Quality ecological assessment of the urbanized territories’ environment

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Abstract. This article shows the results of a socially significant research, the relevance of which is constantly growing in current conditions, due to the impending global crisis. Research objectives are to develop theoretical knowledge in sphere of quality ecological assessment of the urbanized territories and identification of opportunities for their practical use in certain regions. Authors have systemized factors that affect on the quality of urban environment and identified main approaches, which are used in implementing of the quality ecological assessment of the urbanized territories’ environment. Results of ecological and hygienic assessment of air quality of Irkutsk Region’s (Russia) cities have been introduced as a part of the author’s methodology. Main sources of pollution and their impact on atmospheric pollutant emissions have been identified. Urban areas with high level of air pollution have been revealed. Based on the findings, set of measures has been proposed to restore ecological balance in Irkutsk region, the implementation of which will improve the environmental conditions of atmospheric air as one of the criteria of quality assessment of urban territories.

Methods of systemic and comparative analysis, expert opinions and social polls as well as ecological monitoring of the environment have been used during the research

1. Introduction

Quality of urban environment is an object of close attention from scientists, society, people and authorities at various levels. This problem is especially relevant for urbanized territories requiring sustainable development and increase of their competitiveness [1, 2]. A huge number of modern economists and practitioners study the issues of forming comfortable urban environment, its quality assessment and process of urban environment management [3-7].

Economical, biological and ecological factors have significant influence on the urban environment quality. The ecological principles of the Russian Federation policy developed for the next decade (until 2030) determine preservation of favorable environment as one of the strategic goals. Consequently, the minimization of negative influence on the environment with various factors of urbanized territories is the priority task [8].

Population of urbanized territories is extremely affected by techno genic influence. This fact allows to conclude that the reduction of negative impact for these territories is very relevant. Moreover, relevance of the quality assessment of urban environment is increasing too. It is especially important for disadvantaged regions, which include Nizhny Novgorod region, Orenburg region, Irkutsk Region,
Chelyabinsk region and Sverdlovsk region (according to the all-Russian public organization “Green Patrol” in 2019).

In current research, we will take a closer look at the situation in Irkutsk region where the largest power engineering, non-ferrous metallurgy and timber enterprises in Russia are situated. At the present time, the priority objective for Irkutsk region cities is to create favorable environment and support ecological balance of the territory. It confirms by results of the research, which are shown at [9, 10].

Development of cities in terms of forming the comfortable urban environment which includes social and economic, financial, industrial, personnel and other aspects, determines level of development of regional economy as a whole. Choosing a place to live, person takes into account different conditions – climatic, educational, social etc. But ecological conditions are the most important [11, 12]. In this context, we can note that more than 70% of the Russian Federation population is concentrated in cities, development of which leads to deterioration of the urban environment.

In modern conditions, there are serious ecological disruptions at the urban territories of Russia. These problems are primarily associated with environmental pollution [8, 13, 14], which negatively affects urban people’s health [15-17].

An important role in improving the quality characteristics of the environment in urban territories belongs to the development of social and ecological oriented urban-planning [18, 19].

Purpose of the research is to assess the level of chemical air pollution of the urbanized territories of Irkutsk region as a part of the urban environment quality.

2. Research methods
During the current study, various research methods have been used: statistical methods; method of expert assessment and sociological questioning; general scientific methods; system analysis method; experimental methods, which allow to make complex approach to investigate the article’s problem. Objects of this research are individual municipalities of Irkutsk region. Quality of the urban environment has been assessed according to the information from monitoring sources, which are situated in municipalities.

For achieving the target of the current research and solving assigned tasks, the necessary statistical information and laboratory data has been collected, including those presented in [20], for the period from 2005 to 2018. A special attention has been paid to the analysis of atmosphere pollution, because this aspect has the greatest influence on forming of comfortable urban environment.

In this way, the ecological monitoring of environment has been used as a main method of the research; analysis and data processing, comparative and systematization methods has been used as additional.

3. Results
Assessment of the quality of urban environment as a part of the current research has been implementing in the territory of the Irkutsk region characterized by special orographic and climatic conditions.

Complex ecological and hygienic researches suggest dynamics analysis of air pollutant emissions. The research period is 14 years (2005-2018). The monitoring of atmospheric air has been implementing in 9 municipalities (Angarsk, Bratsk, Irkutsk, Shelekhov, Ust-Ilim, Usolye-Sibirskoe, Cheremkhovo, Zima) (Figure 1). It is important to notice that every year the volume of pollutant emissions in cities of Irkutsk region from stationary sources has been carried out at the level from 502.3 to 720.3 thousand tons. The largest volume of the pollutant emissions is specific for Angarsk (from 130 to 265.6 thousand tons a year), Bratsk (from 92.9 to 124.3 thousand tons a year) and Irkutsk (from 58.5 to 70.6 thousand tons a year). The current situation in terms of pollutant emissions has led to the fact that Siberian Federal District ranks third after Krasnoyarsk territory and Kemerovo region.
Figure 1. Air pollutant emissions into the atmosphere of Irkutsk region.

The range of characteristics has assessed quality of the atmospheric air in region’s cities: data about the volume of impurity emissions; chemical pollutant conversions; meteorological parameters, taking into account impurity transfer and dispersion; integrated index of air pollution, etc. Table 1, compiled according to [20], shows the information for 2018 about the state of atmospheric air in Irkutsk Region.

There are many industrial enterprises in the territory of Irkutsk region. Their activity, taking into account the implementing of technological processes, means pollution of environment. In result, many cities are in the category of unfavorable territories.

At the present time, the process of construction of industrial facilities continues. In particular the construction of Taishet aluminum smelter which will increase the environmental burden in the region. To support ecological and economic balance of the region in terms of solving the problems cost-benefit analysis, it can be used approaches and indicators proposed in [21, 22].

Table 1 shows that the most cities have the level of air pollution rated as "very high". In almost all municipalities, the average annual concentration of individual impurities exceeds the maximum permissible concentration: in Bratsk the excess is noted for 4 types of impurities, in Irkutsk, Angarsk and Shelekhov for 3 types, in Baikalsk for 2 types, in the rest for 1 type.

Table 1. The state of atmospheric air in Irkutsk region in 2018.

| City               | Indicators                                                                 |
|--------------------|---------------------------------------------------------------------------|
|                    | Air pollution level | Exceeding annual average maximum permissible concentrations (MPC) |
| Angarsk            | «very high»         | nitrogen dioxide -1,6; benzpyrene - 5,8; ozone - 1,1.              |
| Bratsk             | «very high»         | carbon disulfide - 1,8; suspended substances - 1,5; benzpyrene -6,2; formaldehyde - 2,0; benzpyrene - 7,8; suspended particles PM 10 –1,3; |
| Irkutsk            | «very high»         | benzpyrene -14,6                                                  |
| Zima               | «very high»         | benzpyrene -14,5                                                  |
| Svirsk             | «very high»         | benzpyrene -10,1                                                  |
| Usolye-Sibirskoe   | «very high»         | benzpyrene - 8,7                                                  |
| Cheremkhovo        | «very high»         | ozone -1,3; hydrogen fluoride - 1,4; suspended particles          |
| Shelekhov          | «very high»         | PM 10 - 1,3                                                       |
| Baikalsk           | «high»              | ozone - 2,0; benzpyrene -1,7                                     |
| Sayansaks          | «high»              | benzpyrene -3,2                                                   |
Exceeding concentration of carcinogenic substances into the atmospheric air (formaldehyde and benzpyrene) is observed in 9 cities out of 10 presented in Table 1.

During a general assessment of the urban environment state, the impact of motor transport in pollutant emissions in Irkutsk region has been revealed. It causes a high level of pollution index (table 2). Despite the growth in recent years, the number of motor transport in Irkutsk Region, the pollutant emissions remain almost at the same level of 377,8 thousand tons. However, there is a growth in the city of Bratsk in 2018 of 80% compared to 2005. In Sayans, Angarsk, Ust-Ilim, Cheremkhovo the level of pollution almost do not change.

The analysis conducted by the authors allows concluding that such ecological indicator of the urban environment as air quality, in large Irkutsk Region municipalities for many years remains unsatisfactory. The consequences of such negative trends lead to poor health and the formation of environmentally related pathologies. Hence, there is an objective necessity of development of the methodology of the quality ecological assessment of the urbanized territories’ environment that allows to consider individual characteristics of assessing territories, make conclusions about the state of area and develop activities for solvation of the revealed problems in researched territories.

**Table 2. Pollutant emissions into the atmosphere from motor transport.**

| City            | Pollutant emissions, thousand tons |
|-----------------|-----------------------------------|
|                 | 2005 | 2010 | 2018 |
| Angarsk         | 32.08| 32.35| 32.20|
| Sayansk         | 5.10 | 5.79 | 5.80 |
| Bratsk          | 21.88| 39.54| 39.80|
| Irkutsk         | -    | 92.80| 65.10|
| Ust-Ilim        | 13.93| 13.62| 13.30|
| Usolye-Sibirskoe| 10.09| 9.65 | 16.80|
| Cheremkhovo     | 12.67| 12.78| 12.10|
| Shelekhov       | 9.86 | 9.72 | 10.20|
| Irkutsk region  | 377.88 | 373.87 | 377.80 |

The methodology proposed by the authors includes the following stages:

– detection of factors that influence the quality of urban environment and removal of insignificant factors;
– analysis of importance of the remaining factors in terms of main goals and objectives for development or existing territory problems;
– detection of necessity for conducting an ecological assessment of the quality of urban environment;
– collection and processing of information about ecological state of investigated urban territory, clarification of the most important ecological problems and detection of the most significant factors and sectors of economics that affect the ecological part of the investigated territory;
– situation forecast in area of the changes of urban environment quality;
– development of activities for improvement the quality of investigated urban environment.

This way, the environment of urbanized territories constantly suffers from negative influence of industrial economics sector. In hard modern conditions state, regional and municipal authorities must make a complex approach for solving of the issue of forming a favorable urban environment in the territories entrusted to them. Otherwise, it will negatively affect natural and anthropogenic sustainability and may cause negative social and economic consequences at the micro, meso and macro levels.
4. Discussion

Issues of the quality ecological assessment of the urbanized territories’ environment are debatable and require practical confirmation. Close attention is paid to discussing the problems about influence of city noise, pollutant emissions of industrial enterprises and water quality on people’s health [11,14]. Different ecological and epidemiological researches are implemented [23]. Special attention is paid to assessment of the risks related to influence of environmental factors on health of people who live in urbanized territories [13, 16, 24, 25]. This problem is the most relevant for children [12, 15].

In hard modern conditions, it is necessary to reduce the negative impact of city environment factors on health of urbanized territory population while increasing the objectivity of quality ecological assessment of urban environment.

Conclusion

The research conducted by the authors has allowed to solve the following tasks in sphere of quality ecological assessment of the urbanized territories’ environment:

1. Possibility of an integrated assessment of the quality of the urban environment of cities with overloaded industrial infrastructure has been considered. The role and significance of ecological assessment of specified territories have been determined.
2. Main factors that determine the quality of industrial city environment have been revealed. These factors have been systematized and characterized.
3. Formal ecological assessment approaches of urbanized territories’ environment have been justified
4. The methodology of quality ecological assessment of urban environment that allows to take into account individual features of estimated territories (natural and climatic, demographic, anthropogenic, technogenic, ecological, social and economic features) has been developed.
5. Comparative analysis of ecological characteristics for individual municipalities of Irkutsk region to assess the quality of these territories environment, reveal existing problems and develop activities for their liquidation, has been conducted.

Practical value of the scientific research conducted by the authors is to develop the system of administrative, technological, planning and sanitary measures aimed to solving revealed problems of Irkutsk region in field of formation quality urban environment. Results of the research and developed proposals may be used by regional and municipal authorities for restoration of ecological balance in territory of Irkutsk region.

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