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PHYSICAL AND GEOGRAPHICAL, HYDROLOGICAL AND HYDROCHEMICAL WATER REGIME OF KOSINO LAKES

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Abstract. *The article considers the peculiarity of the three lakes located in Kosino. Briefly, the article gives a limnological characterization of lakes. Hydrological, hydrochemical characteristics are given. It is emphasized that there is a deviation from the previously observed seasonal dynamics of the development of bacterioplankton, which in general may indicate a deterioration in the environmental state of the lakes. The main cause of the problem is the lack of scientific ecological and biological control over the state of unique lakes.*

Keywords: *three lakes, environmental situation, β-samples, hydromorphology, biological station, bacterioplankton.*

Introduction. There are many rivers, streams, and ponds in Moscow – the city was named after the river, but there are practically no lakes in Moscow. The Volga-Oka interfluve is not a lake district, the only exceptions are the glacial lakes in Kosino: Lake Chernoe, Lake Svyatoe, Lake Beloe. We find mentions of these lakes at the beginning of the XV century. It is known that after Izmailovsky Pond and the Yauza River turned out to be too small for Peter the Great, piers were built here, near the eastern shore of Lake Beloe. The traces of the shipyard for a long time indicated the place of Peter the Great's fleet on the lake [Dryabzhinsky O.E., Subbotina Yu.M., 2011].

Kosino lakes are a complex of glacial reservoirs in the Moscow region well known to limnologists all over the world. Three lakes are located on an area of only 65 hectares, the lakes include Beloe, Chernoe and Svyatoe, but they differ from each other in a number of characteristics.

The purpose of the study is to substantiate the data of the hydrological, hydrochemical and physico–geographical water regime of the Kosino lakes.

Lake Beloe is the largest, with a depth of 13.5 m. The total area is 22.0 hectares, the average depth is 4.4 m. The shape of its lakebed is compared with a funnel. This reservoir has gone through 6 stages in its development. Lake Beloe is a eutrophic reservoir containing a lot of dissolved and suspended organic substances. The bottom is composed of silts. Hydrogen sulfide is present in the bottom layers of the water, which is toxic to the inhabitants of the lake. The banks are lined with trees, there is a church on the eastern shore [Babkina A.A., Subbotina Yu.M., 2012].

The disruption of the environmental situation in the lake was initially caused by peat mining, as a result of which lakes Chernoe and Beloe were connected by a channel. As a result, the water regime of both lakes was disrupted, leading to a reduction in representatives of aquatic and coastal vegetation. The aggravation of the ecological situation of the lake is associated with an increasing anthropogenic load from year to year. The influx of vacationers is accompanied by a large amount of waste, trampling of vegetation. Due to noise pollution, many animal species are in a depressed state. Due to the low environmental education, many visitors to the lake prefer to wash their car in the immediate vicinity of the recreation area. All these factors subsequently adversely affect not only the natural inhabitants of the reservoir, which include representatives of flora and fauna, but also the vacationers themselves, demonstrating the famous boomerang effect [Babkina A.A., Subbotina Yu.M., 2012].

In some years, in the summer on Lake Beloe, as well as on other autotrophic reservoirs, there is a massive development of blue-green algae (Aphanisomenon flos aquae). In August, as a rule, (Microcystis and Gloeotrichia verniformis) become dominant [Subbotina Yu.M., 2021].

Blue-green algae make up 95%. They develop where there are a lot of organic substances. The dominant one is Ahpanizomenon flos-aquae – 90% belonging to b – mesosaprobes. If b – mesosaprobes are dominant, this means increased saprobity of the reservoir. This once again confirms that the reservoir is highly eutrophied. Individual populations of Aphanizomenon flos-aquae are able to synthesize neurotoxins called toxins-a, which are toxic to fish and humans [Subbotina Yu.M., 2021].

There are few plants in the lake itself, although twigs of Canadian pondweed, washed ashore by the waves, are visible on the shore. This foreign plant, also called "water plague", has become common in reservoirs near Moscow since the end of the XIX century.

We have repeatedly carried out (in spring, summer, autumn and winter) hydrochemical analysis of the water of Lake Beloe, the results are presented in the table (Table 1).

Table 1

Hydrochemical composition of lake water

Hydrochemical indicators of water quality	**Research results**	**The value of the permissible level, unit of measurement**
Hydrogen ion concentration	7,7 – 11,9	6,5 – 8,5
Scent	2 grades, river	not more than 2 grades
Colour	straw-yellow	-
Sludge, sediment	Moderate, sediment	-
Transparency, cm	20 – 35,0	not less than 30
Dissolved oxygen, mg/dm^3	3,4 – 9,6	not less than 4,0
Suspended materials, mg/dm^3	4,0 –44,5	not more than 30,0
BOD (biological oxygen demand) 5 mg/dm^3	7,4 – 19,5	not more than 4,0
BOD (biological oxygen demand) 20 mg/dm^3	10,5 – 24,3	-
Ammonium nitrogen mg/dm^3	0,42 – 1,65$^-$	not more than 1,5 mg/dm^3
N nitrites, mg/dm^3	0,02 3,2	not more than 3,0 mg/dm^3
N nitrates, mg/dm^3	less than 0,43	not more than 45,0
Dry solid, mg/dm^3	296,4 – 346,5	not more than 1000
Chlorides, mg/dm^3	42,4 – 98,4	not more than 350
Sulphates, mg/dm^3	36,5 343,5	not more than 500
Ferrum, mg/dm^3	0,15 – 2.2	not more than 0,3
Petroleum products, mg/dm^3	0,18 4,43	not more than 0,5
Synthetic Surfactants (SS), mg/dm^3	less than 0,01	not more than 0,5

Lake Beloe, as we can see, is characterized by low values of most indicators of pollution of individual components of the ecosystem. This can partly be explained by the seasonality of sampling: autumn water samples, compared with summer ones, were almost always characterized by better organoleptic and hydrochemical parameters, and low bacterial contamination.

The ichthyofauna of the reservoir is represented by 10 species of fish. Its greatest diversity in Lake Beloe was observed in the 60-85 years, it was at this time that the lake was stocked for fishing enthusiasts. During this period, the «Rybolov-sportsmen» group introduced carp of different ages, crucian carp more than 600 thousand pieces and more than one million pike larvae. Trout, perch, and walleye were also released into the lake. At the moment, perch (Perca fluviatilis), roach (Rutilus rutilus, pike (Esox), silver carp (Carassius gibelio), golden carp (Carassius auratys, tench (Tinca tinca), verkhovka (Leucaspius delineatus), carp (Cyprinus carpio), bream (Abramis brama) can be caught in the lake. you can catch walleye (Stizostedion) [Subbotina Yu.M., 2021].

Based on this, a number of measures should already be taken to improve and restore the ecological situation of Lake Beloe.

The study of sections of Lake Beloe shows that the bottom relief as a whole reveals a complex structure. Two basins of this reservoir are observed, points located in the middle of the lake, suggested that in the most remote period a small reservoir occupied a rounded pit with a steeply falling bottom, in location it coincided with the now existing deep basin.

Lake Chernoe is connected to Lake Beloe by a narrow channel. The lake area is 2.5 hectares. The modern appearance of this reservoir is due to the intensive extraction of peat (40-50s) along its shores, due to which the lake greatly expanded its borders (until the 1940s it was the smallest of all Kosino lakes). The hydromorphological data of the lakes are presented in Table 2 [Rozanov V.B., Skaryatin V.D., 2009, Serebrovskaya K.B., 2004].

Special attention was paid to the choice of the appropriate tool when measuring depths, since the extreme looseness of the soils of the Kosino lakes requires certain precautions when performing these works. As such, instead of the usual lot, a thick metal hoop with a diameter of 9 cm was taken, which was tied to a parachute rope. To study the relief of the lake bottom, several perpendicular sections were made at selected points and graphs were plotted.

Table 2

Hydromorphological data of lakes and quarries

Data:	**Lake Chernoe**	**Lake Beloe**	**Lake Svyatoe**	**Quarry pond**
The area of the basin, ha	2,5-3,0	21,0-22,0	6,0	10,0
Maximum depth, m	4,0	15,0-17,0	5,0	1,5-1,7
Catch basin, ha	150,0	95,0 -105,0	60,0	25,0

In the following years, the lake overflowed widely, capturing part of the modern land. We cannot determine the extent of its shores with sufficient clarity at the present time, because contemporary geological surveys are necessary. The modern lake, due to a new increase in the water level, has expanded greatly, mainly to the south, flooding the sloping surface that makes up the current shallow part of its bottom. Thus, this latter is a newly acquired

and younger part of the bottom of the Lake Beloe [Dryabzhinsky O.E., Subbotina Yu.M., 2011; Rozanov V.B., Skaryatin V.D., 2009].

The different thickness of the silt deposits of Lake Beloe in different parts of it, apparently, can also be partly explained by strong fluctuations in the level. In which significant areas of the bottom protruded above the surface of the water, whereas in other places the accumulation of silt continued continuously.

Lake Chernoe has gone through 5 stages in its development. Large reserves of sapropel, a very valuable substance lying in two layers, were found at its bottom. In Lake Chernoe, diatoms are widespread – 90%, Fragillaria construens – 26% – β-mesasaprobe, Melosira italic – 20%, Synedra ulna – 13%. There is a strong overgrowth of higher aquatic vegetation, macrophytes compete with phytoplankton for food in the water. Due to the fact that β-mesasaprobes are the dominant feature of the lake, the saprobity of the 3-water reservoir is less, from which it can be concluded that Lake Chernoe is cleaner than Lake Beloe. Lake Chernoe is the most interesting in its structure. The thickness of the silt deposits reaches 15 m here. [Dryabzhinsky O.E., Subbotina Y.M., 2011; Subbotina Y.M., 2013].

Peat deposits are strongly developed from the periphery, on the surface of which various representatives of sedges and gypsum mosses grow. The peripheral areas of the peat bog are occupied by birch, to which are mixed: alder, aspen, pine, willow and buckthorn; the lowest tier consists of various grasses and gypsum mosses. Thus, in 1980, the surface of the Chernoozersky peat bog was represented by a low swamp, which is associated with its abundant mineral nutrition. The uppermost layers of the peat bog on the periphery are formed by forest peat, the thickness of which reaches 1.5 m (in the northern part up to 4 m). Below the forest peat lies a layer of sedge peat, with a thickness of 2 m in the south to 4.5 m in the north. The lowest and closest layers to the lake are formed by reed-sedge peat with a thickness of up to 1.25 m [Dryabzhinsky O.E., Subbotina Yu.M., 2011, Rozanov V.B., Skaryatin V.D., 2009].

From this brief description, it can be seen that the vertical sequence of layers corresponds to modern vegetation zones. Typical lacustrine sapropel deposits lie below the peat deposits.

The third of the Kosino Lakes is Lake Svyatoe. The lake has exceptional historical and balneological significance. It is located in the eastern edge of Kosino. It is round in shape and resembles a saucer. In terms of chemical properties, the water of Lake Svyatoe differs sharply from the water of other Kosino lakes: it contains very little organic matter (dystrophic type).

The water of Lake Svyatoe is curative: bottom silt contains iodine, silver, bromine. Peasants in the old days treated rheumatism and various skin diseases by rubbing themselves with silt and pouring lake water. Currently, scientists have shown that the water of Lake Svyatoe is really healing, has special physico-chemical properties determined by low temperature and a special biocenosis. These properties of water contribute to the removal from the body of toxins formed as a result of human radiation exposure or his spacewalk. Mud containing a large amount of blue clay also has medicinal properties.

The ichthyofauna of the lakes is represented by a wide variety of species, and in sufficient numbers they contain fish that are delicious for fishermen (pike, walleye, perch, bream, roach, carp, etc.) [Rozanov V.B., Skaryatin V.D., 2009].

According to researcher Akulova A.Yu. it is said that as a result of complex year-round biological observations on three Kosino lakes, it showed that during the observation period (2010-2012) compared with the latest observations that have taken place since the liquidation of the Kosinsk limnological station in 1942, there has been a significant increase in the values of individual microbiological indicators, there are also deviations from the previously observed seasonal dynamics of bacterioplankton development, which in general may indicate a deterioration in the environmental condition of the lakes. The data presented in this work can serve as a basis for further hydrobiological monitoring of the condition of lakes that are part of the protected area of the Natural-Historical Park Kosinskiy. [Akulova A.Yu., 2017; Aaronson, A.A., 1970; Yanagita, T., 1978.]

Conclusions. Summing up the above, it should be emphasized once again that at present Lake Beloe, like other eutrophic lakes, is experiencing a large anthropogenic load, needs a full environmental survey, and, first of all, the study of hydrobiocenoses to determine the current state, and the development of measures to improve the current situation in order to prevent their death.

The conducted research does not exhaust the whole range of issues related to the essence, content and mechanisms of solving these problems. They represent only one of the attempts to study the ecological system of lake-type reservoirs. Even a small advance in the study of this issue seems to be very useful. The practice of managing environmental problems of lake-type reservoirs constantly puts forward new theoretical problems that require careful analysis, solutions, and practical recommendations.

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ФИЗИКО-ГЕОГРАФИЧЕСКИЙ, ГИДРОЛОГИЧЕСКИЙ И ГИДРОХИМИЧЕСКИЙ РЕЖИМ КОСИНСКОГО ТРЕХОЗЁРЬЯ

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Аннотация. *В статье рассматривается особенность трех озер, находящихся в Косино. Вкратце в статье дается лимнологическая характеристика озер. Приводится гидрологическая, гидрохимическая характеристики. Подчеркивается, что имеет место отклонение от наблюдавшейся ранее сезонной динамики развития бактериопланктона, что в целом может свидетельствовать об ухудшении экологического состояния озер. Основная причина проблемы – это отсутствие научного эколого-биологического контроля за состоянием уникальных озер.*

Ключевые слова: *трехозерье, экологическая ситуация, β-мезасапробы, гидроморфология, биостанция, бактериопланктон.*