg/l downstream of Baia Mare, and in the Lăpuș river upstream confluence with the Someș river it was

below the limit of quantification. The maximum concentration of manganese at the pollution source was 695 mg/l, it decreases to 5.75 mg/l downstream of Baia Mare, and in the Lăpuș river upstream confluence with the Someș river it was 4.23 mg/l, a value influenced by the Baița and Nistru creeks. The maximum concentration of zinc at the pollution source was 28 mg/l, it decreases to 0.195 mg/l downstream of Baia Mare, and in the Lăpuș river upstream confluence with the Someș river it was 0.518 mg/l, a value influenced by the Baița and Nistru rivers. The maximum concentration of cadmium at the pollution source was 65.7 µg/l, it decreases to 0.342 µg/l downstream of Baia Mare, and in the Lăpuș river upstream confluence with the Someș river it was 3.583 µg/l. The maximum concentration of lead at the pollution source was 4.5 µg/l, it falls below the quantification limit downstream of Baia Mare. The maximum concentration of nickel at the pollution source was 473.6 µg/l, it decreases to 23.93 µg/l downstream of Baia Mare, and in the Lăpuș river upstream confluence with the Someș river the value was 17.34 µg/l.

Pollution of the Băița river was due to the exceedance of the treatment capacity of the Câmpurele sewage plant between February 17th, 2021 at 2:00 a.m. and February 18th, at 10:00 a.m. The untreated waters were loaded with iron, manganese, zinc, cadmium, lead, nickel and copper. Water samples were taken from the source of pollution, from the Băița river upstream and downstream of the pollution source, the Lăpuș river downstream of the Băița river confluence and upstream of the Someș river confluence and the Someș river downstream of the Lăpuș river confluence.

The maximum concentration of iron at the pollution source was 319 mg/l, it decreases to 185.2 mg/l on the Băița river upstream confluence with the Lăpuș river, and in the Lăpuș river upstream confluence with the Someș river it was 12.96 mg/ l and on the Someș river downstream confluence with the Lăpuș river was 19.26 mg/l. The maximum concentration of manganese at the pollution source was 43.3 mg/l, it decreases to 21.6 mg/l on the Băița river upstream confluence with the Lăpuș river, and in the Lăpuș river upstream confluence with the Someș river it was 2.38 mg/l and on the Someș river downstream confluence with the Lăpuș river it was 3.44 mg/l. The maximum concentration of zinc at the pollution source was 218.2 mg/l, it decreases to 58.8 mg/l on the Băița river upstream confluence with the Lăpuș river, and in the Lăpuș river upstream confluence with the Someș river it was 4.0 mg/l and on the Someș river downstream confluence with the Lăpuș river it was 8.32 mg/l. The maximum concentration of cadmium at the pollution source was 536.2 µg/l, it decreases to 239.8 µg/l on the Băița river upstream confluence with the Lăpuș river, and in the Lăpuș river upstream confluence with the Someș river it was 38.96 µg/l and on the Someș River downstream of the confluence with the Lăpuș River it was 34.26 µg/l. The maximum concentration of copper at the pollution source was 3906 µg/l, it decreases to 1318 µg/l on the Băița river upstream confluence with the Lăpuș river, and in the Lăpuș river upstream confluence with the Someș river it was 80.1 µg/l and on the Someș River downstream of the confluence with the Lăpuș River was 9.68 µg/l. The maximum concentration of nickel at the pollution source was 330.6 µg/l, it decreases to

119.65 µg/l on the Băița river upstream confluence with the Lăpuș river, and in the Lăpuș river upstream confluence with the Someș river it was 14.5 µg/l and on the Someș River downstream of the confluence with the Lăpuș River it was 32.4 µg/l.

The maximum concentration of lead at the pollution source was 33.45 µg/l, it drops to 20 µg/l on the Băița river upstream confluence with the Lăpuș river, and in the Lăpuș river upstream confluence with the Someș river it was below the limit of quantification.

In the Valea Vinului conservation mining area, Rodna commune, Bistrița-Năsăud county, three incidents of mine water pollution, originating from the Gheorghiu Gallery, were recorded. The first event was on August 10th, 2017, the second one, between 23-24th of April, 2018 and the third one on October, 18th, 2019, when the mining waters were discharged into the Băilor stream through the bypass of the Valea Vinului treatment plant (Figure 4). As in the similar cases presented before the mine waters were loaded with heavy metals. The 2017 pollution recorded the highest loading of cadmium (154.15 µg/l, compared to 0.51 µg/l or 1.44 µg/l), zinc (58.602 µg/l, compared to 39.51 µg/l) and copper (110 µg /l, against 17.33 µg /l).

Fig. 4. ***Pollution wave caused by mining drainage from Valea Vinului on Izvorul Băilor creek and Someșul Mare River (source: Dragotă, C. M., 2017)***

The nickel loading was close in 2017 and 2019, 42.68 µg/l and 46.68 µg/l, but in 2018 it was below the detection limit. In 2018, the waters had the highest loading of iron 128.58 mg/l and manganese 43.08 mg/l.

Immediately after entering the river, the concentration of the pollutant drops a lot by about 10 times, for example, lead drops from 18.23 µg/l to 2.73 µg/l; nickel decreases from 46.68 µg/l to 4.26 µg/l; total copper decreases from 17.33 µg/l to 1.6 µg/l; iron decreases from 21.79 mg/l to 2.31 mg/l and manganese decreases from 12.44 mg/l to 1.4 mg/l.

Water samples were also taken from the Băilor stream upstream of the confluence with the Someș river, as well as from the Someș river downstream of the Băilor stream and downstream of the confluence with the Maieru river.

In the Băița mining perimeter in the town of Nucet, Bihor County, two events took place, the first on September 15th, 2021 and the second one in September 30th, 2021. The wastewaters were loaded with high concentrations of heavy metals like: zinc (170 µg /l on September 15th, 2021 and by 30 µg/l on 30th of the same month, 2021) iron 0.07 mg/l and chromium 14.3 µg/l on September 15th 2021. Comparing the load with heavy metals compared to other perimeters, it is observed that the waters are slightly loaded with heavy metals.

On August 13th 2023, waters loaded with heavy metals were spilled at the Târnicioara settling pond, Ostra commune, Suceava county: iron (111.5 mg/l), copper (857 µg/l), lead (2065 µg/l), zinc (1595 µg/l) and manganese (0.777 mg/l).

On the Brătеasca River, 2 km downstream from the water discharge from the pond, the load with heavy metals was as follows: iron (0.33 mg/l), copper (122.4 µg/l), lead (16.12 µg/l), zinc (455.1 µg/l) and manganese (0.465 mg/l).

On the Suha river 2 km downstream from the confluence with Brătesca, the load with heavy metals was as follows: iron (0.088 mg/l), copper (49.68 µg/l), lead (7.416 µg/l), zinc (134 µg/l) and manganese (0.217 mg/l).

On September 16th, 2020, waters loaded with heavy metals were spilled at the Boița settling pond, Boița village, Răchitova commune, Hunedoara County: iron (28.8 mg/l), copper (29.8, µg/l), lead (39.7 µg/l), zinc (6.4 µg/l), chromium (17.68 µg/l), cadmium (1.81 µg/l) and manganese (0.94 mg/l). It did not have an impact on the Boița stream, the values obtained upstream and downstream of the pond having close values, for example: iron (0.64 mg/l upstream, 0.523 mg/l downstream), copper (17.4 µg/l upstream, 15 .9 µg/l downstream), lead (8.93 µg/l upstream, 8.23 µg/l downstream), zinc (0.036 µg/l upstream, 0.068 µg/l downstream), chromium (17.73 µg/l upstream, 60 µg/l downstream), cadmium (0.447 µg/l upstream, 0.635 µg/l downstream) and manganese (0.058 mg/l upstream, 0.523 mg/l downstream).

Pollution of the Bistrița river with mine waters from the Isipoaia Mine, Suceava county, which polluted the waters of the Bistrița River from May 13th 2023 at 19.30 until May 17th, at 08.45, on the Broșteni section downstream of Holda, up to 5 km border with Neamț county (Figure 5). This part of Siret river catchemnet is often affected by mining drainage from abandoned olt mine sites (Zait, 2021). From the whole studied period this was the longest running pollution of waters loaded with heavy metals (iron, manganese, zinc, copper and lead).

It is observed that the highest value was recorded immediately after the incident 700 m downstream from the pollution source, after which it continuously decreased.

The variation of manganese concentration in the Bistrița River varied between 0.146 mg/l before the pollution source, reaching values of 0.215 mg/l downstream of the pollution source, we can say that there was no manganese pollution.

The variation of copper concentration in the Bistrița River varied between 10.31 µg/l before the pollution source, reaching values of 159.8 µg/l downstream from the pollution source, at 700 meters and 52.09 µg/l at 1500 meters downstream of the pollution source on the first day.

Fig. 5. ***Pollution wave caused by mining drainage from Isipoaia site on Bistrița River (source: Dănăilă, I., 2023)***

The variation of zinc concentration in the Bistrița River suddenly increased above the detection limit, reaching the value of 247 mg/l at 700 meters downstream of the pollution source, decreases to 68 mg/l at 1500 meters, and then decreases below the detection limit. The variation of the lead concentration in the Bistrița River suddenly increased above the detection limit, reaching the value of 2.66 µg/l 700 meters downstream of the pollution source, decreasing to 1.579 µg/l at 5000 meters, then decreasing below the detection limit.

4. CONCLUSIONS

The old background of mining sector in Romania, based on metallic resources extraction and processing is still emphasized in nowadays by the connected pollution events that are triggered based on different causes. The particularities of each accidental pollution are linked to the duration and intensity of the phenomena. In most of our studied cases heavy metals ions are mentioned as the main pollutants that affects the water environment. In order to mitigate this kind of events institutions and companies must rely on each other to inform and act quickly to reduce the negative impact of such phenomena. For every situation the best available solution is to use the downstream reservoirs from the network by evacuating large volumes of fresh waters to be used for dilution purposes with wastewaters with mining origine.

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