Environmental monitoring of water quality in the interstate Ural river

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Abstract. This article analyzes the content of biological oxygen demand, chemical oxygen demand, heavy metals using the example of the content of copper and zinc and oil products in the Ural River, which is transboundary and runs along Bashkoria, Chelyabinsk and Orenburg regions, as well as in The Republic of Kazakhstan, West Kazakhstan and Atyrau regions. An excess is noted for all indicators. So the content of biological oxygen demand exceeds from 2 to 15 maximum permissible concentration, the content of chemical oxygen demand on the territory of the Russian territory exceeds about 2 maximum permissible concentration. The content of heavy metals copper and zinc ranges from 1.5 to 6.3 maximum permissible concentration, while the highest values are typical for the Kazakhstani territory, which is a consequence of the accumulation received from the Russian territory. The content of petroleum products exceeds for the most part up to 2 maximum permissible concentration and more, only in the territory of the village of Makhambet and the village of Bogdanovskoye is it lower than the maximum permissible concentration.

1. Introduction

The Ural River flows out in Bashkortostan near the village Voznesenka in the lowland between the Alabia ridge and the Nazim Tau mountain. Flowing from north to south, the channel in the area of the flat steppe plateau near Novotroitsk and Orsk makes a turn to the west, and not far from Uralsk, it turns with a second bend and carries its waters southward to the Caspian Sea [1]. The Ural River on the map with its waterway runs through: Bashkoria, the Chelyabinsk and Orenburg regions, as well as in the Republic of Kazakhstan, the West Kazakhstan and Atyrau regions [2].

On the territory of the Russian Federation, near the Ural River, industrial enterprises have developed in the following areas: mining and metallurgical business; oil and gas production; raw material processing of the chemical industry; energy complex [3]. The water resources of the river are actively used for the life support of the population of large cities, for which reservoirs have been formed along the channel of the Urals, on the dams of which the communications of water canals and treatment facilities have been built. The agro-industrial complex uses 18% of the consumed water resources of the Urals in the processing of manufactured products. The settlements of the Ural Coast are not as densely populated as the vicinity of rivers in central Europe. Nevertheless, 136 cities and towns are located along its bed. The Ural River on the map of Russia has 86 settlements [4]. The largest of them on the territory of the Federation are the cities: Orenburg is the administrative center of the region of the same name.
Near the metropolis, the Ural River includes its tributaries Bolshoy Ik, Salmish and Salmara. Novotroitsk is the administrative center of the municipality in the Orenburg region, located on the right bank of the Urals along the state border with the Republic of Kazakhstan [5]. Orsk is a city of regional subordination in the Orenburg region, in the vicinity of which the tributaries Or and Bolshoi Kumak enter the river. Magnitogorsk is a settlement in the Chelyabinsk region, the largest center of the metallurgical industry, located on two banks of a waterway [6]. In addition, the cities of Uralsk and Atyrau are located along the channel of the Urals on the territory of the Republic of Kazakhstan [7]. Chapaevo is the administrative center of the district of the same name in the Ural region. Uralsk - within the city limits, its tributaries Chagan and Derkul flow into the river [8]. Downstream of the city downstream of the Urals, the Kushum canal was built for irrigation needs of agriculture, which is considered to be a tributary of the river. After the collapse of the USSR in 1991, the Ural River acquired the status of an interstate transboundary waterway. Scientists unanimously agreed that the cause of all environmental troubles associated with a water body is an anthropogenic factor as a result of human activity [9].

The main types of economic activities that have a direct impact on the state of the environmental situation are: agro-industrial; oil refining; metallurgical; mining of non-ferrous metals; water intake for the life support of the population of large cities; energy; woodworking; engineering; chemical industry.

2. Research methods
Waste water generated as a result of use by the population and industries is discharged into natural water bodies, storage tanks, terrain, cesspools. The main source of pollution of water bodies that has a significant impact on water quality is insufficiently treated wastewater discharged by housing and communal services [10]. The most common criteria for assessing the quality of surface water on land are the maximum permissible concentrations of harmful substances for the water of fishery water bodies (abbreviated as MPC).

The main pollutants characteristic of the Ural (Zhaiyk) River are heavy metal compounds, the main of which are zinc and copper, oil products, easily oxidized organic substances according to BOD5 (biochemical oxygen consumption). The analysis of the quality of surface waters of the river. Ural in the territories of Bashkiria, Chelyabinsk and Orenburg regions, as well as in the Republic of Kazakhstan, West Kazakhstan and Atyrau regions.

3. Results and discussion
The Ural River is a transboundary river, therefore, the monitoring of the state of water in it is carried out both by scientists of the Russian Federation and by scientists of Kazakhstan [11]. Russian ecologists observe the water quality in the river [12]. Ural and its tributaries in the upper and middle reaches, while Kazakhstani researchers monitor the state of water in the river. The Urals are mainly in the very lower reaches of the river - in the area of the city of Atyrau [13].

Intensive use of water resources in the catchment area of the Ural River basin dramatically changed their qualitative and quantitative hydrochemical parameters as a result of the discharge of a wide variety of anthropogenic pollutants into the water, which contributed to the destruction of natural ecosystems, which required an assessment of water quality and the ecological state of water bodies in the territory of Bashkiria, Chelyabinsk and Orenburg regions The Russian Federation and the West Kazakhstan and Atyrau regions of the Republic of Kazakhstan, which are the surface runoff zones of the Caspian Sea basin.

BOD is one of the most important criteria for the level of pollution of a reservoir with organic substances; it determines the amount of easily oxidized organic pollutants in water. Determination of BOD5 in surface waters is used to assess the content of biochemically oxidizable organic matter, habitat conditions of aquatic organisms and as an integral indicator of water pollution.
Figure 1. Biological oxygen demand content in the transboundary Ural river.

Figure 2. Chemical oxygen demand content in the transboundary Ural river.
The content of BOD in the water of the transboundary Ural River exceeds the MPC and ranges from 2.31 to 14.9 mg/l, which is from 1.1 to 7 MPC (figure 1). The maximum value is typical for water in the territory of Magnitogorsk, which indicates the maximum pollution of this reservoir. The minimum values are characteristic of the village of Berezovka and the city of Novotroitsk, which is 2.52 and 2.31, respectively, this is 1.2 and 1.1 MPC. On the territory of the Republic of Kazakhstan, the BOD content is 3.08 mg/l in Makhambet and 3.29 mg/l in Atyrau, which is 1.47 and 1.57 MPC [14, 15].

In the presence of strong oxidants in the water sample and the corresponding conditions, chemical reactions of oxidation of organic substances occur, and the characteristic of the chemical oxidation process, as well as a measure of the content of organic substances in the sample, is the consumption of oxygen chemically bound in oxidants in the reaction. The indicator characterizing the total content of organic substances in water by the amount of chemically bound oxygen consumed for oxidation is called chemical oxygen consumption (COD). As an integral (total) indicator, COD is currently considered one of the most informative indicators of anthropogenic water pollution. This indicator, in one form or another, is used everywhere in monitoring the quality of natural waters, studying wastewater, etc. The content of COD in the Ural River on the territory of the Russian Federation ranges from 16.5 to 36 mg/l, which corresponds to 1.1-2.4 MPC, which shows an indicator of anthropogenic pollution. Most of the territory of Magnitogorsk, Orenburg and Verkhneuralsk is characterized by an increased COD content above 2 MPC. Such indicators indicate constant anthropogenic pollution. COD data are not available on the territory of the Republic of Kazakhstan [14, 15].

Analyzing the composition of heavy metals zinc and copper in the water bodies of the Ural basin, an excess of the MPC was noted. The increased copper content is associated with the activities of the enterprises of the Magnitogorsk Metallurgical Combine, Mednogorsk Copper-Sulfur Combine, etc. In all sections of the Ural River, the copper content is exceeded by 1.5-6.3 times (figure 3). The highest values are typical for the city of Novotroitsk (exceeding the MPC by 6.3 times) and the city of Atyrau (exceeding the MPC by 5.4 times). In the upper sections of the river runoff, the excess of copper content is from 1.5 to 2.7 times. The lowest values are typical for Verkhneuralsk (exceeding the MPC by 1.5 times) and in the village of Bogdanovskoye 0.0027 mg/l (exceeding the MPC by 2.7 times). Downstream of the Ural River, this excess increases to 2.7 times in Ilek to 0.0063 mg/l in Novotroitsk. This excess is due to the accumulation of copper, which comes with wastewater from the above enterprises. This trend persists in the territory of the Republic of Kazakhstan with an excess of up to 0.0022 mg/l in Makhambet to 0.0055 mg/l in Atyrau.

The content of zinc in the water channel of the Ural River is also marked by an excess of the content. This is directly related to the activities of the following enterprises: Magnitogorsk Metallurgical Combine, Gaysky Mining and Processing Combine, Orsk-Khalilovsky Metallurgical Combine, Mednogorsk Copper and Sulfur Combine, etc. As can be seen from the diagram in figure 4, the zinc content in water exceeds the MPC many times. The minimum values of zinc are typical in the territory of Verkhneuralsk and Magnitogorsk, where the zinc content is in the range of 0.027-0.037 mg/l, which exceeds the MPC by 2.7-3.7 times. Downstream, in the West Kazakhstan and Atyrau regions, the zinc content reaches from 0.035 to 0.114 mg/l, which exceeds the MPC by 3.5-11.4 times. Thus, according to the zinc content in the Ural River, there is also an accumulation in the lower reaches, which come from the upper territories from the enterprises along with wastewater[16, 17].
Figure 3. Copper content in the transboundary Ural river.

Figure 4. Zinc content in the transboundary Ural river.
The content of oil products in the channel of the Ural River is associated with the activities of such enterprises as Orenburgneft, Orskneftesintez, Orenburggazpromenergo, etc. The diagram in Figure 5 shows the content of oil products in the Ural River. The content of oil products in all areas slightly exceeds in all areas and ranges from 0.055 to 0.095 mg/l, which is 1.1-1.9 MPC. The maximum value of oil products at the level of 0.095 mg/l is typical in the water of the Ural River in the territory of Verkhneuralsk. The minimum value of oil products, which is lower than the MPC 0.03 mg/l, is noted in the water of the Ural River in the territory of the village of Bogdanovskoe. On the territory of the Republic of Kazakhstan, the minimum value of petroleum products was found in the territory of the Makhambet settlement at the level of 0.02 mg/l, which is lower than the MPC. This territory is characterized by the absence of any industry, as a result of which the content of petroleum products is minimal [18].

4. Conclusion
The analysis of the ecological state of the transboundary Ural River shows that the waters of this river are polluted, as evidenced by the increased BOD values, the content of which varies from 2.31 to 14.9 mg/l, respectively, from 1.1 to 7 MPC. On the territory of Kazakhstan, this figure is about 1.5 MPC. In terms of the COD content, the indicator is also characterized by an increased content from 1.1 to 2.4 MPC, which indicates anthropogenic pollution. At the same time, there is no data on the Kazakh territory. To determine the pollution with heavy metals, the contents of copper and zinc were analyzed, which are part of the wastewater of most enterprises located along the Ural River. The copper content in the Ural River is 1.5-6.3 MPC, with maximum values in g, Novotroitsk and Atyrau, which indicates their accumulation. The zinc content also exceeds the MPC 2.7-3.7 times, with a strong increase in the Ural River in Kazakhstan's territory. Thus, copper and zinc coming from wastewater on the Russian territory accumulates on the Kazakh territory. The content of petroleum products in most of the territory.

Figure 5. Oil products content in the transboundary Ural river.
exceeds the MPC by more than one, and only on the territory of the village of Makhambet and the village of Bogdanovskoye is it below the MPC.

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