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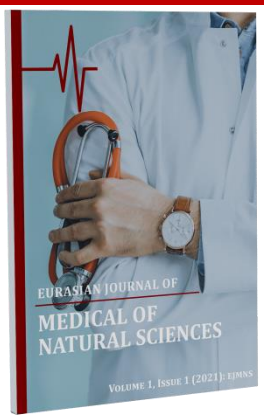

BOTTOM SEDIMENTSAS A SECONDARY SOURCE OF POLLUTION IN RIVERSAND AKHANGARAN

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ABSTRACT

In recent years, environmentalists have been increasingly focused on issues related to the impact of bottom sediments formed during long-term discharge of industrial wastewater on water quality in water bodies. Bottom sediments can accumulate significant amounts of trace elements of natural and anthropogenic origin, actively shaping the water quality of water bodies. The tendency of accumulation of copper, iron, zinc, cadmium, cobalt, mercury and other trace elements in the bottom sediments of rivers in the area of emissions from copper-nickel and copper smelters has been is established.

Relevance. Studies have established that due to the increased content of biogenic elements in bottom sediments, the enzymatic activity of microorganisms increases, which leads to an order of magnitude increase in the mobility of reduced forms of metals with variable valence, such as iron, manganese, copper, molybdenum, cobalt, and lead, and their transfer from bottom sediments to water [6]. A number of authors have noted that metal compounds are found in high concentrations in the bottom sediments of coastal areas of rivers and lakes [1,3,4]. Under the conditions of changes in the hydrological regimes of water bodies and temperature in different periods of the year, a different degree of contamination of bottom water with heavy metals was revealed [2]. A close correlation was established between the content of organic compounds and metals in bottom sediments and in the water of irrigation channels and rivers [7,8]. The authors have shown that bottom sediments contain a significant amount of pollutants that take an active part in the formation of water quality in reservoirs and have an adverse effect on the course of water self-purification processes [5].

The aim of the research was to establish the role of bottom sediments as secondary sources of pollution of the Akhangaran River and their influence on the formation of river water quality.

Research methodology.

The research included sampling of bottom sediments and water from the Akhangaran River in the area above (background) and below (control target) of the waste water discharge of the Almalyk Mining and Metallurgical Combine (AGMK) under the conditions of expedition trips during the spring and summer hydrological seasons of the year. Bottom sediments were

collected at depths of 0-5, 10-15, and 20-30cm from the coastal sections of the water body. The composition of bottom sediments and chemical analysis of water samples taken from the Akhangaran River were carried out using standard methods in accordance with GOST 950: 2011 " Sources of centralized domestic drinking water supply. Hygiene, technical requirements and selection rules".

The paper uses statistical methods to assess the reliability of the compared values, correlation and regression analysis of the dynamics of the main indicators of river water quality. The correlation between the composition of discharged industrial wastewater and the indicators of water pollution in the Akhangaran River is calculated.

Results and their discussion.

Bottom sediments are grayish-brown mud formations of complex composition, mainly contained in the coastal sections of rivers along the course of water flow.

During the long – term period of discharge of wastewater into water sources, the phenomenon of dynamic equilibrium in the system "bottom sediments-water of reservoirs" has emerged, and the processes of migration of elements into water have stabilized. However, this balance is disturbed as a result of changes in the hydrological conditions of rivers in the conditions of irrevocable water withdrawal for irrigation of agricultural crops, especially from small rivers. When chemical elements enter water bodies, they are involved in complex processes of physico-chemical and biological migration, which significantly complicate their topography and distribution in water and bottom sediments. The intensity of this effect depends on the hydrological and hydrochemical conditions of rivers, the physicochemical properties of elements, their mobility, the amount and migration paths in the aquatic environment.

Our research shows that the processes of bottom sediment formation are largely determined by the amount of pollution in wastewater, water temperature, and seasonality. In our opinion, an increase in the migration ability of trace elements from bottom sediments to water in the summer period may be associated with an increase in the activity of microorganisms, the development of anaerobiosis conditions, and an increase in recovery processes occurring in the "bottom sediments - water of reservoirs" system.

It is revealed that in the bottom sediments, in the alignment below the discharge of AGMK effluents, trace elements accumulate in significant quantities and are distributed unevenly throughout its thickness. The mineral composition of bottom sediments is characterized by the presence of various forms of nitrogen, the most common type of which is nitrates. Copper, zinc, and lead are mostly found in the upper layers. Iron and manganese are found in deep layers of bottom sediments (Table 1).

Table 1-Total content of trace elements in the bottom sediments of the Akhangaran River (mg/g).

Bottom sediments	Iron		Copper		Manganese		Zinc		Lead		Nitrates	
	sred	macS.	sred.	macS.	sred.	macS	sre. mack sre d.	mac k sS.	sred.	macS	sred.	macS

0-50-5 cm	23,0	30,0	7,5	10,0	4,5	6,0	0,12	0,20	0,09	0,20	20,2	37,5
10-15see	30,2	32,6	6,2	9,0	5,0	5,6	0,10	0,20	0,03	0,04	18.5	32.5
20-30cm	32,1	39,0	5,5	8,2	5,3	6,2	0,08	0,20	0,01	0,02	14,5	16,1

It is established that the priority content of iron and copper in bottom sediments and in smaller amounts – zinc, manganese and lead.

Under the spring hydrological regime, concentrations of trace elements, with the exception of lead, exceed the maximum permissible concentrations (MPC) established for them in the water of the control section of the Akhangaran River. At the same time, water quality meets environmental requirements in terms of nitrate content (Table 2).

Table 2-Influence of bottom sediments of the AGMC on the water quality of the Akhangaran River

Seasons 2017	Target	Costs, m^3/s	t ^{0}With	Indicators, mg/dm^3 (average 3 series definitions)					
				zinc*	lead	copper	iron	manganese	nitrate
1	2	3	4	5	6	7	8	9	10
Springs NY Pavo Doc	Fono St	41,2	12,5	0,0001	n/o	n/o	n/o	n/o	0,041
		41,6	12,8	0,0001	n/a	0,22	n/a	n/a about	0,041
		42,3	13,7	0,001	n/a	of 0.27	n/a	n/a about	0,042
Springs NY Pavo Doc	control tion	43,4	12,1	1,008	0,0013	1,31	0,05	0,14	0,44
		43,2	12,2	1,200	0,0011	1,33	0,06	0,13	0,42
		44.1 kHz	13,4	1,100	0,0014	1,25	0,06	0,14	0,63
Summer low-water period	Fono St	3,50	22,5	0,0054	n/o	n/o	n/about	n/a	0,037
		5,10	23,3	0,0070	n/o	n/o	n/o	n/o	0,046
		5,10	20,1	of 0.0036	n/o	n/o	n/o	n/o	0,053
SummerI low water	Kont role tion	of 3.40	21,9	of 4.018	0,015	5,44	of 1.79	0,29	0,81
		3,20	22,5	4,025	0,014	5,52	1,78	0,34	0,84
		4,10	22,9	4,600	0,013	5,47	of 1.70	0,33	0,85

** MPC: for zinc-1.0,0 mg/dm^{dm3}, lead-0.01 mg/dm^{dm3}, copperu-1.0,0 mg/dm^{dm3}, irona-0.3 mg/dm^{dm3}, manganesea-0.1 mg/$dm3^3$*

During the summer low-water period, concentrations of trace elements in the river water in the Akhangaran River control area significantly increase, which negatively affect the self-purification of the reservoir and its ecological state. Thus, the concentrations of iron in 5,6-5,9; copper in 5,4-5,5; manganese in 2,9-3,4; zinc in 4,0-4,6 and lead in 1,3-1,5 times exceed the maximum permissible concentration in the water of surface reservoirs.

Consequently, metal salts accumulated in bottom sediments are an additional source of secondary pollution of small rivers, whose role increases in the summer hydrological season.

The established differences in the levels of microelement contamination of bottom sediments and the reservoir indicate the complexity of internal relations between them. To identify these relationships and the importance of priority indicators in the formation of water quality in water bodies, we conducted a correlation and regression analysis of the results obtained. The results of calculations showed that element there is a direct (r>0.5) correlation

between the content of elements in the bottom sediments and their concentration in the water of the Akhangaran Riverr. Iron, copper, zinc, manganese and lead contained in bottom sediment shave a strong correlation with their concentrations in the water of the Akhangaran River. The revealed quantitative relationships correspond to linear regression equations of the form Y=A+BX.

Conclusions. Thus, the performed studies have shown that bottom sediments contain specific chemical pollution ingredients that are characteristic of the composition and quality of wastewater from non-ferrous metallurgy facilities that discharge wastewater into water bodies. The research results indicate that bottom sediments significantly affect the formation of water quality in watercourses due to the migration of toxic elements into the water, thus confirming the data from literature sources. In the bottom water, trace elements are contained in quantities exceeding the maximum permissible concentrations set for them, and their concentrations increase during the summer hydrological period of the year. The results obtained can be used by the territorial bodies of the State Committee for Ecology and Sanitary and Epidemiological Service to improve monitoring of the ecological state of small rivers, taking into account possible secondary pollution from bottom sediments.

The content of elements in bottom sediments varies widely, on average from 0.01 (surface layers) to 32.1 mg/g (deep layers). It is characteristic that iron and copper in the bottom sediments are present in higher concentrations than other elements. The total content of toxic metals in bottom sediments significantly exceeds their concentrations in the water of a water body. It is established that bottom sediments are additional sources of pollution in the Akhangaran River, since concentrations of toxic metals in river water exceed their standard values, especially in the summer season. There is a direct strong correlation between the content of elements in bottom sediments and their concentration in the water of the Akhangaran River ($r>0.5$).

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