Distribution of heavy metals in small streams of the south-west of the Altai territory (Russia) under the influence of anthropogenic impact

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Abstract. Based on the environmental monitoring materials of Joint-stock company "Sibir-Polimetally", as well as Altai State Technical University scientific research, an analysis was made of the ecological state of the surface waters of small streams in the south-west of the Altai territory: the Nikitikha, Krutishka and Korbolikha rivers. The main pollutants in these water bodies are identified. The research results are relevant for the Altai territory, where small watercourses in the area where industrial enterprises are located can be a source of pollution of large waterways, which are of great economic importance for the Siberian region.

1 Introduction

The Nikitikha, Krutishka and Korbolikha rivers flow in the south-west of the Altai Territory (Russia). Krutishka flows into the Korbolikha river, the latter together with the Nikitikha river, are the tributaries of the Alei River, which, in turn, flows into the Ob River (Fig. 1).

The main source of possible pollution of the Nikitikha river is Rubtsovsk Metall Processing Plant based in the Rubtsovsk district of Altai Krai. The Korbolikhinsky polymetallic mine, located in the Zmeinogorsky district of Altai Krai, is a potential source of heavy metal pollution in the waters of the Krutishka and Korbolikha rivers. The studied pollutants were selected taking into account the specific character of these enterprises.

The purpose of the study is the analysis and synthesis of environmental observations data on the Nikitikha, Korbolikha and Krutishka rivers.

2 Materials and research methods

The data of surface water environmental monitoring carried out by Joint-stock company (JSC) "Sibir-Polimetally" in the location area of the enterprise's production facilities from 2011 to 2017 are used in the work [1, 2]. Besides, the analysis of the ecological state of natural waters is based on the research data performed by the authors in 2015, 2016 and 2018.

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The objects of research are small streams in the south-west of the Altai Territory (the Nikitikha, Krutishka and Korbolikha rivers) have been undergone to anthropogenic impact from industrial facilities, they flow into the main waterways of the studied region.

Laboratory studies were carried out in accordance with certified methods [3, 4]. Sampling was made in accordance with the requirements of GOST 31861-2012 [5]. Surface water quality assessment was carried out taking into account the requirements of hygienic standards [6].

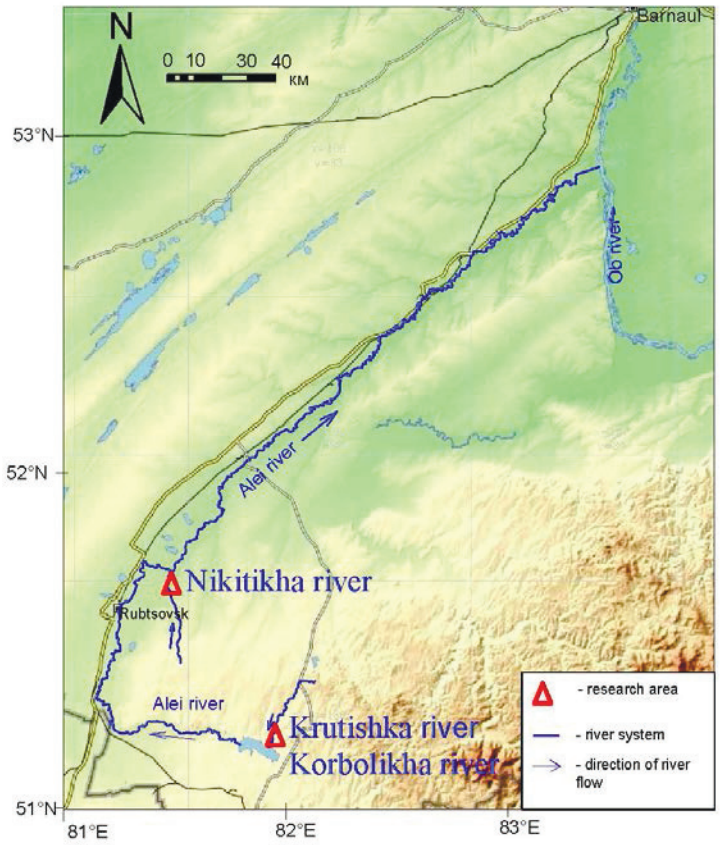

Fig. 1. The layout of the objects of study.

3 Results and Conclusions

In order to determine the degree of negative impact on natural waters, JSC "Sibir-Polimetally" conducts systematic monitoring of the ecological state of the Nikitikha, Krutishka, Korbolikha rivers surface waters in the area where its production facilities are located.

The generalized results of the Nikitikha river environmental monitoring in the area of Rubtsovsk Metal Processing Plant for the period from 2011 to 2017 and the data of scientific research conducted in 2018 are presented in Table 1and Fig. 2.

Dynamics of changes of studied heavy metals content of the Nikitikha river surface waters is shown in Fig. 2.

Table 1. The results of the Nikitikha River environmental monitoring and scientific research in the area of Rubtsovsk Metal Processing Plant.

Indicator, mg/dm^3	Before discharge point						After discharge point						MPC[2)]
	2011	2012	2013	2014	2017	2018	2011	2012	2013	2014	2017	2018	
Iron	0,51	0,13	1,5	0,14	0,11	0,06	0,31	0,14	0,56	1,3	0,10	0,05	0,3[1)]
Copper	0,014	0,014	0,021	0,021	0,008	0,026	0,014	0,014	0,018	0,051	0,018	0,031	1[1)]
Lead	0,02	0,022	0,029	0,050	0,015	0,017	0,02	0,019	0,029	0,086	0,036	0,016	0,03[1)]
Zink	0,012	0,06	0,04	0,19	0,024	0,098	0,012	0,06	0,04	0,27	0,70	0,105	5[1)]

[1] GN 2.1.5.1315-03 [6]. [2] MPC – maximum permissible concentration.

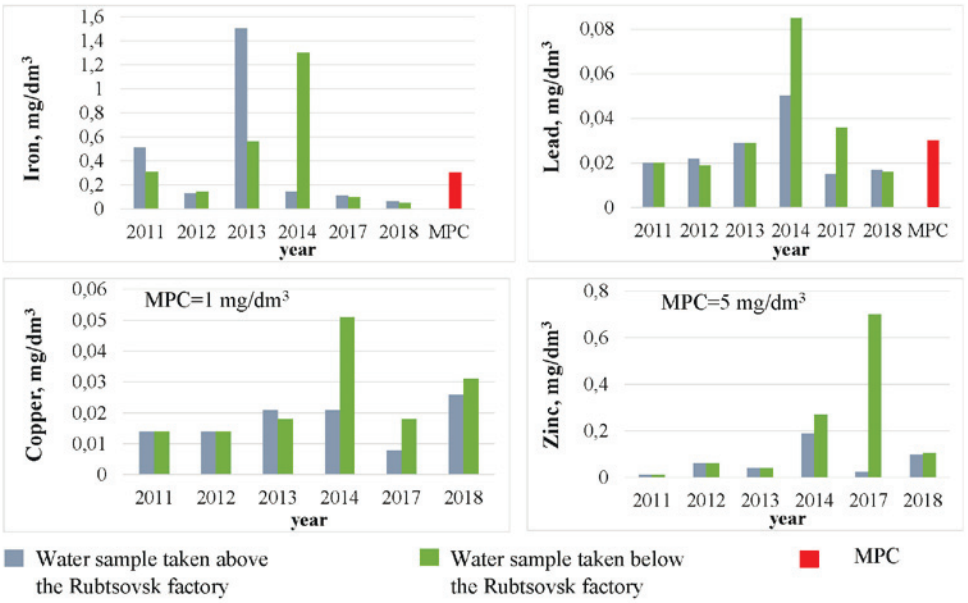

Fig. 2. Heavy metals content in the water of the Nikitikha River from 2011 to 2018.

As a result of the analysis of the data obtained it was determined that elevated concentrations of iron and lead in the water of the Nikitikha river below the discharge point from the factory were recorded in 2014. A slight increase in concentration of copper and zinc in water was also observed for this year, but their level did not exceed the standard values. In general, we can conclude that in the research area the influence of the anthropogenic object on the surface water body takes place, but not higher than the permissible norms. A correlation between the concentrations of heavy metals before and after discharge point of the processing plant industrial site was not found.

The Krutishka and Korbolikha rivers observing in the area of the Korbalikhinsky mine were carried out in 2015-2016. Their generalized results are shown in Tables 2 and 3.

Heavy metals come from the Korbalikhinsky mine and enter the Krutishka River, while increased concentrations were recorded in 2016 for iron only. However, in this case it is not correct to speak about the unambiguous impact of the mine, since the detected excess of

iron content was observed in the area up to the point of discharge from the mine. An excess of the normative level of other metals in the water of the Krutishka River was not recorded.

Table 2. The Krutishka River environmental monitoring results in the area of the Korbalikhinsky mine.

Indicator, mg/dm^3	Before discharge point		After discharge point		MPC[2)]
	2015	2016	2015	2016	
Iron	0,080	0,31	0,107	0,32	0,3[1)]
Copper	0,002	0,001	0,003	0,001	1[1)]
Lead	0,002	0,001	0,005	0,002	0,03[1)]
Zink	0,008	0,005	0,009	0,007	5[1)]

[1] GN 2.1.5.1315-03 [6]. [2] MPC – maximum permissible concentration.

The Korbolikha River study results are shown in Table 3. They relate to the confluence of the Krutishka River below the mine location. Summarized data for both watercourses are presented in Fig. 3.

Table 3. The Korbolikha River study results in the area of the Korbalikhinsky mine.

Indicator, mg/dm^3	After the confluence of the Krutishka River		MPC[2)]
	2015	2016	
Iron	0,3	0,179	0,3[1)]
Copper	0,007	0,003	1[1)]
Lead	0,008	0,003	0,03[1)]
Zink	0,004	0,006	5[1)]

[1] GN 2.1.5.1315-03 [6]. [2] MPC – maximum permissible concentration.

The data obtained suggest that the mine impact on the Krutishku River is not significant. No correlation between the heavy metals concentrations in the Krutishka River and the Korbolikha River was found.

The generalized data for two-industrial facilities discharges allow us to conclude that iron is the main pollutant of the natural waters area under the study. Also, attention should be paid to zinc, the content of which in water is commensurate with the standard level. Anthropogenic impact is recorded, but it is not the only source of natural waters pollution. For retrospective assessment of small watercourses heavy metal pollution and the possibility of their further migration into the main waterways of the region, it is necessary to carry out comprehensive studies of water samples and bottom sediments throughout the river flow from the source of pollution to the confluence of the inflow into the Ob River.

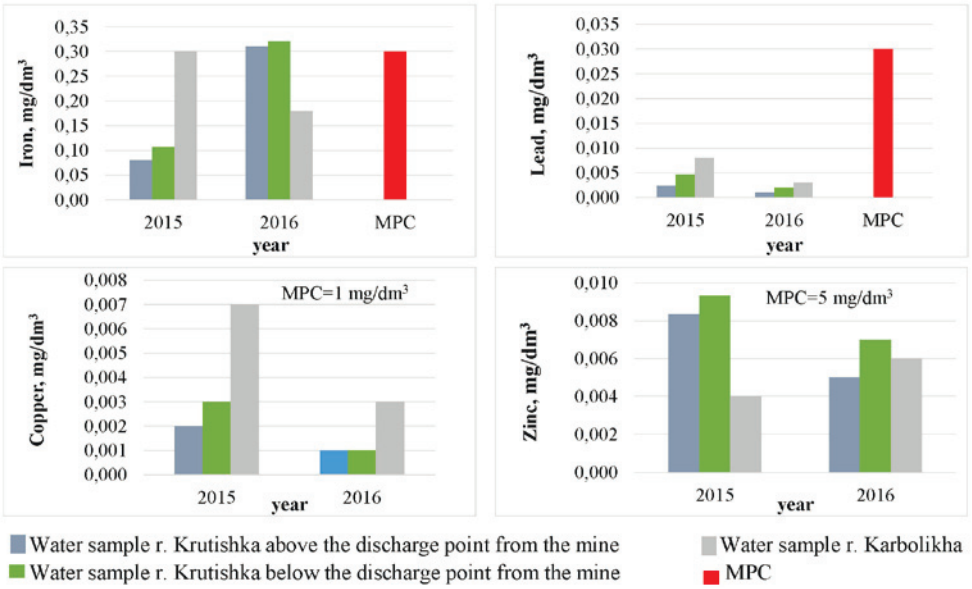

Fig. 3. Heavy metals content in the Krutishka and Korbolikha rivers in the period from 2015 to 2016.

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