Current problems of environmental monitoring in urban agglomerations at the regions of Russia

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Abstract. This article outlines the results of a study of environmental problems and environmental monitoring conducted in large cities located in the territories of the subjects of the Russian Federation, in particular, at the territory of Krasnoyarsk Krai, a subject of the Russian Federation. Meanwhile, the main trends in the development of cities and the urban environment as a whole are indicated. The paper provides data on the pollution of water resources of the Krasnoyarsk Krai, caused, among other things, by the anthropogenic impact on the environment, and identifies environmental problems arising from the functioning and development of large urban agglomerations. In addition, the tasks and problems associated with the realization of environmental monitoring have been investigated, the prospects for its application in cities have been determined, and the tasks solvable by using data on the state of the natural urban environment, as well as areas close to the city and experiencing serious impacts due to the livelihood of the urban population, have been identified. Within the study, sufficient attention is paid to the issues of ensuring the purity of water resources used in urban agglomerations, the issues of environmental pollution caused by accumulations of waste of the urban population at urban landfills, as well as landfills positioned in areas adjacent to cities, the problems of changes in the landscape, soil, and vegetation cover in large cities. The issues of atmospheric air pollution in large urban agglomerations are also considered.

1. Introduction
The topicality of the problem considered in the study is determined by the current situation, due to the need to ensure the environmental well-being of the population of the country, and favorable and acceptable living conditions of residents of urban agglomerations [1], [2].

It is clear that any relatively large urban agglomeration is a population center that facilitates organization of citizens' livelihoods, as well as functioning of industry, transport and other social and economic components [3].

The larger the agglomeration, the more developed the industrial production and utilities are [4], which in turn has a huge impact on the natural environment at the city location [5]. This affects the redistribution, concentration and dispersion into the environment of significant amounts of chemical compounds of both natural and technogenic origin [6].

Emissions of waste of life of the urban population or industrial enterprises quite often are of uncontrolled, arbitrary nature. That is why the creation and operation of the environmental monitoring system is one of the main pressing tasks of environmental protection in general.
It is obvious that a well-established and well-functioning system of environmental control, regulation of emissions into the atmosphere and water sources will ensure the environmental safety of people's life, as well as the effective development of urban society as a whole. Monitoring the environmental safety of urban settlements thus becomes a necessary and integral part of our existence that ensures the prosperity and survival of the urban population.

2. Problem setup
The main goal of our study is to establish a range of problems ensuring the process of control and quality monitoring of the environmental state of natural areas of urban agglomerations, which directly affects the well-being of the population living in the cities of the Russian Federation.

3. Research questions
The study will provide answers to the following questions:
1. Which factors and conditions should be taken into account during environmental monitoring in densely populated cities?
2. Which major environmental problems are characteristic for the urban agglomerations at the regions of the Russian Federation?
3. Which problems and challenges of urban agglomeration environmental safety monitoring do specialists face?
4. What are the prospects for environmental monitoring in urban agglomerations?

4. Purpose of the study
The main purpose of our study is detection of environmental problems in urban agglomerations and identification of ways to effectively monitor environmental conditions in densely populated cities.

5. Research methods
The research methods used in our study are:
- theoretical (analysis of scientific literature, analysis and comparison of results of using ecological engineering in large urban agglomerations);
- empirical (observation, etc.).

6. Results and discussion
Concerning the study of the environmental well-being of the population of densely populated urban agglomerations, we should note that in order to implement effective and optimal control (monitoring) of the environment, it is necessary to take into account the main features of the transformation of the geological situation within large cities associated with the trends in the construction of urban agglomerations.

One of the leading trends in the modern formation of urban agglomerations is the tendency to significantly increase the number of large cities surrounded by smaller satellites.

The following trend is the consequence of the first one and is defined as the increase in the floor count of the buildings constructed. This trend is also determined by the lack of territory, and, consequently, by the need to meet the real estate requirements of the population not by increasing the area of development, but by increasing the number of floors.

In addition, the need to expand urban agglomerations is also formed by the development of land previously unsuitable for construction, such as swamps, ravines, contaminated areas, etc.

Also, we should note that the functioning of a large urban agglomeration causes a significant dynamic impact on the land under them.

It is also necessary to understand that all the urban areas can be divided into two large groups: territories inhabited by people and territories where people do not live.
Undoubtedly, in large urban areas, the territories inhabited by the population usually make up 40 to 60% of the entire territory of the city, and the rest of the territories include such zones as industrial, recreational, sanitary, etc.

Thus, to establish a network of environmental monitoring points in large urban agglomerations, as well as to properly plan and carry out monitoring and observation through various instrumentation equipment, it is necessary to take into account the current trends in the development of large cities [7], and to determine the features of the spatial structure of the development of the territory at each specific urban settlement, taking into account their quantitative as well as qualitative parameters.

Moving on to the research and identification of the major environmental problems of modern large cities, it should be noted that these problems are multifaceted, quite diverse and tend to be multidimensional in nature [8].

Meanwhile, it is possible to identify a number of problems that are characteristic of any large city in the Russian Federation and not just them [9].

For example, often, in large cities we can observe significant anthropogenic changes in soil relief, namely, the alignment of land surfaces, destruction and systemic disappearance of the microrelief, change of depth, dismemberment of relief surfaces, change of the inclination of the relief surface.

Such changes in land resources lead to problems with water basins, which determine the water resources of large urban agglomerations, as they simplify their structure, reduce the natural relief slopes that form the delivery of water to these basins due to the reduced intensity of water flow from the surface.

In addition, in large urban agglomerations mainly due to the intensive use of groundwater and surface water by industrial and other economic entities, water resources are being depleted. At the same time, funnels form in the water intake locations, water resources become polluted, and the hydrochemical composition of groundwater changes.

In general, we should note that the problem of water quality in large urban agglomerations is one of the most important [10], [11].

Supporting these arguments, we will cite the data on pollution of water bodies in the Krasnoyarsk Krai for 2020. During this period, 7 cases of ultra-high pollution were recorded at 5 water bodies (table 1) and 31 cases of high pollution at 15 water bodies (table 2).

**Table 1. Ultra-high pollution of water bodies in Krasnoyarsk Krai in 2020.**

| No. | Water body / monitoring point | Pollution ingredient | Concentration, mg/dm |
|-----|-------------------------------|----------------------|----------------------|
| 1.  | Lower Tunguska river / uts. a Tura | Copper ions | 0.083 |
| 2.  | Boguchanskoye reservoir / above the dam of the Boguchanskoe reservoir | Copper ions | 0.055 |
| 3.  | Serezh river / Anthropovo village | Copper ions | 0.058 |
| 4.  | Schuchya river / Norilsk city | Petroleum products | 7.93 |
|     |                               | Cadmium ions | 0.0096 |
|     |                               | Nickel ions  | 0.503  |
| 5.  | Adadyym river / Nozarovo city | Manganese ions | 0.616 |

a urban-type settlement

**Table 2. High pollution of water bodies in Krasnoyarsk Krai in 2020.**

| No. | Water body / monitoring point / number of pollution cases | Pollution ingredient | Concentration, in fractions of the maximum allowable concentration |
|-----|-------------------------------------------------------|----------------------|-----------------------------------------------|
| 1.  | Lower Tunguska river / uts. Tura / 3 | Copper ions | 36.0–43.0 |
|     |                                             | Zinc ions  | 14.3   |
2. Boguchanskoye reservoir / above the dam of the Boguchanskoye reservoir / 1
   Copper ions 34.0
3. Serezh river / Anthropovo village / 1
   Copper ions 33.0
4. Schuchya river / Norilsk city / 12
   Cadmium ions 17.1–49.0 Nickel ions 3.0–4.4
5. Adadym river / Nozarovo city / 2
   Manganese ions 42.6–49.5
6. Kacha river / Krasnoyarsk city / 1
   Manganese ions 33.4
7. Chulyam river / Achinsk city / 2
   Copper ions 31.0–39.0
8. Kamenka river / Kamenka village / 1
   Copper ions 37.0
9. Chadobets river / above the mouth of the Chadobets river / 1
   Copper ions 31.0
10. Yenisei river / uts. Strelka / 1
    Zinc ions 11.1
11. Yenisei river / Podtesvo village / 2
    Zinc ions 12.1–13.3
12. Karabula river / above the mouth of the Karabula river / 1
    Copper ions 34.0
13. Ambarnaya river / Alykel railway station / 1
    Nickel ions 17.8
14. Daldykan river / Alykel railway station / 1
    Cadmium ions 3.0
15. Norilsk river / Norilsk city / 1
    Nickel ions 11.7

Thus, we see quite frequent and significant pollution of the water resources of urban agglomerations, which can not but affect their environmental situation, and, consequently, the quality of life and health of urban population.

Accordingly, high-quality, timely and systematic monitoring of water resources, tracking the facts of water pollution is highly important for the environmental situation of a large urban agglomeration, and the quality of life of its population.

Another important, significant environmental problem of large urban agglomerations is the systematic pollution of the air [13].

We should note here that atmospheric pollution can be easily identified through monitoring, as well as the dynamics of air changes in large urban agglomerations can be easily recorded.

At the same time, the atmospheric pollution is strongly influenced by the industries operating in a particular city. Despite the positive changes in the use of treatment facilities by enterprises of ferrous and non-ferrous metallurgy, as well as oil and gas processing enterprises, the problem of harmful emissions of such economic entities is still relevant. Also, we should take into account the associated gas flaring accompanying the operation of industrial enterprises.

In addition, another significant problem is the operation of thermal power plants, which provide the urban agglomerations with heat. Such facilities operate on coal, the burning of which particularly heavily pollutes the atmosphere of major cities. This process is aggravated by the length of the heating season in large cities, located in a zone with cold climatic conditions, as well as features of the relief location of large cities.

For example, Krasnoyarsk is located mainly within the terrace complex, surrounded by heights and slopes. Accordingly, it can be said that this urban agglomeration is located in some sense in the "pot". This location in windless weather prevents intense change of air masses, and therefore, the polluted air "dome" hangs over the city, and environmental monitoring of the air records the "black sky" regime.

We should note that such circumstances once again emphasize the importance of timely systematic monitoring of air indicators of large urban agglomerations to adjust the operation of industrial and heating urban enterprises.

Another environmental problem of cities is biochemical pollution caused by landfills of various urban wastes, often located in cities or in their immediate vicinity. Complex organic matter, dissolved in the process of aerobic decomposition, accumulates in landfills. Accordingly, surface waters flowing through landfills are polluted due to oxidation by these compounds and can dissolve carbonate rocks,
cause corrosion of various buildings and structures. In addition, in the case of poor aeration, gaseous substances such as ammonia, hydrogen sulfide, methane, etc. are released into the atmosphere. At the same time, for example, excess hydrogen sulfide emissions adversely affect living organisms, increase corrosion processes in metal structures, increase the aggressiveness of water and soils. An excess of methane, in its turn, inhibits vegetation, which leads to a decrease in the concentration of oxygen in the atmospheric air.

Analyzing the above environmental problems, we should note that the experts monitoring and controlling the environmental situation in cities face a difficult goal: to provide quality monitoring of the state of basic natural resources, the state of the animal and plant world. We should also note here the need to compare various indicators and data in order to adjust the life of the city as a whole and its individual structures and spheres in particular, maximizing the preservation of the biosphere, as well as ensuring the favorable development of large urban agglomerations.

Thus, environmental monitoring in cities should consist not only of collection and analysis of the data received, but also of preparation of the necessary recommendations to improve and restore the natural urban environment and minimize the anthropogenic impact on it [14].

Accordingly, we believe that environmental monitoring acts in modern society as a promising element of regulation of the livelihood of the population of cities and other settlements, and its application in the system and on the digital platforms will ensure rapid collection, processing, and storage of the data received, and most importantly, adjustment of the activities and functioning of urban structures and the population as a whole. At the same time, we would like to emphasize that our point of view is shared by many researchers [15].

7. Conclusions
The environmental problems of modern large urban agglomerations are multifaceted in nature and are associated with strong negative anthropogenic impact on the environment.

For the efficient and safe development and functioning of large urban agglomerations, it is necessary to carry out systematic environmental monitoring of the environmental state of cities (atmosphere, soil, water, vegetation, etc.).

Environmental monitoring should not only allow to accumulate, analyze and generalize complete data on the state of biosphere, but also propose necessary actions to improve the legal and socioeconomic policies of urban agglomeration management to reduce anthropogenic impacts on the environment.

Environmental monitoring now becomes a tool necessary for ensuring safe and productive livelihood of cities and urban populations.

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