

SECTION OF BIOLOGICAL AND MEDICAL SCIENCES

HYDROCHEMICAL ASSESSMENT OF THE WATER OF THE OKKEVIL RIVER

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Abstract

Okkervil is one of the small rivers of St. Petersburg, which, like many other small rivers on the territory of cities, is subject to diverse anthropogenic pressure, which worsens the quality of its waters. Thus, the water of the Okkervil River may not be of adequate quality for recreational and other uses. The main objective of this work is to determine the chemical composition of the waters of the river and to establish its suitability for various types of water use.

Sampling was carried out during the open water period at three points with different levels of anthropogenic load: outside the city, near the village of Novosergievka; at the entrance to the city; and in the residential area near the metro station. At each point, the main hydrochemical indicators were determined: the concentrations of iron, copper, ammonium ions, phosphates, nitrates and nitrites, heavy metals, as well as the concentration of dissolved oxygen and BOD₅.

At all points of sampling during the period of research in water, the normative indicators for the content of nitrites, phosphates, iron and copper were exceeded. The highest level of water pollution was noted at a point located in a residential area. The water here corresponds to the V class of quality (dirty). In two other sections, the water of the river corresponded to III-IV quality classes (moderately polluted - polluted). The deterioration of the water quality of the Okkervil River is caused by an increase in the anthropogenic load on the river in the direction from the source to the mouth, which makes the sections of the river within the city unsuitable for various types of water use.

Keywords: water quality, Okkervil river, ecological state, chemical composition of waters.

Okkervil is a river located in the east of St. Petersburg. The length of the river is about 18 kilometers, the width is up to 25 meters; the depth is shallow, usually less than one meter. The source of the Okkervil River is located in the Leningrad Region, on the Koltush Heights; mouth - in the river Okhta, 1.8 km below its mouth, on the left bank. In the Leningrad region, Okkervil passes through several garden associations, as well as through the rapidly developing settlements of Novosergievka and Kudrovo. Further, Okkervil flows through the territory of St. Petersburg until it flows into the Okhta River. River embankment Okkervil has been used for recreation and recreational fishing for many years.

It is due to the fact that Okkervil passes through St. Petersburg and its suburbs that its waters are subject to diverse anthropogenic impacts. Outside the city, a significant contribution to river water pollution is made by runoff from areas used in agricultural production, mainly as a result of the use of mineral and organic fertilizers, agrochemicals in the watershed and the flow of untreated and undertreated effluents from agricultural enterprises directly into the river. In addition, a significant impact on the state of the river has a recreational load. Within the city, in addition to recreation, transport and the construction industry contribute to the pollution of the Okkervil River. Along its course, the river passes through a number of large transport junctions, and also

flows through the actively built-up area of Kudrovo. Mechanical and chemical pollution of water leads to a change in its chemical composition, as well as to disruption of the photosynthesis process. This has a detrimental effect on the state of aquatic organisms and the hydroecosystem as a whole. The unsatisfactory sanitary condition of the watercourse poses a threat to human health. Unfortunately, there is very little information in open sources about the chemical composition of the water of the Okkervil River and the dynamics of its change under the influence of a diverse anthropogenic load. Given that the territories through which the river flows are being actively transformed and built up, we can expect, on the one hand, an expansion of the scope of water use, on the other hand, a change in the nature and intensity of anthropogenic impact on the watercourse and its catchment. Assessment of the water quality of the river. Okkervil will allow to determine the suitability of water for various needs, as well as to assess the environmental risks arising in the process of water use. The purpose of this work is to determine the chemical composition of water in the sections of the river. Okkervil in the city and beyond, and the suitability of using its waters for recreational and other types of water use.

Sampling for hydrochemical analysis of water in the Okkervil River was carried out at three points with different levels of anthropogenic load (Table 1).

Table 1.

Geographical location and characteristics of sampling points

Point number	Point coordinates	Description
1	59.921808, 30.470644	Near the village of Novosergievka, a household load is possible. Almost no car traffic.
2	59.909836, 30.494433	Departure from St. Petersburg towards Kudrovo. Residential area with car traffic.
3	59.907202, 30.549149	Near metro station and sports complex. Near the point - a large highway with heavy traffic

Sampling was carried out during the open water period in 2021-2022 from the surface, according to GOST R 59024-2020. The following indicators were determined: the concentration of nitrates, nitrites, phosphates and ammonium salts, as well as iron and copper ions in water; in addition, the concentration of dissolved oxygen and BOD5 were also determined. In accordance with GOST R 58556-2019 and SanPiN 1.2.3685-21, the water pollution index was calculated.

According to the data obtained, both in the spring-summer and autumn periods, the maximum permissible concentrations of a number of pollutants were exceeded. So, in spring and summer, the nitrite content was, on average, 2.5, 1.25, and 1.25 times higher than the MPC at points 1, 2, and 3, respectively. Salts of nitrous acid (NO₂) are products of incomplete oxidation of ammonia under the influence of microorganisms during nitrification. Seasonal fluctuations in the content of nitrites are characterized by their absence in winter, the appearance of maximum concentrations associated with phytoplankton activity at the end of summer and a subsequent decrease in autumn. In pure natural waters, nitrites are not found or are found in extremely low concentrations. These compounds are less stable than nitrates and are easily converted into them during self-purification. Therefore, the constant presence of nitrates in the analyzed water in excess amounts indicates water pollution. MPC of nitrites in water according to SanPiN 2.1.4.1175-02 is 3 mg/dm³. Nitrites are more toxic than nitrates, their appearance in water poses a significant danger to hydrobionts and humans, therefore their content in water is controlled more strictly than the content of nitrates and ammonium ions. The source of nitrites in water can be the use of nitrogenous fertilizers in the catchment area, effluents from industrial enterprises and livestock farms, untreated and undertreated household wastewater. The systematic excess of the maximum allowable concentration of nitrites in the water indicates the pollution of the river throughout the study section. At the same time, in a zone with a lesser degree of urbanization, the concentration of nitrites was higher than in the city. This may be due to the use of nitrogenous fertilizers in this area and their entry into the water from the catchment area.

In autumn, excess concentrations of phosphates, copper and iron ions were noted in the river water. Phosphorus, like nitrogen, is a biogenic element, so its presence in water bodies is observed even in the absence of wastewater discharge. Small amounts of this element and its compounds are present in water bodies as derivatives of the biological cycle. However, phosphorus is widely used, so its concentration in wastewater can be high. Phosphorus compounds are

used in the manufacture of fertilizers, since phosphorus, along with potassium and nitrogen, stimulate the growth and fruiting of crops. In addition, it finds use in the food industry as acidifiers, thickeners and preservatives for oils and frozen vegetables. Phosphorus compounds are part of the surfactants of detergents and washing powders. Phosphates and other phosphorus compounds in residential areas enter the water mainly with domestic wastewater. Excessive entry of phosphates into the water triggers the processes of eutrophication of water bodies.

Studies have shown that the content in the water of the river. Okkervil phosphates exceed the maximum allowable concentration in summer, on average, by 2.5, 3.5, and 7.5 times at points 1, 2, and 3, respectively, and in autumn, by 6, 2, and 2.5 times.

The copper content exceeded the MPC during the study period, on average, 10 times at points 2 and 3. Despite its prevalence in the earth's crust, copper enters the water mainly with mine waters, wastewater from chemical and metallurgical enterprises, or when using aldehyde reagents during purification reservoirs from algae. In the central water supply, an impurity may appear when this component is washed out of the fittings and pipe walls. In this case, copper pollution was observed at points located within the city, near transport hubs, which allows us to conclude that the river was technogenically polluted.

The amount of iron in rivers and lakes depends on the chemical composition of the solution, pH, and partly on temperature. In surface waters, the main form is complex compounds of trivalent iron ions with dissolved inorganic and organic compounds, mainly with salts of humic acids. A significant amount of iron is noted in watercourses passing through forested and wetlands. These streams include the river. Okkervil. In terms of the parameter of iron concentration in water, an excess was also observed in the autumn observation period: 6 times at points 1 and 3, and 7 times at point 2. In addition to high background concentrations, an increase in the content of iron in water may be of a technogenic nature, especially given the presence of large industrial enterprises and transport routes near the river in the city.

The concentration of dissolved oxygen and BOD5 for the entire period of research did not go beyond the normative indicators specified in the Order of the Ministry of Agriculture of Russia dated December 13, 2016 No. 552. The content of dissolved oxygen at all points did not fall below 6 grams/liter. BOD5 throughout the entire period of research in the entire studied area, on average, was 2 mg/liter. These indicators are favorable

for the life of hydrobionts and have a positive effect on the processes of self-purification of the reservoir.

For each point, the water pollution index was calculated in the spring-summer (Table 2) and autumn

(Table 3) periods, and its quality class was established [5].

Table 2.

Water quality classes at sampling points in the spring-summer period

Sampling point number	Water pollution index	Water quality class
1	2.50	IV (polluted)
2	2.38	III (moderately- polluted)
3	4.38	V (dirty)

Table 3.

Water quality classes at sampling points in autumn

Sampling point number	Water pollution index	Water quality class
1	2.11	III (moderately-polluted)
2	3.34	IV (polluted)
3	3.31	IV (polluted)

According to the data obtained, the water at all points, both in summer and in autumn, corresponded to quality class III and above. In the spring-summer period, the most polluted point was water at point 3 - V class of water quality. Water at point 1 corresponded to the IV quality class, and at point 2 - to the III quality class. In autumn, water at point 1 corresponded to the III quality class, and points 2 and 3 - to the IV class.

According to the criteria of GOST R 58556-2019, the ecological state of the waters of the Okkervil River is assessed as the state of reversible and irreversible changes at all points under study. This state of the watercourse can lead to negative consequences for public health if the water of the river is continued to be used. Okkervil for household and recreational purposes. Continued water pollution may lead to the degradation of the studied ecosystem and the loss of the watercourse, as an object of any type of permitted water use.

The ecological state of the river. Okkervil, in general, is typical for the rivers flowing on the territory of St. Petersburg. Similar data were obtained by monitoring services for the Okhta River, into which the Okkervil flows. The water quality class in this river ranges from IV to VII, which makes it one of the most polluted watercourses in St. Petersburg. In addition, for Okhta, as well as for the river. Okkervil marked a deterioration in water quality in the direction from the source to the mouth [1].

Comparing Okkervil with other small rivers of St. Petersburg, for example, with the river. Volkovka and Pulkovka, one can also note similar values of the water quality class. River waters Volkovka corresponded to III-IV quality class. Thus, these rivers, as well as Okkervil, are of little use for fisheries and recreational purposes [3].

The data obtained indicate that the waters of the Okkervil River are currently in an unsatisfactory con-

dition. The data obtained indicate a significant technogenic load on the river; in addition, there is an increase in the level of water pollution from the source to the mouth, and it is especially significant in the city. Water quality in the river Okkervil, as well as in most small and medium-sized rivers in urban areas, is quite low, which does not allow the use of the waters of these rivers for recreational, domestic and other purposes. Thus, it is necessary to inform the population about the inadmissibility of using the water of the Okkervil River for swimming and fishing. It is also necessary to conduct further research to identify sources of river pollution and clarify the water quality class.

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