

Quality assessment of urban environment

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Abstract. Socio-economic and ecological stability of an urban area is closely related to environmental management. The best way to determine the urban environment is the quality rating system. The research aimed to determine indicators of urban development quality and their weight coefficient using the analytic hierarchy process (AHP) method. The study reveals five main groups of indicators where safety and ecology of the urban environment has the biggest influence on the quality of urban development.

1 Introduction

The development of urban areas is closely related to environmental management (EM). The environmental management system includes the quality management of the urban environment to the extent that it relates to the technologies and approaches development for effective management of the main problems associated with strengthening of environmental potential. It includes environmental protection, directions of environmental activities, development and improvement of EM mechanism, assessment of resources, methods for calculating the economic damage from environmental pollution, determination of the economic efficiency from implementation of environmental measures, methods for determining the size of payments for pollution of the environment, etc.

The following concepts are of interest for EM development:

1. Ecological capacity is the overall ability of an ecosystem to maintain its natural, original, or current condition and to produce goods and services [1]. It is related to the ability of the natural environment to contain anthropogenic pressures, harmful chemical and other effects to the extent that they do not lead to land degradation and the entire environment. It can be characterized by:

- the share of environmentally friendly products in total GDP;
- specific values of pollution per 1 unit of final products.

In the system of international indicators, the ecological potential displays the volume of emissions of harmful substances per unit of GDP [2].

2. Ecological equilibrium determines and regulates the load on nature (discharge, emission, load, concentration, degradation), since the loads beyond its capabilities (capacity) lead to a

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violation of the natural law of ecological balance. Maximum permissible norms of load on the environment, taking into account its potential (permissible emissions and discharges; maximum permissible concentrations; maximum permissible levels, etc.), are regulated by the Russian Environmental Protection Law [3].

3. *Environmental security* is the major challenge concerns the global environmental change, focusing on the interactions between ecosystems and mankind, the effects of global environmental change on environmental degradation, the effects of increasing social request for resources, ecosystem services, and environmental goods [4]. It reflects the level of environmental and vital human eco-protection from the possible negative impact of economic and other activities, emergencies of natural and technogenic character. Environmental security is one of the main components of economic security, along with food security, information security, demographic security, etc.

2 Materials and methods

The quite proper way to determine the urban environment is the quality rating system. It is a method for calculating and comparing the quality of an urban environment based on collecting, describing and evaluating quantitative and qualitative indicators.

For the study, the quantitative indicators were taken from the annual statistical data posted on Federal State Statistic Service web-resource [5]. Evaluation objects independently produced the qualitative indicators.

The purpose of the ranking is to conduct an integrated, collective, public analysis of the urban environment, comparing the urban environments, assessing strengths and weaknesses, preparing data for management analysis and personnel decisions [6].

The expert surveys helped to identify several basic blocks with a list of indicators to assess the quality of the urban environment (Table 1):

- Economy of the urban environment, E_U ;
- Safety and ecology of the urban environment, SE_U ;
- Architecture and landscape of the urban environment and housing, AL_U ;
- Social environment and leisure infrastructure of the urban environment, SEL_U ;
- Engineering and transport infrastructure of the urban environment, ETI_U .

To determine the weight coefficients, was used the analytic hierarchy process (AHP) developed by Thomas L. Saaty [7]. The AHP is a structured technique for organizing and analysing complex decisions, based on mathematics and psychology. It helps to structure a complex decision-making problem on the basis of a scale relations in the form of a hierarchy. The AHP converts evaluations to numerical values that can be processed and compared over the entire range of the problem in a clear and rational way.

3 Results

Our studies determine the contribution of each indicators group to the overall assessment of the urban environment quality.

Table 1. The main indicators determining the quality of the urban environment.

Economy of the urban environment, E_U
Expenses for the implementation of programs for the development of small and medium businesses
The share of budget funds allocated for environmental protection
The share of local budget funds aimed at landscaping, street lighting and landscaping
The share of budget funds directed to the renewal and repair of yard areas, apartment buildings, entrances to yard areas
The share of budget funds aimed at the development of engineering infrastructure, including roads (attributable to the costs of the municipal road fund)

Safety and ecology of the urban environment, SE_U	
The amount of pollutants per capita, waste from all stationary sources	
Air emissions density of pollutants from stationary sources	
Amount of solid domestic waste removed	
The crime rate	
Number of victims in traffic accidents	
Number of accidents per capita	
Number of participants in voluntary organizations for the protection of public order	
Architecture and landscape of the urban environment and housing, AL_U	
Provision of the population with housings	
Share of dilapidated and emergency housings in the total housing	
The area of land plots allocated for construction	
The share of green space within the city limits in the total area of urban land within the city limits	
New housing constructions, variety of residential buildings	
City illumination level	
Social environment and leisure infrastructure of the urban environment, SELI_U	
Rate of migration increase	
Provision of the population with doctors	
Share of students in educational institutions engaged in the second (third) shift in the total number of students in educational institutions	
The level of actual provision of cultural institutions	
The size of retail areas	
Capacity of foodservice institutions in catering industry	
Engineering and transport infrastructure of the urban environment, ETI_U	
The share of vehicles equipped with equipment for people with limited mobility	
Passenger traffic of urban public transport	
Average distance between public transport stops	
Road congestion	
Share of replaced water and steam heat networks	
Share of the replaced street water supply system	
Share of replaced street sewer network	
The level of gasification of the city	

The results of the indicators calculation based on the analytic hierarchy process represented in Table 2.

Table 2. Calculation of weighting factors.

	E_U	SE_U	AL_U	SELI_U	ETI_U	Score	Weight
E_U	1.000	2.284	3.121	2.554	3.108	12.067	0.244
SE_U	2.003	1.000	3.476	3.084	2.673	12.236	0.247
AL_U	1.600	1.208	1.000	2.592	1.889	8.289	0.168
SELI_U	1.884	1.189	1.854	1.000	2.073	8.000	0.161
ETI_U	1.782	1.806	2.199	2.071	1.000	8.858	0.180
Total	-	-	-	-	-	49.450	1.000

Summary the integral model of the urban environment quality indicators looks next:

$$UEQ = 0.244 E_U + 0.247 SE_U + 0.168 AL_U + 0.161 SELI_U + 0.180 ETI_U \quad (1)$$

3 Discussion

Improving the quality of the urban environment is one of the most important areas of environmental security management. Urban planning should be directly related to solving the problems that arise when addressing the quality of the urban environment. For example, if the level of air pollution is higher than the standard, then it is necessary to immediately develop measures that will reduce emissions. Environment quality improvement can be indicated by changes of indicators closer to the normative.

From a sociological point of view, a high-quality urban environment is an environment that satisfies human needs for:

- health, education, work and communication,
- equality, solidarity, which must be responded by the city public spaces,
- security,
- for active and productive activities that enable people to launch and improve their abilities.

The structure of a quality system of the urban environment is shown in Fig. 1.

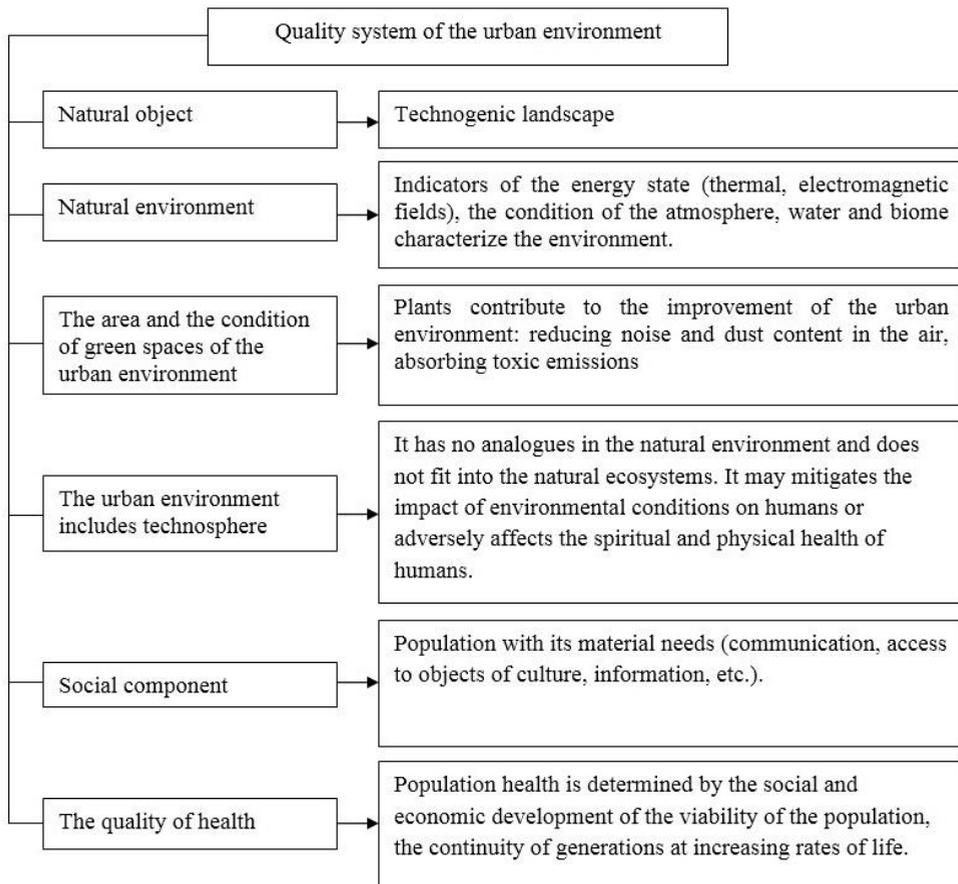


Fig. 1. The structure of a quality system of the urban environment.

Analysis of the quality of the environment means the assessment of both useful and useless (creating a sense of the beautiful, sublime) human environment. The aesthetic expression of the city gives the successful placement of the object in the natural landscape, the use of rational planning of suburban buildings with preservation of greenery and

buildings of historical culture, i.e. the natural complex. Their combination has a general effect on a person.

5 Conclusion

The modern experience of Russian cities displays the division of territorial management according to participants' interest:

- the quality of the urban environment improvement in the interests of residents,
- the growth of real estate capitalization in the interests of the developers,
- and the interests of the authorities are private investment attraction individual infrastructure elements construction, state and municipal programs execution, the general level of social tension reduction, and territorial investment attractiveness incensement.

Therefore, the quality management of the urban environment is the primary task of public administrations in terms of creating a set of mandatory elements of improvement, and forming a multi-tasking functional environment for different types of social groups.

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