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DOI: 10.15405/epsbs.2024.10.36

SCTMG 2023 International Scientific Conference "Social and Cultural Transformations in the Context of Modern Globalism"

ECOLOGICAL STATE OF MOSCOW'S WATER RESOURCES AND ICH SOCIAL RECREATION

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Abstract

The article considers the problems related to the ecological condition of rivers in the urban environment. Territorial boundaries of the study: different functional zones of Moscow city. A comparative analysis of the ecological condition of surface waters in the main urban area and within the specially protected natural areas is presented. In the conditions of urban environment all landscape components, including surface water, experience anthropogenic load. The degree of anthropogenic impact and concentrations of pollutants directly depend on the area within which the river valley is located. The study is based on the materials of annual reports on the state of the environment, placed in the public domain, scientific publications, statistical data, as well as on our own research. The main methods used in the work: analytical, statistical, comparative-geographical, cartographic. The result of the work was a comparative analysis of the ecological state of the rivers: the Moscow River, Setun, Skhodnya, Yauza and small rivers - Gorodnya, Kotlovka and Likhoborka at present. In the rivers flowing within residential and industrial zones, the increased content of a number of pollutant elements was revealed. In the rivers of specially protected natural territories lower content of pollutants was detected. On the basis of statistical data, graphical materials have been created to demonstrate the ecological state of Moscow rivers.

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Keywords: Ecological state, environment, industrial zones, pollutants, water resources



Introduction

Inland waters, rivers, are an integral component of any landscape, including anthropogenic landscapes. The functioning of ecosystems in general depends on the degree of their alteration by economic activity and ecological load on them. In the urban environment a specific composition of water is formed, special conditions for the functioning of rivers are created (Ahmad et al., 2024; Singh et al., 2024; Waite, 2024). The ecological condition of river waters of cities, including the largest megacity - Moscow - is the most important problem that needs to be solved.

1. Problem Statement

Transformation of water bodies under the influence of economic, including urban development activities in cities is inevitable. Rivers, as part of inland waters, are provided for use for various purposes and, together with riparian areas, become part of the urbanised environment, performing many functions, including drainage, transport and recreational. At the same time, water quality and pollutant content in river water depends on the type of use (Lipich & Balahura, 2024; Regnerová et al., 2024; Shumilina & Antsiferova, 2024).

2. Research Questions

The rivers of Moscow are the most important element of the natural ecological framework represented by specially protected natural areas (SPNAs) of different ranks, which contribute to the preservation of all components of the landscape, including rivers. Watercourses flow not only through the territories of SPNAs, but also through residential areas and industrial zones, which inevitably leads to river pollution (Dokuchayeva et al., 2024; Tang & Yang, 2024).

3. **Purpose of the Study**

Pollution monitoring of Moscow rivers is necessary to assess the ecological condition of urban areas. Establishment of protected areas in the river valleys and river basins of Moscow contributes to the preservation of river valley landscapes. A favourable ecological condition of river waters is a necessary condition for environmental safety.

4. Research Methods

The materials for the study were annual and monthly reports on the state of the natural environment in the city of Moscow, statistical materials, scientific articles on similar topics (Eremina et al., 2016; Sabater et al., 2016). The article includes the results of visual analysis of the ecological state of landscape elements (including rivers) of specially protected natural areas of Moscow. The data of water samples taken in several sections of the Likhoborka River in October-November 2020 were used. The research was carried out using analytical, comparative-geographical, statistical and cartographic methods.

5. Findings

The ecological condition of water bodies of the Moscow region located within SPNAs, as well as water protection zones, near residential and industrial areas is heterogeneous, but largely unfavourable.

Water protection zones in the city often do not fulfil their functions due to anthropogenic influence. River banks are lined with granite, embankments become part of the motor transport network, and anthropogenic landscape areas are formed in the adjacent territories.

To preserve natural aquatic ecosystems, PAs of regional significance have been established on some sections of urban rivers (in particular, the Moskva River, Setun, and Yauza). At the same time, the improvement of protected areas, including riverbanks, the formation of walking and recreational areas also negatively affects the natural components of landscapes.

Outside the protected areas, in industrial zones and residential areas there is damage and destruction of wood and other vegetation, littering, littering, water protection zones due to their use for spontaneous recreation, earthworks for economic purposes without subsequent reclamation. In addition, the invasive plant species Echinocystislobata (Michx.) Torr. et A. Gray - Echinocystis lobata (spiny lobate, mad cucumber), which actively displaces indigenous species of meadow vegetation, which is also an ecological problem of river valleys.

At the same time, in the areas of New Moscow, with the predominance of private residential development and less intensive anthropogenic impact than in the rest of the city, many rivers have open channels, natural banks, preserved landscapes of floodplains and river valleys, which contributes to natural self-purification of water. However, water bodies in New Moscow are characterised by ammonium nitrogen and phosphate pollution, which is mainly due to domestic wastewater. In addition, these waters may contain nitrites, nitrates, potassium, as well as surface active substances (surfactants).

On the basis of the studied data, it is possible to differentiate the ecological condition of the city's rivers from the following positions:

- i. Concentration of pollutant elements depending on the river sections (upstream, middle or downstream, tributary inlets).
- ii. Content of different pollutants in surface waters depending on their location in different functional zones (industrial, residential, protected areas);

The specifics of pollutant concentrations in different parts of the same river are related to the functional features of the urban areas where this or that section of the river is located, as well as to the tributaries of the river.

The example of the Moscow River clearly shows this: in the upper reaches of the river at its entrance to the city, the content of pollutants is much lower compared to their concentration in the lower reaches at the exit from the city. However, it is worth noting the widespread excess of chemical oxygen demand (COD). The data presented above shows the content of pollutants on average per year.

Monthly monitoring of river water pollution is also important. Shown in the work (Yashin et al., 2015) the dynamics of exceeding the maximum permissible concentrations (MPC) of the content in the water of the Moscow River of the main pollutants - copper, phenols, petroleum products, as well as easily oxidisable organic substances by total biological oxygen demand (BOD 5) in the section from the village

of Ilyinskoye (at the entrance of the river into the city limits) to the exit outside the city limits of Moscow for December 2021.

As follows from the pollution data, within the city, including in its central part, as well as at the outlet of the Moskva River outside the city limits (in the area of the Besedinsky Bridge), the amount of pollutants in the water increases significantly, especially copper and oil products.

The waters of the Moscow River tributaries - Skhodni, Setuni, Yauza - also noticeably pollute the water area of the Moscow River within the city limits. According to some data, the concentration of oil products, iron and ammonium in the water of the Yauza River can exceed the norms by 50-100 times; below the confluence of the Yauza into the Moskva River, water quality deteriorates sharply: the content of oil products increases by 3 times, bacterial pollution increases by an order of magnitude, and the content of suspended solids increases by 6-8 times (Yashin et al., 2015).

As the data show, the lowest content of pollutants is observed in the Skhodnya River estuary. The content of suspended solids is significantly higher in Skhodnya water and slightly higher than in the Yauza of oil products. Yauza is the "leader" in terms of iron and manganese content. It should be noted, the valleys of these rivers together with green areas fulfil recreational functions, despite the fact that river water pollution is caused by industrial and residential areas.

Small rivers play an important role in the formation of the hydrographic network. One of the topical problems is their ecological state (Shirokova et al., 2018). The ecological state of water in the Likhoborka River, the right tributary of the first order of the Yauza River flowing into the Moskva River, is also unfavourable. The river flows within industrial and residential areas, which affects a number of water quality indicators. The riverbed and floodplain are littered with household and construction waste in some parts of the valley.

Water analyses carried out in October-November 2020 showed that a significant increase in the temperature regime was observed in a number of sections of the Likhoborka River channel (Mainasheva & Nelyubin, 2020). In addition, periodic studies of water pollution levels in the river reveal significant exceedances of MPCs for COD, oil products, heavy metals and other substances.

The site of the lower reaches of the Likhoborka River has been a SPNA in the status of "Nature Monument" within the Ostankino Nature and Historical Park since 1991, which contributes to the preservation of the river valley landscapes.

Many small rivers in Moscow flow through both protected areas and industrial and residential areas, which causes their pollution.

Let us consider the ecological state of river waters on the example of the rivers Gorodny and Kotlovka.

The Gorodnya River flows through the territory of the Tsaritsyno Nature and Historical Park and the Brateevskaya Floodplain faunal reserve, located in the Southern Administrative District (SAO) and South-Eastern Administrative District (SEAD) of Moscow.

The Kotlovka River valley is a natural monument and is located in the South-Western Administrative District (SWAD) of Moscow, within the landscape reserve with the same name, established in 2021. For a number of indicators, concentrations do not exceed MAC. However, the content of iron and manganese is significantly exceeded, which may be due to both anthropogenic -

destruction of forests, erosion processes, development of water protection zones (Yashin et al., 2015), and natural factors: increased concentration of metals in groundwater, swamps, from which many watercourses originate, and the prevalence of podzolic soils, in which the process of leaching of these metals occurs.

The role of protected areas in the conservation of Moscow's natural landscapes, including rivers, is increasing. In 2020, there were 136 protected areas of different ranks in Moscow, with a total area of 19.5 thousand hectares, which is 7.6% of the city area (Voronova et al., 2020). And although the resource for the formation of protected areas is limited, the organisation of new protected areas in Moscow (mainly natural monuments) continues.

It should also be noted as environmental problems of urban rivers the manifestation of unfavourable natural processes - bank erosion, landslides on slopes, increase or decrease of channel bed elevations, siltation. In urbanised urban areas, due to the high degree of development and improvement of water bodies, such risks are significantly reduced or excluded. However, the above processes may occur in unregulated river sections located within protected areas and in the New Moscow area.

6. Conclusion

Moscow rivers flow through various urbanised territories - industrial and residential areas, perform transport, water management and recreational functions. Therefore, the waters of many rivers are polluted, littering of river banks and riverbeds is observed.

In the rivers Moskva, Skhodnya, Yauza, Likhoborka the results of studies revealed exceedances of MPC of such pollutants as oil products, phenols, copper, iron, manganese. High COD values were noted, as well as anthropogenic increases in water temperatures.

In the rivers flowing through the territories of protected areas - Gorodnya, Kotlovka, a lower content of pollutants was detected compared to the rivers, most of the valleys of which are located in industrial and residential areas.

In order to preserve the ecological and recreational function of urban rivers as the most important elements of the ecological framework of the city, including as part of protected areas, it is necessary to preserve existing protected areas and organise new ones.

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