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Influence of Bottom Sediments on the Quality of Water of Effluents

MakhmudovaDildora Ernazarovna, Usmanov Islam Abbasovich, TulbayevBakhtiyor Bozorovich

Candidate of Technical Sciences, Assistant professorof the Department "Design, construction and operation of engineering communications"
Doctor of Medical Sciences, Professorof the Research institute of irrigation and water problems
Assistantof the Department "Design, construction and operation of engineering communications", Tashkent Institute of Architecture and Civil Engineering, Uzbekistan

ABSTRACT: The purpose 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. In this work the statistical methods for assessing the reliability of the compared values, a correlation and regression analysis of the dynamics of the main indicators of river water quality was used. The calculation of the correlation dependence of the composition of discharged industrial wastewater with indicators of water pollution of the Ahangaran River was held. The results can be used by the territorial bodies of the State Committee for Ecology and the Sanitary and Epidemiological Service to improve monitoring of the ecological state of small rivers, taking into account their possible secondary pollution from bottom sediments.

KEY WORDS : water quality, pollution,bottom sediments, wastewater, small rivers,metal compounds.

I. INTRODUCTION

In recent years, more and more attention of ecologists has been attracted by issues related to the influence of bottom sediments on the water quality of reservoirs formed during the long-term discharge of industrial effluents [9]. Bottom sediments can accumulate significant amounts of trace elements of natural and anthropogenic origin, taking an active part in the formation of water quality of reservoirs. The tendency to accumulate the copper, iron, zinc, cadmium, cobalt, mercury and other trace elements of bottom sediments of effluents in the zone of emissions of copper-nickel and copper-smelting plants was established [10].

A number of authors noted that metal compounds are found in high concentrations of bottom sediments on coastal places of rivers and lakes [1,3,4]. Under the conditions of changes in the hydrological regimes of reservoirs and temperature in different periods of the year, an unequal degree of water pollution by heavy metals was revealed [2].

Researches was established that due to the increased content of biogenic elements in the bottom sediments, the enzymatic activity of microorganisms increases, which leads to an increase in the mobility of the reduced forms of metals with several valencies, such as iron, manganese, copper, molybdenum, cobalt, lead and their translocation from bottom sediments in water [6].

A close correlation between the content of organic compounds, metals in bottom sediments and in the water of irrigation canals and rivers has been established [7,8]. The authors showed that bottom sediments contain a significant amount of contaminants that take an active part in the processes of formation of water quality in reservoirs and have an adverse effect on the course of water self-purification processes [5].The purpose 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.

II. RESEARCH METHODOLOGY

The research involves the sampling bottom sediments and water from the river Akhangaran in the area above (background) and below (control target) of wastewater discharge from the Almalyk Mining and Metallurgical Combine (AMMC) during expedition trips during the spring and summer hydrological periods of the year. Bottom sediments were taken at a depth of 0-5, 10-15 and 20-30 cm from the coastal sections of the water body. The composition of bottom sediments and the analysis of water samples from the Akhangaran River according to chemical indicators was carried out by standard methods in accordance with GOST 950: 2011 "Sources of centralized drinking water supply. Hygienic, technical requirements and selection rules. "

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III.RESULTS AND DISCUSSION.

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

Over a many-year period of wastewater discharge into water sources, the phenomenon of dynamic equilibrium arose in the system of "bottom sediments - water of reservoirs", and the processes of migration of elements to water stabilized. However, this equilibrium is disturbed as a result of changes in the hydrological regime of rivers in the conditions of irrevocable water withdrawal for irrigation of crops, especially from small rivers. Once in the water, chemical elements are included in the complex processes of physico-chemical and biological migration, which greatly complicate their topography and distribution in water and bottom sediments. The intensity of this effect depends on the hydrological and hydrochemical conditions of the rivers, the physicochemical properties of the elements, their mobility, quantity and migration routes in the aquatic environment.

Our studies show that the processes of bottom sediment formation are largely determined by the amount of pollution in wastewater, water temperature and seasonality. An increase in the migratory ability of trace elements from bottom sediments to water during the summer period, in our opinion, can be associated with an increase in the activity of microorganisms, the development of anaerobiosis conditions and the intensification of recovery processes occurring in the system of "bottom sediments - water of resevoirs".

It has been revealed that in bottom sediments, in the section below the discharge of AMMC effluents, trace elements accumulate in significant quantities and are distributed unevenly over its thickness. The mineral composition of bottom sediments is characterized by the presence of various forms of nitrogen, the most common form of which is nitrates. Copper, zinc and lead are found to a greater extent in the upper layers and the iron and manganese - in the deep layers of bottom sediments (table 1).

Table 1

Gross content of trace elements and nitrogen compounds in bottom sediments from the Akhangaran River (mg / g).

Bottomse diments	**Iron**		**Copper**		**Manganese**		**Zinc**		**Zinc**		**Nitrates**	
	avera ge	max	avera ge	max	aver age	max	aver age	max	aver age	max	aver age	max
0-5 см	23,0	30,0	7,5	10,0	4,5	6,0	0,12	0,20	0,09	0,20	20,2	37,5
10-15 см	30,2	32,6	6,2	9,0	5,0	5,6	0,10	0,20	0,03	0,04	18,5	32,5
20-30 см	32,1	39,0	5,5	8,2	5,3	6,2	0,08	0,20	0,01	0,02	14,5	16,1

The priority content of iron and copper in bottom sediments and in smaller amounts of zinc, manganese and lead was established.

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

Table 2

Theinfluence of bottom sediments of AMMC on water quality of Ahangaran River

Periods of 2018	Range	Costs, m^3/s	$t\ ^0C$	Indicators, mg/dm^3 (average data of 3 series of definitions)					
				Zinc*	lead	copper	iron	manganese	nitrates
1	2	3	4	5	6	7	8	9	10
Springflo od	Backgro und	41,2	12,5	0,0001	н/о	н/о	н/о	н/о	0,041
		41,6	12,8	0,0001	н/о	0,22	н/о	н/о	0,041
		42,3	13,7	0,001	н/о	0,27	н/о	н/о	0,042
Springflo	Control	43,4	12,1	1,008	0,0013	1,31	0,05	0,14	0,44

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od		43,2	12,2	1,200	),0011	1,33	0,06	0,13	0,42
		44,1	13,4	1,100	),0014	1,25	0,06	0,14	0,63
Summerl owwater	Backgro und	3,50	22,5	0,0054	н/о	н/о	н/о	н/о	0,037
		5,10	23,3	0,0070	н/о	н/о	н/о	н/о	0,046
		5,10	20,1	0,0036	н/о	н/о	н/о	н/о	0,053
Summerl owwater	Control	3,40	21,9	4,018	0,015	5,44	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	1,70	0,33	0,85

** MPC: for zinc - 1.0 mg / dm3, lead - 0.01 mg / dm3, copper - 1.0 mg / dm3, iron - 0.3 mg / dm3, manganese - 0.1 mg / dm3*

In the conditions of a summer low water in the control section of the Akhangaran River, the concentration of trace elements in river water increases significantly, adversely affecting the self-purification of the reservoir and its ecological state. So, the concentration of iron in 5.6-5.9; copper in 5.4-5.5; manganese in 2.9-3.4; zinc 4.0-4.6 and lead 1.3-1.5 times higher than the MPC in the water of surface reservoirs.

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

The established differences in the levels of microelement pollution 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 of reservoirs, we conducted a correlation-regression analysis of the results. The calculation results showed that between the content of elements in bottom sediments and their concentration in water Ahangaran River there is a direct (r> 0.5) correlation (table 3).

Table 3

Correlation and regression relationship of the content of trace elements in bottom sediments with their concentrations in the water of the Akhangaran River.

Indicators, mg/dm^3	Correlationcoefficient(r)	Regression equation У=A+BX*
1	2	3
ZInc	0,89	5,723+0,7369X
1	2	3
Lead	0,73	0,025+0,1627X
Copper	0,95	0,025+0,3548X
Iron	0,99	3,126+0,2295X
Mangenese	0,82	0,248+0,1070X
Nitrates	-0,09	-

**Y-dependent variable (concentration of contaminants in bottom sediments);*

A-free term of the equation;

B-regression coefficient;

X-independent variable (concentration of pollution in river).

Iron, copper, zinc, manganese and lead contained in bottom sediments have a strong correlation with their concentrations in the water of the Akhangaran River. The identified quantitative relationships correspond to linear regression equations of the form Y = A + BX.

Thus, studies have shown that bottom sediments contain specific chemical contamination ingredients that are characteristic of the composition and quality of wastewater from non-ferrous metallurgy facilities that discharge effluents into reservoirs. The research results indicate that bottom sediments significantly affect the formation of water quality of watercourses in connection with the migration of toxic elements into water, thereby confirming data from literature sources. In the bottom water, trace elements are contained in amounts exceeding the MPC established on them, their concentrations increase during the summer hydrological period of the year.

The results can be used by the territorial bodies of the State Committee for Ecology and the Sanitary and Epidemiological Service to improve monitoring of the ecological state of small rivers, taking into account their possible secondary pollution from bottom sediments.

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IV. CONCLUSION

1. The content of elements in bottom sediments varies over a wide range from an average of 0.01 (surface layers) to 32.1 mg / g (deep layers). It is characteristic that iron and copper in bottom sediments are present in higher concentrations compared to other elements.
2. The gross content of toxic metals in bottom sediments significantly exceeds their concentration in the water of a water body.
3. It has been established that bottom sediments are additional sources of pollution of the Akhangaran River, because concentrations of toxic metals in river water exceed their normative values, especially in the summer season.
4. Between the content of elements in bottom sediments and their concentration in the water of the Akhangaran River, a direct strong correlation relationship was established (r> 0.5).

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