The features of small rivers monitoring in the Russian cities (on the example of the Novosibirsk city)

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Abstract. Attention to such natural objects as small rivers of the Russian cities is constantly growing. This is due to the desire of urban citizens to create recreational zones near their homes, the central place of which are sections of small rivers. It explains the need to expand the network of hydrological posts in the agglomeration, where observations of water quality indicators, hydrological regime, etc. provide important information for the creation and implementation of improvement projects for the territories under consideration. This article provides a small part of the necessary hydrological and environmental monitoring on the small river Eltsovka-2 in the city of Novosibirsk.

1. Introduction
At present, along with the preserved biological interpretation, the term "ecology" was introduced into the scientific lexicon at the beginning of the second half of the 19th century by the German scientist E. Haeckel, this concept is widely used by other branches of science and technology that interpret the ecological situation as a combination of natural and social phenomena and items that determine the conditions of human life and health. A favorable or unfavorable ecological situation for people can be a consequence of the natural conditions of the human environment and the very activity of people. To identify and predict changes in the state of the environment (especially negative and dangerous for the population, economy and the natural environment), as well as to develop measures to prevent the negative consequences of these changes, assess the effectiveness of such measures, information support, organize environmental monitoring. The term "monitoring" comes from the Latin "monitor" - "observing", "checking", "warning" [13-15]. Monitoring of water bodies is part of the monitoring of the natural environment. According to modern international approaches, monitoring of any component of the natural environment (including water bodies) should include a set of standardized observations and techniques for processing, analyzing and transmitting the results of these observations to consumers. State monitoring of water bodies established in the Russian Federation. The organization and conduct of the State monitoring of water bodies in the Russian Federation is entrusted to the Federal Agency for Water Resources (Rosvodresursy) and the Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet).

Monitoring of water bodies - constant control over the state of water bodies, over the complex of their hydrological, hydrochemical and other characteristics and their temporal and dimensional changes, i.e. their hydrological regime.

A feature of monitoring of small rivers in the cities is the presence of only one observation post at their mouths in the absence of an organized wastewater discharge (according to clause 5.1.2 of
Working Documentation 52.24.309-2011 [1]). Observations are carried out monthly, and in the main phases of the water regime more often: during high water - on the rise, peak and fall, during the summer low water period - during the passage of a rain flood [2]. An example of observation posts for water bodies of the city of Novosibirsk is shown in the figure 1 [4, 5].

Figure 1. Observation posts on water bodies of the city of Novosibirsk.

Small rivers are unique natural objects that experience colossal anthropogenic pressure [9, 10]. For example, the small rivers of the city of Novosibirsk have lost their former significance. Over the past 40-50 years, water has not been taken from the rivers of Novosibirsk for household needs, drinking, and their fishery value has practically been lost. According to the data of the Federal State Budgetary Institution "West Siberian UGMS", Table 1 shows the water quality of the rivers of the city of Novosibirsk, where 4 «A» and 4 «Б» - dirty; 4 «В» - very dirty; 5 - extremely dirty. The negative impact of intensive economic activity on the small rivers is manifested in a change in the volume and flow regime, violation of the hydrochemical regime, their siltation and shallowing, water quality deterioration.

The small rivers are characterized by low self-cleaning ability [3]. The complexity of the processes of natural self-purification of natural waters is caused by the variety of pollutants, specific features of water channels. Among the unfavorable factors affecting the self-purification processes, chemical pollution by industrial effluents, biogenic elements, which inhibits natural oxidative processes, kills microorganisms, is of particular importance. The rate of water purification and decomposition of carbon-containing compounds depends on the temperature, oxygen availability, nutritional regime of the water environment.
Table 1. Water quality of the rivers of the city of Novosibirsk. (according to the specific combinatorial index of water pollution).

| Section location          | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---------------------------|------|------|------|------|------|------|------|
| The Inia River            | 4 «А» | 4 «А» | 4 «А» | 4 «А» | 4 «А» | 4 «А» | 4 «А» |
| The Kamenka River         | 4 «В» | 4 «Б» | 4 «Б» | 4 «Б» | 5    | 4 «В» | 4 «В» |
| The Kamyshevka River      | 4 «А» | 4 «А» | 4 «Б» | 4 «Б» | 4 «Б» | 4 «А» | 4 «А» |
| The Yeltsovka-1 River     | 4 «Б» | 4 «В» | 4 «Б» | 4 «В» | 4 «В» | 4 «В» | 4 «В» |
| The Yeltsovka-2 River     | 4 «Б» | 4 «Б» | 4 «Б» | 4 «Б» | 4 «Б» | 4 «Б» | 4 «Б» |
| The Tula River            | 4 «Б» | 4 «Б» | 4 «Б» | 4 «Б» | 4 «Б» | 4 «Б» | 4 «Б» |
| The Plyushchikha River    | 4 «В» | 4 «В» | 5    | 4 «В» | 5    | 5    | 5    |
| The L. Yeltsovka River    | 4 «А» | 4 «А» | 4 «А» | 4 «А» | 4 «А» | 4 «А» | 4 «А» |

In recent years, the attitude towards the small water bodies in the Russian cities has fundamentally changed. The active development of urban areas, the density and area of construction have led to the fact that at present an important criterion for assessing urban water bodies is their recreational significance. This is not only the degree of compliance of the state of the water body with sanitary and hygienic standards, allowing people to stay on it, but also the ability of this object to satisfy the aesthetic needs of the urban population. The floodplain-channel complexes are becoming the main elements of the projected green frame of the agglomeration, the green infrastructure of the Russian cities. The creation of projects for the ecological optimization of floodplain-channel complexes of small rivers in the cities, projects for the recreational development of park zones, including sections of small rivers, requires a number of information, for example, channel survey of the river, analysis of the state of the river in this section, quantitative and qualitative assessment, etc. [6, 7]. In this respect, all small rivers of the Russian cities are poorly researched. The role of ecological monitoring of small rivers is increasing, which makes it possible to take into account all the features and changes in time and space.

The research purpose is to study the ecological characteristics of a small river in the city of Novosibirsk, located in a park zone with a natural forest, but currently uncomfortable (from Zhukovsky street downstream of the river), where an improvement project is planned. The research object is the section of the Yeltsovka-2 river, located in the Zaeltsovsky forest.

The Yeltsovka-2 River flows through the territory of the Kalinsky, Zaeltsovsky districts in the northeastern part of Novosibirsk and discharges its waters into the Ob River near the beginning of 2-Suharnaya street. The source of the river is the Lake of Spartak. The lake and the river are fed from springs, flood and surface waters, as well as from industrial waste waters (about 60%). The length of the river is about 14 km, the width of the channel reaches 5 m in some places, and the depth is in the range of 0.1–1.2 m and more. The catchment area is about 20 km². The river's hydraulic regime is extremely uneven. The highest water flow rate are typical for the spring flood period and the period of intense rains. 80% of the length of this river it is silted, the banks erodes at a rate of 20 cm / year, overflows for 4-5 days during the year, the water flow decreases by 25%, on the floodplains the average building density, mechanical change of the floodplain is absent [8].

2. Materials and Methods

The work of the hydrological post was organized for the organization of system observations of hydrological and ecological monitoring. Within the framework of this research, the hydrological post is located in the section of the bridge on well-fixed metal piles across the Yeltsovka-2 river, its work was carried out using the material and technical base of Novosibirsk State University of Architecture and Civil Engineering (Sibstrin). The observations were carried out as follows. Once every 2 weeks, samplings were taken to analyze the water quality, and once a week, observations were made of the quantitative indicators of the water body condition. The equipment was used to the water flow: a steel
rod (to determine the water level and depths at 8 verticals in the alignment of the hydrological post) and a hydrometric flow meter GR-21M (to determine the speed of the water flow) [12].

The assessment of water quality was carried out according to the following hydrochemical indicators: chemical oxygen demand (COD), nitrate, nitrite, iron, phosphates, ammonium nitrogen, hardness, pH. The first seven indicators were determined using a spectrophotometer DR 3900 from LANGE (made in Germany). Its scope includes surface water quality control. The available electronic and optical components of this device provide sufficiently accurate results (photometric error is 0.005A or 1%). The pH was determined using a Biomer pH meter [11].

3. Discussion
To determine the water flow rate according to the continuity equation \( Q = V \times w \) water depths at 8 verticals in the alignment of the hydrological post were measured to calculate the cross-sectional area. The velocities of the water flow were measured with hydrometric flow meter on the same verticals to determine the average velocity in the section.

All the data that was obtained was first recorded in the diary, then entered into the table, a fragment of which is given in the Table 2.

**Table 2.** Depth data (cm) and water flow rates \( Q_{\text{average}} \), m\(^3\)/c in the alignment of the hydrological post of the Yeltsovka-2 River.

| Date   | "0" | "1" | "2" | "3" | "4" | "5" | "6" | "7" | "8" | \( Q_{\text{average}} \) |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------------------|
| 10.03. | 0   | 15  | 168 | 149 | 122 | 85  | 50  | 50  | 50  | 1.25                 |
| 17.03. | 2   | 15  | 170 | 145 | 125 | 85  | 52  | 50  | 50  | 1.25                 |
| 31.03. | 17  | 40  | 185 | 165 | 155 | 115 | 93  | 55  | 40  | 1.6                  |
| 04.04. | 25  | 63  | 205 | 185 | 170 | 130 | 115 | 95  | 85  | 1.8                  |
| 08.04. | 10  | 35  | 175 | 136 | 120 | 83  | 92  | 72  | 63  | 1.5                  |
| 16.04. | 11  | 37  | 176 | 137 | 120 | 80  | 90  | 70  | 60  | 1.5                  |

According to the data obtained in Table 2, graphs of changes in water depths \( H \), cm, are plotted, presented in Figure 2, on which the verticals of the hydrological post are marked on the abscissa. Figure 3 shows the dependence \( Q = f(H) \), where \( V \) – the water level relative to “0” of the hydrological post.

**Figure 2.** Change of the water depths in the hydrological post of the Eltsovka-2 River.
Table 3 was compiled to assess the water quality of the Yeltsovka-2 river in the section. Table 3 shows that the COD value exceeds the maximum permissible value. It can be assumed that this value is influenced by the volume and regime of wastewater.

![Graph of dependence Q = f(H)](image)

Figure 3. Graph of dependence Q = f(H).

Table 3. Assessment of the water quality.

| Name            | Permissible value | 13.03. | 20.03. |
|-----------------|-------------------|--------|--------|
| Ammonium nitrogen | Up to 14.45 mg/l  | 0.425 mg/l | 0.36 mg/l |
| Nitrite         | Up to 0.08 mg/l  | 0.039 mg/l | 0.049 mg/l |
| Nitrate         | Up to 9.1 mg/l  | 1.84 mg/l | 1.88 mg/l |
| Phosphates     | Up to 0.2 mg/l  | 0.056 mg/l | 0.062 mg/l |
| COD             | Up to 12 mg/l  | 28.3 mg/l | 14.7 mg/l |
| pH              | 6.5 to 8.5       | 7.2     | 7.74 |
| Iron            | Up to 0.3 mg/l  | 0.890 mg/l | 0.18 mg/l |
| Hardness        | Up to 7 mg-eq/l | 6.75 mg-eq/l | 6.75 mg-eq/l |

4. Results
The state of the Yeltsovka-2 River in the selected area (according to 8 indicators) is generally satisfactory. However, to assess the possibility of using the selected area for recreational purposes, it is necessary to organize hydrological and ecological monitoring, including monitoring a large number of indicators of water quality, hydrochemical, hydrological regimes of water flow, etc.

The results of this research can be used in the following areas of practical activity of the city of Novosibirsk: when organizing environmental control over the state of the territory of Novosibirsk, in the development and implementation of engineering and technical measures to restore the recreational potential of the Eltsovka-2 River.

5. Conclusion
This research work is a small part and a small example of the necessary hydrological and ecological monitoring of small rivers in the cities. The need of it in park zones is justified by the great attention of the city public and the desire of the citizens to create recreation zones near their homes, the central place of which is occupied by sections of small rivers. The tasks of this type of work are in the main blocks of monitoring: monitoring system for the state of water bodies and its changes; collection, processing, storage of data; analysis, calculation and forecast of changes in the standing of water bodies; transmission of results to consumers.
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