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Assessment Of Water Quality Of Small Rivers Of The Syrdarya Basins For The Safe Water Use

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ABSTRACT

Introduction. The aim of the research was to study the water quality of small rivers of the Syr Darya river basin – the Chirchik and Akhangaran rivers, which are the main sources of industrial and economic drinking water supply for the population of the Tashkent region of Uzbekistan. **Research methods** included laboratory and field studies with the selection of water from reservoirs in accordance with the intended work plan.Sampling of water from rivers was carried out in the established monitoring sites, and the assessment of the quality of river water was carried out for the 2018 seasons in accordance with GOST 951: 2011 " Sources of centralized drinking water supply. Hygiene, technical requirements and selection rules". **Results.** It was found that the concentrations of ammonia nitrogen, nitrite nitrogen, and nitrate nitrogen, as well as BOD and COD, exceed the normative values on the Chirchik river section after the discharge of industrial effluents from the MAXAM-Chirchik joint venture. Downstream in the Akhangaran river, after the discharge of waste water from the Almalyk mining and metallurgical plant, phenols are determined at the level of 0.003 mg/l in the winter period. Their concentrations in spring and summer increase to 0.004 mg / l, and in autumn they are 0.005 mg/l (MPC 0.001 mg/l). The same dynamics was found in the content of petroleum products in river water: in winter their concentrations are 0.36 mg / l, in spring 0.46 mg/l, in summer 0.53 mg/l and in autumn 0.56 mg/l (MPC 0.3 mg / l). In winter, copper is found in the water of the Akhangaran river at concentrations of 7.2 mg / l, rising to 8.9 mg/l in the spring, to 9.2 mg/l in the summer, with a maximum value in the autumn of 10.2 mg/l (MPC 1.0 mg / l). Similar dynamics are found

for zinc and cobalt. The maximum concentrations of iron and molybdenum in the section of the Akhangaran river below the effluent discharges of the Almalyk mining and metallurgical combine were found in summer and autumn – at the level of 1.3 mg / l (MPC 0.3 mg/l) and 0.71 mg/l (MPC 0.25 mg / l), respectively. Lead in the water of the Akhangaran river was found at 0.03 mg/l in winter and spring, and 0.04 mg/l in summer and autumn (MPC 0.01 mg/l).

1. Introduction

Water, as one of the main components of the natural environment, is critical to ensuring life on earth. The problem of water resources and water quality, their decisive role for the functioning of industry, economy and ecosystems have now acquired particular relevance in many countries [1,2,3]. Water is of particular value for Uzbekistan, located in the zone of insufficient natural moisture in the territories [4, 5, 13,15].

In recent years, studies have been carried out on the ecological state of the rivers in the lower reaches of the Amu Darya, such as Zeravshan, Kashkadarya, Surkhandarya, Sherabaddarya and others [6,7,8,12,14]. In the literature, there are few data on the study of the water quality of rivers in the middle reaches of the Syrdarya basin, which are sources of water supply for the population [9,10,11].

The purpose of the research was to study the state of water quality of water bodies ¬– the Chirchik and Akhangaran rivers, which are the main sources of industrial and drinking water supply for the population of the Tashkent region of Uzbekistan to develop measures to protect them from further pollution.

2. Materials And Research Methods

The universal properties of the Chirchik and Akhangaran rivers are substantiated as model objects for conducting comprehensive environmental studies of water quality and conditions of water use of the population, which have national economic, drinking, cultural, household and environmental significance.

Research methods included laboratory and expeditionary research with water withdrawal from reservoirs in accordance with the planned work plan. The conditions for the formation, treatment and disposal of waste waters of various origins into surface water bodies have been studied. The assessment of the conditions for the formation, treatment and discharge of industrial wastewater was carried out by generalization and statistical processing of the results of analyzes of wastewater samples. For priority industrial facilities, which are the main sources of pollution of the Chirchik and Akhangaran rivers (Maksam-Chirchik JV and Almalyk Mining and Metallurgical Combine), wastewater samples were previously taken and analyzed, which were necessary to characterize their composition and the efficiency of treatment facilities [10, 11].

To assess the water quality of the Chirchik and Akhangaran rivers, water samples were taken at various sections (sections) of river observations in the 2017 seasons. Water samples were analyzed by standard methods in

accordance with GOST 950: 2011 “Sources of centralized household drinking water supply. Hygienic, technical requirements and selection rules ”.

The paper uses quantitative and nonparametric statistical methods for assessing the reliability of the compared values, correlation and regression analysis of the dynamics of the main indicators of water quality in water bodies. The calculation of the correlation dependence of the composition of discharged industrial wastewater with indicators of organic and microelement pollution of water in water bodies has been carried out.

To study the dynamics of changes in the water quality of the Chirchik and Akhangaran rivers, we selected 6 observation points in the places of domestic drinking and cultural and domestic water use, taking into account the nature of the sources of water pollution in water bodies (Figures 1, 2).

Site 1 is located 0.3 km upstream of Gazalkent in the upper reaches of the Chirchik River, in the mountainous zone where the main river flow is formed.

Site 2 is located below 0.5 km of the city of Gazalkent, where the river receives wastewater from city treatment facilities in the amount of 9.36 thousand m3 / day.

Site 3 is installed 800 m above the wastewater discharges of JV "Maksam-Chirchik". On this section there are water intake facilities for the utility and drinking water supply system of the city of Chirchik.

Site 4 is located on the river section 1000 m below the industrial wastewater outlet of the Maksam-Chirchik JV.

Tashkent region

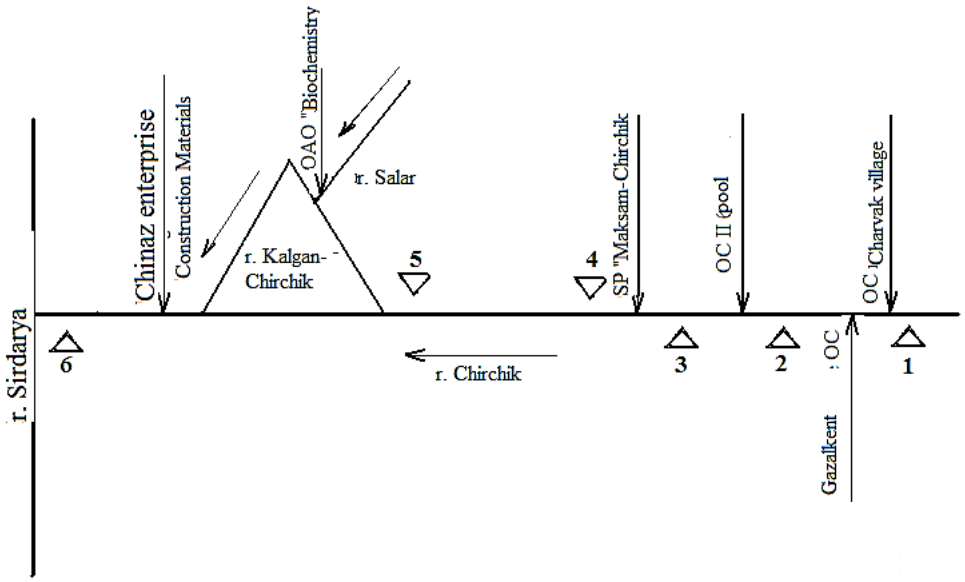

Fig. 1. Linear layout of sections for monitoring pollution of the river. Chirchik

Tashkent region

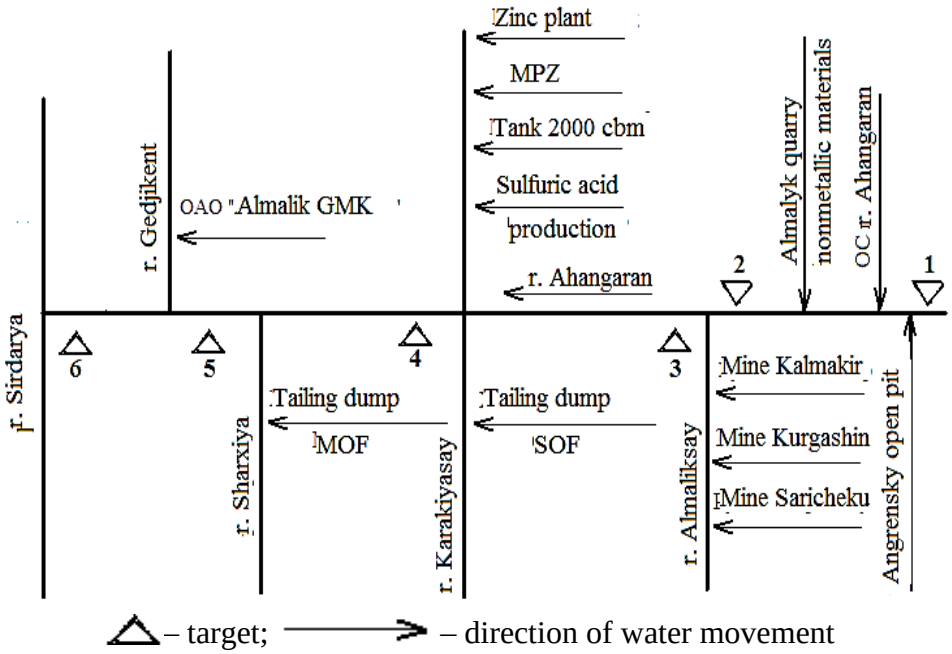

Fig. 2. Linear layout of sections for monitoring pollution of the river. Akhangaran

Section 5 is located downstream of the river before the discharge of sewage and industrial effluents of JSC Biochemistry. Selected to characterize the water quality of the Chirchik River in the middle reaches.

Section 6 was installed in the mouth of the river before its confluence with the Syrdarya river.

The next 6 observation points were installed on the Akhangaran river.

Site 1 was installed above 1000 m in Angren to characterize the quality of river water before discharges from industrial facilities.

Site 2 is located on the river section downstream of industrial wastewater discharges from the Angrensky coal mine, utility wastewater from the city of Akhangaran and the Almalyk quarry of nonmetallic materials.

Site 3 is located on the section of the Akhangaran River, which receives wastewater from the Kurgashin, Kalmakyr and Sary-Cheku mines.

Site 4 is installed on the Akhangaran River, which receives insufficiently treated wastewater from a copper smelter, sulfuric acid production, wastewater from the tailing dump of a lead concentration plant (SOF) and a 2000 m3 tank.

Site 5 was installed on the Akhangaran River and was selected to study the impact of wastewater from the tailing dump of a copper concentrating plant (MPP) on river water quality.

Gate 6 is installed on the section of the Akhangaran River, which receives wastewater from the Alma-lyk Mining and Metallurgical Combine.

3. Results And Discussion

It has been established that the main source of pollution of the Chirchik River is insufficiently treated wastewater of the JV "Maksam-Chirchik" (the former production association "Electrokhimprom"), an enterprise that produces mineral fertilizers for agricultural needs. It should be noted that water sampling from the Chirchik River and its analyzes were carried out at all six sections (Fig. 1). However, we presented the results of water quality analyzes only for three sections. This is due to the fact that section 3 was installed on the river section above the priority source of pollution of the reservoir, section 4 was chosen to characterize the quality of river water after the discharge of industrial wastewater, and section 6 is the end section of the Chirchik River, before it flows into the Syrdarya River (Table 1) .

Table 1: **Seasonal dynamics of indicators of organic pollution of the river. Chirchik (average data from 3 samples)**

Index	Season 2018 г.	PDK**	Side 3	Side 4	Side 6
$BOD_{full.}$, $mg0_2/l$	Winter	4,0	2,21±0,088	9,24±0,388	3,97±0,152
	Spring		2,33±0,093	9,36±0,374	3,99±0,154
	Summer		3,24±0,124	11,6±0,516	4,22±0,171
	Autumn		3,45±0,145	11,7±0,524	4,11±0,165
COD, mg 0_2/l	Winter	30,0	14,6±0,588	39,3±1,528	22,2±0,887
	Spring		16,7±0,588	39,2±1,481	24,4±0,896
	Summer		18,6±0,657	49,2±1,647	37,4±1,358
	Autumn		19,5±0,744	48,8±1,592	36,6±1,328
Ammonia (nitrogen), mg / l	Winter	1,5	0,42±0,017	6,44±0,270	1,22±0,052
	Spring		0,59±0,021	6,74±0,282	1,64±0,064
	Summer		0,87±0,039	8,42±0,320	1,97±0,082
	Autumn		0,86±0,036	8,97±0,340	1,89±0,079
Nitrite (nitrogen), mg / l	Winter	3,0	0,43±0,017	9,16±0,389	0,34±0,013
	Spring		0,57±0,021	9,72±0,421	0,49±0,019
	Summer		0,69±0,029	12,2±0,511	0,62±0,024
	Autumn		0,72±0,031	11,9±0,467	0,67±0,026
Nitrates (nitrogen), mg / l	Winter	45,0	3,66±0,145	117,2±4,59	3,99±0,161
	Spring		4,92±0,164	129,9±4,88	4,71±0,175
	Summer		6,72±0,249	159,2±6,67	6,94±0,199
	Autumn		6,34±0,235	157,4±6,45	6,72±0,216

* Measurement errors (uncertainty) of organic substances in water correspond to the parameters specified in the technical passport of the spectrophotometer "SPEKOL-2014", which were confirmed in 2017 by the certificate of conformity of the Uzbek National Institute of Metrology (UzNIM).

** MPC is the maximum permissible concentration of harmful substances in the water of water bodies for drinking and cultural and domestic purposes (GOST 951: 2011).

Table 1 shows that the indicator of biochemical oxygen demand (BOD) in the river section (section 3), located before the discharge of industrial wastewater by the JV "Maksam-Chirchik" in all studied seasons of the year does not exceed the standard values. Further down the river, after the discharge of industrial wastewater (section 4) in winter and spring, the BOD values increase to 9.24-9.36 mg02 / l, and in summer and autumn up to 11.6-11.7 mg02 / l (MPC 4.0 mg02 / l). In the end section of the Chirchik River (section 6), the BOD values decrease to standard levels.

The indicator of chemical oxygen consumption (COD) in the water of the Chirchik River before the discharge of industrial wastewater does not go beyond the permissible values for all studied seasons of the year and is 14.6 mg02 / l in winter; in spring 16.7 mg02 / l; in summer 18.6 mg02 / l and in autumn 19.5 mg02 / l (MPC 30.0 mg02 / l). After the discharge of insufficiently treated wastewater from JV “Maksam-Chirchik” into the Chirchik River (section 4), an increase in the COD index is observed, the values of which are outside the permissible values. The maximum COD values fall on the summer-autumn season of the year: 48.8 - 49.2 mg02 / l (MPC 30 mg02 / l). In the lower reaches of the Chirchik River (section 6), the dynamics of changes in the COD indicator is characterized by a decrease in its values. However, in autumn and summer, the COD in river water is determined at the level of 36.6-37.2 mg02 / l, which is 1.2 times higher than the established MPC.

The concentration of ammonia in the water of the river, in the area before the discharge of industrial wastewater, is 0.42 mg / l in winter, 0.59 mg / l in spring, 0.87 mg / l in summer and 0.86 mg / l in autumn. Although in summer and autumn ammonia in river water is determined in higher concentrations, it does not exceed the limits of permissible values (MPC 1.5 mg / l). In the section of the Chirchik River after the discharge of industrial wastewater by the JV “Maksam-Chirchik” (section 4), ammonia is contained in the water in winter at concentrations of 6.44 mg / l, in spring 6.74 mg / l, in summer 8.42 mg / l and in autumn 8 , 97 mg / l, which is 4.29; 4.49; 5.61 and 5.98 times, respectively, exceed the MPCs set for them. In the lower reaches of the Chirchik River (section 6), ammonia in the water exceeded the maximum permissible concentration from 1.1 (in spring) to 1.3 times (in summer).

In the section of the river before industrial effluent discharges and in the lower reaches of the Chirchik River, the content of nitrites by seasons of the year does not go beyond the permissible values, although in the summer-autumn season there is a slight increase in their concentrations in water. On the river section after discharge of wastewater from JV "Maksam-Chirchik", nitrites are determined in winter in water at an average level of 9.16 mg / l, in spring 9.72 mg / l, in summer 12.2 mg / l and in autumn 11.9 mg / l, which is 3.05; 3.24; 4.06 and 3.96 times higher than the MPC.

A similar pattern of water pollution along the established sections of the Chirchik River was revealed by the concentration of nitrates (see Table 1). Above the effluent discharges and in the lower reaches, the Chirchik River is

not polluted with nitrates. However, in the area after wastewater discharges (section 4), nitrates are found in the water of the reservoir in winter, spring, summer and autumn at concentrations of 117.2; 129.9; 159.2 and 157.4 mg / l, which is 2.60; 2.88; 3.53 and 3.49 times, respectively, exceeds the MPC.

It should be noted that JV "Maksam-Chirchik" produces mineral fertilizers for the needs of agriculture: ammonia, ammonium nitrate, urea and ammonium. The production technology of the main workshops of the enterprise involves the use of outdated equipment and does not meet environmental requirements. The qualitative composition of wastewater discharged into the Chirchik River is characterized by the presence of large amounts of nitrogen compounds and high BOD and COD. Heavy metals and oil products were not detected in water samples from the Chirchik River, and therefore such data are not shown in Table 1.

Almalyk Mining and Metallurgical Combine (OJSC "Almalyk MMC") is one of the largest non-ferrous metallurgy enterprises in the CIS countries and includes a complex of mining, processing, metallurgical and sulfuric acid industries. The enterprise mines copper and lead-zinc ore, produces copper, lead, zinc and pyrite concentrates, molybdenum industrial product, smelts blister copper, zinc, lead and iron. Wastewater from the Almalyk Mining and Metallurgical Combine contains high concentrations of phenols, oil products and heavy metals.

Dynamics of changes in the main indicators of water quality in the established sections of the river. Akhangaran is presented in table 2.

Table 2: **Indicators of water quality r. Akhangaran (average data from 3 samples)**

Index	PDK**	Season 2018 г.	Side 4	Side 6
rN	6,5–8,5	Winter	6,66±0,20	7,20±0,25
		Spring	6,26±0,18	7,10±0,24
		Summer	6,98±0,20	7,14±0,24
		Autumn	6,99±0,21	7,94±0,27
Phenols, mg / l	0,001	Winter	0,006±0,00012	0,003±0,00006
		Spring	0,006±0,00012	0,004±0,000065
		Summer	0,007±0,00013	0,004±0,000065
		Autumn	0,008±0,00013	0,005±0,00007
Oil products, mg / l	0,3	Winter	2,14±0,06	0,36±0,011
		Spring	3,52±0,11	0,46±0,014
		Summer	2,94±0,09	0,53±0,015
		Autumn	2,97±0,08	0,56±0,016
Copper, mg / l	1,0	Winter	13,2±0,43	7,2±0,25
		Spring	14,3±0,45	8,9±0,29
		Summer	15,9±0,47	9,2±0,31
		Autumn	16,8±0,51	10,2±0,33
Total iron, mg / l	0,3	Winter	1,6±0,049	1,1±0,035
		Spring	1,7±0,050	1,1±0,035

		Summer	1,9±0,056	1,3±0,039
		Autumn	1,9±0,056	1,2±0,037
Lead, mg / l	0,01	Winter	0,04±0,0012	0,03±0,0011
		Spring	0,05±0,0013	0,03±0,0011
		Summer	0,06±0,0014	0,04±0,0012
		Autumn	0,06±0,0014	0,04±0,0012
Zinc, mg / l	1,0	Winter	4,61±0,15	2,07±0,05
		Spring	5,51±0,18	2,10±0,06
		Summer	7,97±0,25	2,81±0,08
		Autumn	7,86±0,24	2,94±0,09
Molybdenum, mg / l	0,25	Winter	0,64±0,018	0,51±0,016
		Spring	0,79±0,023	0,68±0,019
		Summer	0,94±0,031	0,71±0,022
		Autumn	0,89±0,027	0,70±0,021
Cobalt, mg / dm^3	0,1	Winter	0,41±0,012	0,28±0,008
		Spring	0,47±0,013	0,33±0,009
		Summer	0,59±0,018	0,38±0,011
		Autumn	0,58±0,017	0,39±0,012

* Measurement errors (uncertainty) of phenols, oil products and heavy metals in water correspond to the parameters specified in the technical passport of the Photometer "Expert-003", which were confirmed in 2018 by the certificate of conformity of the Uzbek National Institute of Metrology (UzNIM).
** MPC is the maximum permissible concentration of harmful substances in the water of water bodies for drinking and cultural and domestic purposes (GOST 951: 2011).

It should be noted that we are interested, first of all, in the water quality of the Akhangaran River at section 6, since after the discharge of waste water by OJSC Almalyk MMC downstream, the river water is used for household and drinking water use by the population. From table 3 it follows that in water the concentration of phenols in the studied section of the river is 0.003 mg / l in winter, 0.004 mg / l in spring and summer, and 0.005 mg / l in autumn (MPC 0.001 mg / l).
The same dynamics is observed in the concentration of oil products: in winter they were found in water at a level of 0.36 mg / l, and by autumn their concentrations increased to 0.56 mg / l (MPC 0.3 mg / l).
Copper in water samples was determined at the level of 7.2 mg / l in winter, 8.9 mg / l in spring; in summer 9.2 mg / l and in autumn 10.2 mg / l (MPC 1.0 mg / l).
Iron is present in river water in winter and spring at a level of 1.1 mg / l, rises to 1.3 mg / l in summer and decreases in autumn to 1.2 mg / l (MPC 0.3 mg / l).
Lead concentrations in winter and spring in river water samples are set at 0.03 mg / l, and in summer and autumn at 0.04 mg / l (MPC 0.01 mg / l).
In river water (section 6), zinc concentrations in winter are determined at the level of 2.07 mg / l, slightly increase in spring to 2.10 mg / l, and in summer

and autumn they increase to 2.81 and 2.94 mg / l, respectively (MPC 1.0 mg / l).

The minimum content of molybdenum in the river water in the Akhangaran River was set in winter at 0.51 mg / l, the maximum - in summer 0.71 mg / l. In spring and autumn, the concentration of molybdenum in water is 0.68 and 0.70 mg / l (MPC 0.25 mg / l). The dynamics of changes in the concentration of cobalt is characterized by a minimum of their values in winter and a maximum in autumn. In winter, in the water of the river (section 6), cobalt is found at a level of 0.28 mg / l, in spring 0.33 mg / l, in summer 0.38 mg / l and in autumn 0.39 mg / l (MPC 0.1 mg / l).

Analysis of the water quality of the Akhangaran River after the discharge of wastewater from the Almalyk MMC (section 6) indicates that, compared to the winter-spring period of the year, in summer and autumn, there is an increase in the concentration of harmful substances in the water. It is during this period of the year that significant water withdrawals from the river are noted not only for household and drinking water consumption, but also for irrigation needs of agricultural production.

To prevent further pollution of the Chirchik and Akhangaran rivers and improve monitoring of the discharge of industrial wastewater and water quality at the points of household, drinking and cultural water use of the population, recommendations for their protection and rational use were developed, sent for approval to the Ministry of Health of the Republic of Uzbekistan.

4. Conclusion

1 The main source of pollution of the Chirchik river is the joint venture “Maksam-Chirchik”, of the Akhangaran river - the Almalyk mining and metallurgical plant.

2 Waste waters discharged into the Chirchik and Akhangaran rivers are characterized by the content of significant concentrations of nitrogen compounds, specific chemicals and heavy metals.

3 In the section of the Chirchik River below the discharge of industrial effluents of the Maksam-Chirchik JV, water quality indicators do not correspond to the established standards for BOD, COD, ammonia nitrogen, nitrite nitrogen and nitrate nitrogen.

4 The discharge of industrial effluents from the Almalyk Mining and Metallurgical Combine into the Akhangaran River leads to the pollution of the water body with phenols, oil products and heavy metals, the concentration of which exceeds the maximum permissible concentration established for them.

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