

A study of the natural pollution of the Aries River

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Received: 12 August 2011; Accepted: 19 September 2011

Abstract

The Aries river is permanently affected by the toxic pollutants of natural origin from the acid mine drainage waters, which can be considered a historical or natural pollution because the gold extraction from the region has been made for more than 2000 years. The heavy metals toxicity is increased into the acid environment. Some wastewaters can contain reducing substances - sulphate or ferrous compounds - which quickly reached in the receiver consumes dissolved oxygen. This phenomenon is more pronounced when, in addition to reducing substances, wastewater contain putrescible organic matter substances. Reducing substances are found in large quantities in mine waters, which are completely devoid of oxygen at the beginning and therefore life. Bunk bed is covered usually with red-colored deposits formed from the ferric hydroxide. Discharged into a river with low flow they produce shortcomings both by decreasing oxygen and by depositing suspended solids. The paper aims is to study Aries river water contamination due to historic mining activities from the area, by determination of the evolution of heavy metals total concentrations of the ion forms, which are considered toxic pollutants of natural origin.

Keywords: Aries River, pollution, toxic pollutants of natural origin

1. Introduction

Heavy metals are metallic elements which have a high atomic weight and a density much greater (at least 5 times) than water. There are more than 20 heavy metals, but four are of particular concern to human health: lead (Pb), cadmium (Cd), mercury (Hg), and inorganic arsenic (As). These four heavy metals are four of the top six hazards present in toxic waste sites. They are highly toxic and can cause damaging effects even at very low concentrations. They tend to accumulate in the food chain and in the body and can be stored in soft (e.g., kidney) and hard tissues (e.g., bone). Being metals, they often exist in a positively-charged form and can bind on to negatively-charged organic molecules to form complexes [1-2]. Some wastewater can contain reducing substances - sulphate or ferrous compounds - which quickly reached in the receiver consumes dissolved oxygen.

This phenomenon is more pronounced when, in addition to reducing substances, wastewater contain organic substances. Reducing substances are found in large quantities in mine waters, which are completely devoid of oxygen at the beginning and therefore life. Bunk bed is usually covered, with formed ferric hydroxide red-colored deposits. Discharged into a small stream flow, they produce shortcomings, both by decreasing oxygen and by depositing suspended solids.

Research made between 2004 and 2008 on the Aries River have revealed that this type of pollution of natural origin didn't decrease a lot in its intensity, even if some of the mining activities were stopped.

2. Materials and methods

Laboratory methods used to highlight water quality, are commonly used in water quality laboratories. Samples were collected from the following stationary:

Arieseni, upstream confluence with the Cobles river, left tributary of Aries, Campeni, downstream confluence with the Sohodol river, right tributary of Aries, Baia de Aries, downstream confluence with Cioara river, right tributary of Aries, Moldovenesti, downstream confluence with the Remetea river, right tributary of Aries and Gura Ariesului, upstream of the confluence with Mures river.

The samples were collected from a depth of 1ft below the surface using Nansen type water sampler and kept in polythene containers (500 mL) with the addition of 2 mL concentrated HNO₃ at 2 mL in order to preserve the metals and also to avoid precipitation.

Water samples were collected from Aries River every year in August, between 2004 and 2008, and the samples were analyzed by atomic absorption spectrophotometry, using the following standards: SR ISO 8288 /2001 – for: Cu_{total}, Pb_{total}, Zn_{total}; SR EN ISO 5961 / 2002 – for: Cd_{total}; SR 8662-2/1997 AAS – for: Mn_{total}; SR 13315/1996 AAS – for: Fe_{total}.

3. Results and discussion

To show the evolution of the heavy metals concentrations from toxic pollutants of natural origin category, the plot used also maximum limits of their concentrations in surface waters, established by Order 161/2006 approving the Norms concerning the classification of surface water quality to establish ecological status of water bodies.

Evolution of priority hazardous substances concentration in Aries river. Regarding toxic pollutants of natural origin, total ionic forms, copper is present in the river Aries in large amounts because of the mineral deposits rich in copper in the area. The tests performed between 2004 and 2008 showed that its allowable concentration is exceeded only from Baia de Aries stationary (figure 1), due to the input from Abrud and Sesei rivers, very loaded with pollutants from acid mine drainage, especially from Rosia Montana area. In Arieseni and Campeni sites determined concentrations were below maximum admissible concentrations (0,02mg/l) [4,5]. It may be noted that in 2004 in Baia de Aries stationary was a maximum of 0.437 mg/l.

The lowest value was recorded in 2007 when all mining operations was ceased. The results obtained from tests conducted in research sites are shown in the table 1.

Table 1. Total copper concentration in Aries river

	2004	2005	2006	2007	2008
Arieșeni	0.017	0.014	0.007	0.006	0.01
Câmpeni	0.023	0.017	0.012	0.018	0.015
Baia de Arieș	0.437	0.396	0.272	0.189	0.237
Moldovenești	0.236	0.256	0.209	0.085	0.105
Gura Arieșului	0.173	0.239	0.187	0.084	0.091

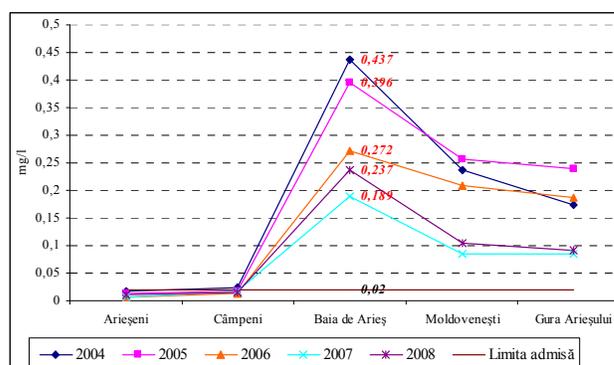


Figure. 1 - Evolution of total ion copper concentration in Aries river

Table 2 - Total cadmium concentration in Aries river

	2004	2005	2006	2007	2008
Arieșeni	0.2	0.2	0.2	0.3	0.3
Câmpeni	0.3	0.2	0.4	0.3	0.2
Baia de Arieș	2	1.3	1.2	1.1	1.2
Moldovenești	0.9	1.1	0.8	0.9	0.9
Gura Arieșului	0.8	0.9	0.7	0.8	0.7

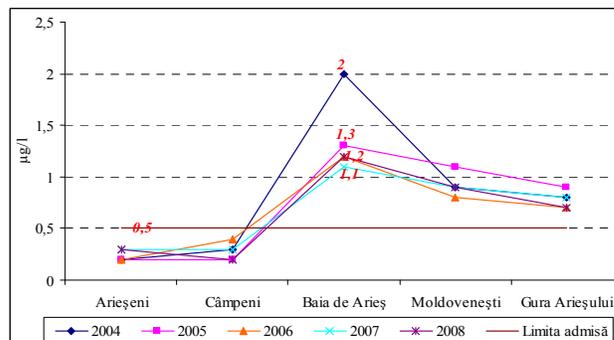


Figure. 2. Evolution of total cadmium concentration in Aries river

To protect the aquatic life, primarily fish, lead concentration into the surface water was limited to 0.005 mg/liter permitted for Class I water quality (order no. 161/2006) [3,5]. The tests performed between 2004 and 2008 showed that allowable lead concentration is exceeding only from Baia de Aries site due Abrud river intake, heavily loaded with pollutants from acid mine drainage that is flowing naturally, without being previously treated. In Arieseni and Campeni sites the determined concentrations were below the permissible limits. In Baia de Aries site, limits were exceeded throughout the research, while in Moldovenesti and Gura Ariesului researches sites, were exceeded only in 2004 and 2005. The results obtained from tests conducted into the researches sites are shown in the table 3.

Table 3. Total lead concentration in Aries river

	2004	2005	2006	2007	2008
Arieșeni	1	1	0	1	0
Câmpeni	2	3	1	3	3
Baia de Arieș	14	10	9	7	8
Moldovenești	8	7	3	2	2
Gura Arieșului	5	6	2	3	3

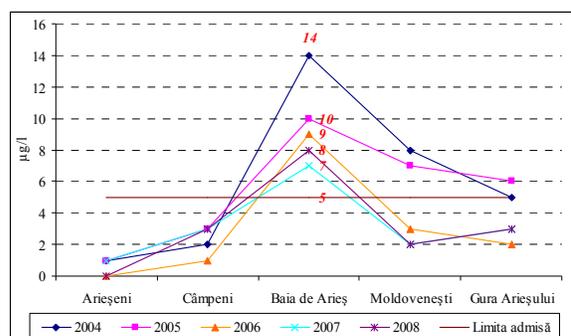


Figure. 3 Evolution of total lead concentration in Aries river

The tests performed between 2004 and 2008 showed that allowable concentration of cadmium is exceeded only from Baia de Aries stationary, due to the input from Abrud river, very loaded with pollutants from acid mine drainage, which is naturally flowing there in without being previously treated. Determined concentrations exceed the maximum admissible concentrations (0,5 µg/l) throughout the Aries River to the confluence with the Mures river[5].

The highest values of total cadmium were recorded in Baia de Aries site, where, in 2004, there was a value of 2 µg/l. In Arieseni and Campeni sites determined concentrations were below the maximum admissible concentrations. The results obtained from tests conducted in research sites are shown in the following table.

The Zinc toxicity for the aquatic animals is influenced by environmental factors, including pH, temperature, hardness and dissolved oxygen. The increasing temperature and the dissolved oxygen concentration reducing, favored the increasing of zinc toxicity. The tests performed between 2004 and 2008 showed that the allowable zinc concentration (0.1 mg/l) is exceeding only from Baia de Aries site due Abrud and Valea Sesei river intake, heavily loaded with pollutants from the acid mine drainage that is naturally flowing, without being previously treated [5]. In Arieseni and Campeni sites the determined concentrations were below the permissible limits. In Baia de Aries site, the limits were exceeded throughout the research, with a maximum value of 0.302 mg/l recorded in 2004, while in Moldovenesti and Gura Ariesului researches sites, determined concentrations were below the maximum admissible concentrations only in 2007. The results obtained from tests conducted in the researchs sites are shown in the table 4.

Table 4. Total zinc concentration in Aries river

	2004	2005	2006	2007	2008
Arieșeni	0.084	0.071	0.035	0.03	0.042
Câmpeni	0.088	0.068	0.047	0.026	0.031
Baia de Arieș	0.302	0.289	0.232	0.131	0.142
Moldovenești	0.271	0.209	0.136	0.086	0.114
Gura Arieșului	0.194	0.204	0.103	0.092	0.102

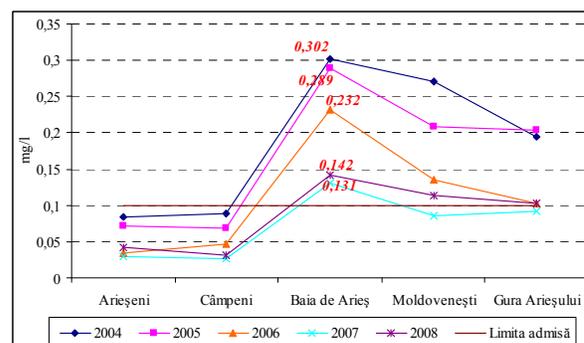


Figure. 4. Evolution of total cadmium concentration in Aries river

Into the surface waters, manganese concentrations rarely exceed 1 mg/l. The tests performed between 2004 and 2008 showed that the allowable manganese concentration (0.05mg/l) is exceeding in all the researches sites, excluding Arieșeni research site, where the concentrations determined were below the maximum admissible concentrations[5]. The manganese concentration into the Aries River increases to a maximum of 0.620 mg/l, recorded in 2004 in Baia de Aries site. In fact, throughout the research, the maximum value was recorded in each year in Baia de Aries site, due Abrud and Valea Sesei river intake, heavily loaded with pollutants from the acid mine drainage that is flowing naturally, without being previously treated. The results obtained from the tests conducted in the researches sites are shown in the following table.

Table 5. Total manganese concentration in Aries river

	2004	2005	2006	2007	2008
Arieșeni	0.049	0.042	0.038	0.029	0.037
Câmpeni	0.133	0.107	0.132	0.070	0.064
Baia de Arieș	0.620	0.508	0.431	0.387	0.562
Moldovenești	0.440	0.412	0.352	0.270	0.390
Gura Arieșului	0.468	0.421	0.341	0.287	0.412

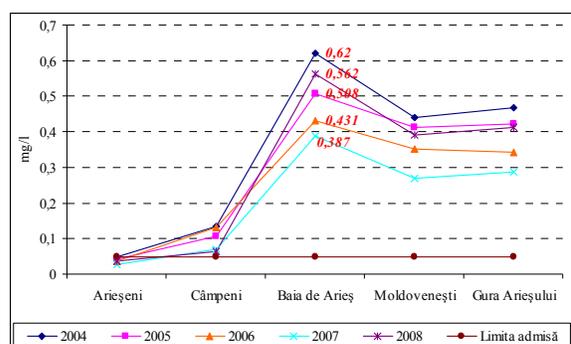


Figure 5. Evolution of total manganese concentration in Aries river

The iron is presented into the Aries River above the first class quality permissible limit, only from Baia de Aries site. The tests performed between 2004 and 2008 showed that the allowable iron concentration (0.3 mg/l) is exceeding in all researches sites, excluding Arieșeni and Campeni researches sites, where the determined concentrations were below the maximum admissible concentrations[5].

Total ionic iron concentration increases along the Aries River to a maximum of 1.48 mg/l, recorded in 2004 in Baia de Aries site. In fact, throughout the research, the maximum value was recorded each year in Baia de Aries site, due to Abrud river intake, heavily loaded with pollutants from acid mine drainage and dumps that is flowing naturally, without being previously treated. The results obtained from the tests conducted into the researches sites are shown in the table.

Table 6. Total iron concentration in Aries river

	2004	2005	2006	2007	2008
Arieșeni	0.21	0.18	0.12	0.14	0.11
Câmpeni	0.24	0.21	0.18	0.17	0.21
Baia de Arieș	1.48	1.15	0.61	0.96	1.24
Moldovenești	0.88	0.51	0.34	0.72	0.68
Gura Arieșului	0.65	0.36	0.32	0.67	0.48

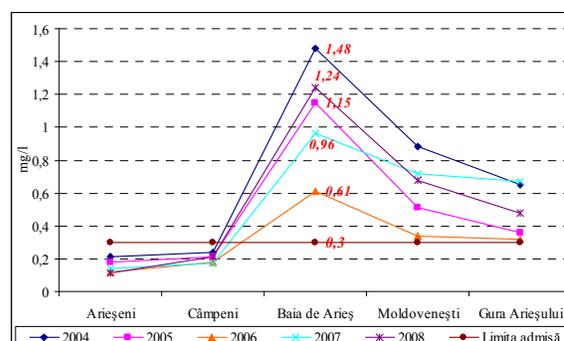


Figure 6. Evolution of total iron concentration in Aries river

4. Conclusions

The results obtained from analysis of indicators from toxic pollutants category, show that natural pollution of Aries River, from acid mine drainage, remained roughly constant during the research, even if they have closed a large part of mining. Their impact on river water quality is felt strongly throughout Aries river length from Baia de Aries site to the confluence with the Mures river confluence, and the phenomenon of pollution intensity varies with Aries river flow.

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