

Urban environment quality assessment and its ecological factors

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Abstract. The article analyses the international and domestic experience of integrated approach and the process of indicators system formation for the urban environment quality assessment. The analysis of the presented indexes and indicators systems of the urban development quality showed that the ecological factors and the quality of urban environment occupy a significant place among the main components of the assessment. It is noted that during the last decade in the Russian Federation there was significantly increased an interest for the development of various indicators and mechanisms for a comprehensive assessment of the situation for solving economic, social and environmental problems in regions and cities. One of the generally accepted approach creation process results was the approval of the Methodology for the formation of the Urban Environment Quality Index. The possibilities of taking into account such ecological factors like the atmospheric air pollution, water bodies quality, the elimination of accumulated environmental damage results and a noise level were analysed in the Urban Environment Quality Index. It is concluded that at the first stage of expanding and optimizing the criteria system for calculating the Urban Environment Quality Index, it is necessary to consider the possibility of applying criteria reflecting the results of federal projects to resolve environmental problems of cities for the development of the urban environment and improving its quality.

1 Introduction

At the largest UN conference of the XXI century in Rio de Janeiro (2012), dedicated to sustainable development, it was noted the need for a holistic approach for urban planning and management of urban development. In international and domestic practice, considerable experience has been accumulated in comparing cities on the basis of structured systems of criteria that allow us to judge the state or change of economic, social and environmental conditions. One of the first comprehensive development in this area can be considered a system of indicators of sustainable development proposed by the UN Commission on Sustainable Development. [1] At the moment, international organizations,

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countries, cities, and organizations already have official integral indicators (indexes) and indicator systems for assessing urban development. Here there are some examples:

- ecological and socio-economic index of Adjusted Net Savings, used by the World Bank;

- a joint project of the United Nations Environmental Protection Program (UNEP) and the Non-profit Center for Environmental Communications GRID-Arendal to develop a system of indicators of the life quality in cities to summarize information and prepare reports on the state of the environment in cities, as well as to analyze and solve urban problems;

- practically oriented indicators of urban development for Global Urban Monitoring Framework within the framework of the United Nations Human Settlements Program (UN-Habitat);

- the UN-Habitat City Prosperity Index, proposed by the United Nations Human Settlements Program (UN-Habitat);

- Human Development Index, developed by the United Nations Development Programme (UNDP);

- principles of the European Charter of Cities;

- a tool of the World Health Organization (WHO) for assessing the quality of life of the urban population of WHOQOL and proposals for taking into account its results in urban territorial planning;

- EU project on the creation of indicators for monitoring the strategy for sustainable urban development EU-TISSUE;

- the "smart city" model;

- the project "Indicators of Glasgow" by the Center for the Glasgow Population Health Protection;

- a project of the World Wildlife Fund (WWF) of Russia and RIA Novosti to develop an ecological and economic index that takes into account the environmental, economic and social factors of the Russian Federation regions development;

- The Global Ecological Footprint project to measure the level of consumption of natural capital by cities and regions and compare it with the available reserves of renewable resources;

- other approaches to the assessment of urban development based on comprehensive knowledge: Cities Globalization Index (the number of global connections and firms providing consulting services in the city), The Global Cities Index (the level of business activity, human capital development, information exchange, cultural level and the political weight of the city), Global Cities Outlook (level of personal well-being of residents, economic development, innovation potential, urban governance), Global Power City Index (economics, research and development, cultural contacts, environment, accessibility of movement), Prime Global Cities Index (assessment of the real estate market for each city), Global Economic Power Index (economic development, financial opportunities and infrastructure, innovation potential), Global City Competitiveness Index (economy, infrastructure, finance, quality of institutions, socio-cultural factors, human capital, environment and natural threats, global integration), Knowledge-based urban development Assessment Model (KBUD/AM) (economics, socio-cultural development, the role of the environment in urban development, development of institutions), Quality of Living Survey (political and social environment, economic environment, socio-cultural environment, healthcare, education, public services and transport, recreational resources, consumer goods, non-property, environment). [2]

The analysis of the presented indexes and systems of indicators of urban development shows that the ecological factors and the quality of urban environment occupy a significant place among the main components of the urban environment quality assessment.

2 Methods

The Urban Environment Quality Index (UEQI) is a tool for assessing the quality of the material urban environment and the conditions for its formation, which allows using the results of the assessment to create recommendations for improving the environment.

The index is formed by the Ministry of Construction and Housing and Communal Services of the Russian Federation. The results of the Index formation are used in the implementation of the provisions of the Decree of the President of the Russian Federation dated 21.07.2020 No. 474 "About National Goals of the Russian Federation Development for the period up to 2030", the national project "Housing and Urban Environment", including for determining the amount of subsidies from the federal budget to the budgets of the constituent entities of the Russian Federation to support state programs of the constituent entities of the Russian Federation and municipal programs for the formation of a modern urban environment. [3]

The index is formed on the basis of an assessment of six types of urban spaces in accordance with six criteria for the quality of the urban environment. This assessment implies the allocation of one key indicator for each type of space for each of the criteria. As a result, an evaluation matrix of 36 indicators is formed. Since the quality of the urban environment is not a simple sum of the quality of housing, streets, landscaping, infrastructure, etc. and it also requires an assessment based on indicators, the values of which are calculated for the entire city, a citywide space is added to individual types of spaces in the matrix, in fact combining all the others. This is designed to make the Index calculation as complete and efficient as possible. [4]

The calculation of the index is carried out in several stages:

1. Data collection and calculation of indicator values

At this stage, the initial data is collected and the values of the indicators are calculated. 36 Index indicators are selected taking into account the possibility of a one-time and relevant assessment of the quality of the urban environment of all cities of the Russian Federation, as well as the availability of data for desk analysis.

The main methods of collecting information for the formation of the Index are state statistics, data from geoinformation systems and remote sensing of territories.

2. Definition of size and climate groups

According to the Methodology, the cities are divided into 10 climatic and dimensional groups for the correct compilation of assessment scales. When assigning a city to the corresponding group, 2 indicators are taken into account: the geographical location of the city (unchanged indicator) and the population of the city (updated annually according to the Federal State Statistics Service as preceding the year of the assessment).

According to the Methodology, two climatic territories of the Russian Federation are distinguished: conditionally comfortable climate and severe climatic conditions.

3. Calculation of point values of indicators

Within each size and climate group of cities, an individual 10-point scale is formed, the maximum and minimum values of indicators corresponding to a certain score are set.

A separate assessment scale is built for each size and climate group. As a result, the cities with the highest indicator values in the group receive 10 points, the cities with the lowest — 1 point.

4. Calculation of the city index

The city index is calculated as the sum of points for all 36 indicators, evaluated on a scale from 0 to 10. Thus, the city index is measured on a scale from 0 to 360 points.

Depending on the final score, the quality of the urban environment is determined.

Unfavorable urban environment — the index of the city is in the range from 0 to 180 points.

Favorable urban environment — the city index ranges from 181 to 360 points. [4]

3 Results

In accordance with the national goals and strategic objectives of the economic and social development in the Russian Federation, one of the main conditions for the urban areas development should be to ensure the environment's comfort and safety. At the same time, special attention is paid to the comfort and safety of the environment in the strategy:

- quality, attractiveness and accessibility of the urban environment;
- creation of a sustainable and rational system of solid municipal waste management;
- reducing emissions of pollutants that have a negative impact on the environment and public health;
- elimination of dangerous objects of accumulated harm to the environment;
- ecological improvement of water bodies.

During the last decade, there has been significantly increased an interest to the development of various indicators and mechanisms for a comprehensive assessment of the situation for solving economic, social and environmental problems in cities and regions in the Russian Federation. In INFRAGRIN Annual Report "Regions and Cities of Russia: sustainable development and socio-ecological priorities in management 2023" there was presented a list of existing ratings (rankings) for 2023 for assessing economic and socio-environmental factors in the management in the subjects of the Russian Federation. [5]

One of the long process of creating a generally accepted approach results was the approval of the Methodology for the Formation of the Urban Environment Quality Index (UEQI) in 2019 by the Government of the Russian Federation. In 2020 based on that document there were submitted "Guidelines for determining priority areas for the development of the urban environment with the help of the Urban Environment Quality Index" by the Ministry of Construction and Housing and Communal Services of the Russian Federation. [6]

Depending on the value of the UEQI, two qualitative levels of the urban environment's comfort and safety can be distinguished:

- Favourable environment (181 points or higher out of 360 points according to 36 criteria);
- Unfavourable environment (up to 180 points inclusive of 360 points according to 36 criteria).

In order to monitor the quality of the urban environment and its changes, as well as to assess the effectiveness of measures to improve the urban environment's comfort and safety, the Ministry of Construction of Russia carries out the I UEQI calculation annually.

According to the UEQI 2018 calculation results, the share of Russian cities corresponding to the "Favourable Environment" level was 23%, the average value of ICGS was 163 points, and by the end of 2022, the share of such cities was already 54%, and the average value of ICGS in the country reached 192 points.

St. Petersburg is the largest city with a relatively comfortable climate, showed an increase in the value of UEQI for the period 2018-2022 from 238 to 264 points. [4]

UEQI is undoubtedly one of the tools for assessing the dynamics of the life quality, focusing on specific aspects of urban improvement and development, and teaching innovations in specific areas of urban development. However, we note that the growth of cities with a favourable environment in the period 2018-2022 is observed in the context of the system of indicators development for assessing the work of regional authorities effectiveness (in 2017-2021, several indicators lists of the executive power effectiveness for regions were adopted by the Presidential Decrees, including "a quality of the urban

environment" and "quality of the natural environment"). At the present moment there is no mechanism for assessing and taking into account the importance of UEQI indicators for certain territories, and the criteria do not reflect all aspects of the urban population life.

Considering that in the Russian Federation, the environmental factor significantly determines the quality of life of the country's urban population majority, and therefore indicators reflecting the ecological state of territories acquire a huge role in the formation of a comfortable and high-quality urban environment, we note the lack of attention in the UEQI to environmental criteria. The criteria of environmental safety in the UEQI are represented by the share of solid municipal waste directed to processing and disposal in the total volume of waste generated; the share of green areas of common use in the total area of green spaces; the level of landscaping; the state of green spaces associated with the levels of pollution of the atmosphere, soils and surface waters; the share of the population with access to green areas of common use in the total population. This generally corresponds to the domestic and international practice of creating systems of environmental criteria for assessing the quality of life in cities and settlements. However, it is necessary to recommend paying attention to indicators that are significant for research, monitoring and statistics in the field of environmental protection and environmental safety in Russia.

First of all, the UEQI criteria should take into account the impact on the urban population of the level of atmospheric air pollution by the main pollutants - nitrogen dioxide, carbon dioxide, sulfur dioxide, nitrogen oxide, benz(a)pyrene, formaldehyde, as well as relatively recently entered the field of view of environmental monitoring systems large and large cities with ozone and fine-dispersed suspended particles (PM – Particulate Matter) PM2.5 (size up to 2.5 microns) and PM10 (size up to 10 microns). PM can include inorganic components, soot, biological components, aluminum, iron, sodium and zinc are inorganic components in road transport dust, and manganese, iron, lead, nickel, chromium, copper, cadmium, vanadium are in industrial dust. [7] The ongoing medical research has proved the priority for the morbidity and mortality of the urban population of the level of air pollution by solid particles, in connection with which the World Health Organization in 2005 established and in 2021 tightened the permissible levels of atmospheric air pollution PM2.5 and PM10.

Data on air pollution in cities and regions are provided in Reports on the environmental situation for the year. For St. Petersburg, such data are generated on the basis of information received, including from the automated atmospheric air monitoring system (AFM-AB) of the Committee for Nature Management, Environmental Protection and Environmental Safety. Monitoring data on concentrations of pollutants in the atmospheric air of St. Petersburg, presented in Reports on the environmental situation in St. Petersburg for 2018-2021, confirm the facts of exceeding the hygienic standards for PM2.5 and PM10 established for Russia with an increase in the value of UEQI for the same period. It should be noted that St. Petersburg is one of few cities that provides monitoring data on PM.

The main problems of monitoring the level of atmospheric air pollution in cities and the possibility of taking its data into account in the UEQI can be called the problems of standardization of approaches, differences in the use of the term "suspended substances", insufficient technical equipment of monitoring points, uneven location across territories, insufficient density or absence of monitoring points on the territory, inconvenient monitoring data presentation format, lack of public monitoring systems, as well as the implementation of territorial monitoring by various departments with their own characteristics and regulatory documents. Separate regulatory, methodological and technical support is required for monitoring atmospheric air pollution PM2.5 and PM10. Despite the large number of problems in the implementation of territorial monitoring of atmospheric air quality, we note that such monitoring significantly increases the awareness of the population about the problems and about reasonable and effective solutions,

including managerial ones, to solve them, and thereby improves the quality of the urban environment.

In the period 2019-2024, the national project "Ecology" is being implemented on the territory of the Russian Federation, which is aimed at solving environmental problems and within the framework of which the federal project "Clean Air" is being implemented, aimed at reducing emissions of harmful substances into the atmosphere in the participating cities of the project and improving the system of industrial monitoring of atmospheric air on the borders of sanitary protection zones and in residential areas. The need to introduce an indicator in the UEQI that characterizes the change in the level of atmospheric air pollution is illustrated by the data on the calculation of the UEQI for 2021 for the cities participating in the Clean Air project. Of the 12 participating cities, Bratsk, Mednogorsk, Novokuznetsk, Nizhny Tagil and Omsk are classified as "Unfavourable environment", the rest have an ICGS value in the range of 181-219 and belong to the "Favourable environment" category, although the risks associated with atmospheric air pollution to the health of the population of Norilsk, Krasnoyarsk and Chita according to the results research are still very high, the presence of dust and soot in the air of Siberian cities is the cause of frequent negative emotional reactions on the part of residents, which is undoubtedly, it cannot be called factors of a favourable urban environment. [8]

Elimination of accumulated environmental damage is one of the important conditions for improving the quality of the environment and the quality of the urban environment, especially when it comes to the elimination of abandoned or idle industrial facilities and unauthorized landfills within the boundaries of cities. Such objects negatively affect the condition of lands, water bodies, atmospheric air, landscapes, vegetation, visual environment, and are sources of potential threat to the life and health of the population of the city. Therefore, by virtue of Article 80.1 of the Federal Law of 10.01.2002 No. 7-FZ "On Environmental Protection", when assessing the object of accumulated environmental damage, it is necessary to "establish the level and volume of negative impact on the environment, the possibility of contamination of water facilities, including those that are sources of drinking and domestic water supply, the possibility of environmental risks, as well as the number of people living in the territory where the object of accumulated environmental damage is located." [9]

The first option for eliminating accumulated environmental damage – in the absence of a culprit and a new owner – is an environmental protection measure, the implementation of which is entrusted to public authorities. [10] However, at this moment, the authorities of the subjects of the Russian Federation and local self-government bodies only have the right, but are not obliged to identify and assess the objects of accumulated harm. The second option is to carry out work by new owners of such facilities, who have assessed the balance of prospects and risks and have assumed the obligation to eliminate harm.

4 Discussion

As the practice shows, the potential of abandoned or idle industrial zones in St. Petersburg has recently been most effectively realized by new owners through the reuse of territories and their reorientation for the arrangement of public spaces, the creation of creative clusters, the construction of office, administrative and residential buildings, which undoubtedly contributes to a positive transformation of the urban environment. But at the same time, it is possible to talk about improving the quality of the environment and reducing the negative impact on public health only after confirming the elimination of accumulated environmental damage in accordance with the requirements of the environmental and sanitary-epidemiological legislation of the Russian Federation by the

owner of the land plot, who is responsible for the volume and quality of the work carried out. The situation is different with those objects that have been identified, inventoried, entered into a special state register, have passed the categorization procedure and can be eliminated by providing subsidies from the federal budget for co-financing reclamation measures, including within the framework of the implementation of the federal project "Clean Country" (an integral part of the national project "Ecology"). In this case, the contractor for the elimination of accumulated damage develops a work project that contains a justification for achieving environmental quality standards, sanitary and hygienic requirements and requirements for the condition of land plots for the purposes of their subsequent use, and is undergoing examination and approval.

One of the main environmental problems of cities, which significantly reduce the quality of the urban environment, is the location of production and consumption waste (unauthorized landfills and landfill). As part of the implementation of the federal project "Clean Country", special attention is paid to the elimination of unauthorized landfills within the boundaries of cities. In accordance with the Passport of the National project "Ecology" until 2024, it is planned to re-cultivate the land plots on which 191 unauthorized landfills were found on 01.01.2018 within the borders of the cities. From 2025, the "Clean Country" project will continue the General Cleaning project, preparation for which is already underway in terms of making proposals by the regions to form a list of objects of accumulated harm, including waste dumps, which will be liquidated after the completion of the current project. 1929 objects with signs of objects of accumulated environmental damage have already been identified in the subjects of the Russian Federation. [11]

The process of eliminating objects of accumulated harm will continue, therefore, when calculating the UEQI, the effectiveness and efficiency of this process should be taken into account in cities and not in terms of the total area of reclaimed land, but according to the criteria of the area of land plots returned to circulation and use and the compliance of land with environmental, sanitary and epidemiological requirements.

Most large cities are built on the banks of rivers, which have a significant impact on the formation of these cities and the quality of the urban environment. Initially, coastal land plots were considered as unsuitable and difficult for the construction of real estate and ensuring their safety, and therefore were not in demand for development. However, recently, due to the growth of cities, the development of engineering technologies, landscaping and construction, the need, along with the safety of the modern urban environment, to ensure the comfort, attractiveness and aesthetics of this environment for the population, the potential of land plots adjacent to open water bodies, including those that were previously occupied by production facilities, has been actively used, transport and other economic objects and have prerequisites for redevelopment.

Among the main directions of the modern process of revitalization (from Latin re-vita - return to life) of near-water territories, activities for the restoration of water and adjacent spaces to favourable environmental and sanitary-hygienic indicators are highlighted. [12]

Improving the safety and quality of the urban environment is impossible without ensuring the environmental safety of urban water facilities and protecting them from pollution. Water bodies and their aquariums within the city are actively used in the implementation of economic and other activities, for example, for water supply, sanitation, as transport highways and experience intensive negative technogenic and anthropogenic impacts. Therefore, often during monitoring, the water of urban surface water bodies is assessed by hydrochemical indicators and pollutants in the range "polluted" - "very dirty", the presence of debris, films and spots on the surface of water objects and other visual signs of pollution are noted.

Dispersed runoff from residential areas has a significant negative impact on water bodies. The criterion existing in the UEQI calculation methodology "The share of the street-road network provided with storm-water sewerage in the total length of the street-road network" could be attributed to environmental criteria, provided that its value is expanded to reduce the contamination of water bodies with polluted atmospheric and melted water runoff.

The Water Code of the Russian Federation prohibits designing direct-flow systems of technical water supply, dumping untreated and untreated wastewater into water bodies, and withdrawing water in a volume that has a negative impact on a water body. The legislation of the Russian Federation also defines responsibility for violations committed by subjects of economic and other activities of these requirements. However, in the realities of the existing water legislation of the Russian Federation, one should not hope for an improvement in water quality only due to changes in the practice of rationing, strengthening control and supervisory activities, expanding the capabilities and component composition of monitoring of water bodies.

The most tense ecological situation has developed in the basin of the Volga River, in connection with which, in the period 2018-2024, the federal project "Improving the Volga" (an integral part of the national project "Ecology") is being implemented, within the framework of which the modernization of treatment and hydraulic structures is being carried out, the bottom is being cleaned, and a decision has been made on additional partial financing at the expense of budgetary funds of measures for the isolation and elimination of environmental pollution sources located in the river basin, and, above all, on its banks.

The introduction of amendments to the federal project "Improvement of the Volga" in terms of financing the isolation and liquidation of a number of economic facilities allows us to hope that in addition to strengthening control over compliance with the requirements of the current legislation on the protection of water bodies, attention in cities will also be paid to deindustrialization of coastal territories, sanitation of water areas and reclamation of adjacent to them land plots, landscaping, landscaping, rational development of land plots to ensure that water bodies perform social, health and recreational functions, as well as modernization of engineering and technical infrastructure, which should be reflected in the environmental criteria of the UEQI . [13]

Noise pollution is recognized as an important factor affecting the quality of the urban environment. The problem of noise is particularly acute for the population of roadside areas, where noise levels can exceed hygienic standards and negatively affect the quality of life and significantly reduce its comfort. Therefore, we consider it appropriate and having a significant potential to influence the overall assessment of the quality of the urban environment to include in the system of criteria for calculating UEQI noise characteristics of roadside territories and noise impact zones of objects of economic and other activities, as well as the effectiveness of measures to reduce the noise burden on the population cities.

5 Conclusion

As international practice shows, when creating, distributing and developing metric systems for evaluating cities and regions, there is always a problem of the lack of necessary data from regional and city services. The only exceptions are large cities. The same problem was faced by the developers of the UEQI calculation methodology, who had to take into account the availability of a set of statistical data, their completeness to form the evaluation context and the reliability of sources.

In conclusion, we note that at the first stage of expanding and optimizing the criteria system for calculating UEQI, the possibility of applying environmental criteria reflecting

the results of federal projects to resolve environmental problems of cities for the development of the urban environment and improving its quality should be considered.

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