A model for assessing the sustainable development of the city area

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Abstract: The balanced management and development of the territory requires the development of the concept of sustainable development of the territory. In addition to the sustainable development of the territory, it is necessary to ensure the balance of all the main aspects that determine the sustainable development of the territory. The search for an optimal balance of urban area development is the most important task which requires the development of scientific methodologies.

The article deals with the principle model of agglomeration in the context of the aspects of sustainable development of the territory. In the model the assessment is carried out in two stages. The purpose of the first stage is to determine the degree of balance of the territory on a particular aspect. The purpose of the second stage is to determine the degree of compliance of the urban planning organization of the territory with the conditions of sustainable development of the territory.

In order to create a strategy for the development of urban space it is necessary to monitor the urban planning condition of the territory, as well as to assess its compliance with the conditions for sustainable development of the city territory.

Keywords: Scheme of territorial planning, General plan, Master plan, theory of central places, wave model of city growth, balance of the territory, urban assessment of the territory.

1 Introduction

The management of urban development is among humanity's most pressing challenges. Urban population growth, the evolution of cities into agglomerations and conurbations, the sprawl of urbanized areas along with their local depopulation, natural phenomena and environmental challenges, socio-economic and political crisis cycles of development, and many other aspects are among the attention of urban planners and urbanists throughout the world. Today the dominant paradigm in urban planning practice for a balanced solution of these problems is the concept of sustainable development.

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The Urban Planning Law of the Russian Federation defines sustainable development as: "ensuring safety and favorable conditions of human life, limiting the negative impact of economic and other activities on the environment and ensuring the protection and rational use of natural resources in the interests of present and future generations" when carrying out city planning activities.[1].

The UN's long-term development program, approved in 2015, defined general goals (17 goals) for the sustainable development of the world's countries for the period up to 2030. The sustainable development goals established by the UN program are defined in the form of universal global qualitative benchmarks for all developing countries and, as such, cannot be used as goals for the spatial development of the region, but rather as imperative axioms for future development [2].

In the developed countries of the world the regulation of spatial development is focused on achieving the goals of sustainable development of a region, a territorial entity. The concept of "sustainable development" contains national peculiarities of development and its planning. In the UK, for example, sustainable development is understood as harmonious, balanced development, in France - reliable, durable development, in Germany - sustainable construction, modernization. The European Community has approved the "Basic Principles for Sustainable Spatial Development of the European Continent", which have no legal force and are subject to voluntary application in the EU countries. The fundamental principles establish methodological approaches to the justification of sustainable spatial development objectives of territorial formations [3].

In addition to the need to ensure sustainable development, it is important to balance all the main aspects that determine the sustainable development of the territories of settlements. The balance of the settlement system and places of application, the balance of territorial and functional development, the balance of the natural-historical framework with territorial development, etc., etc. - in various combinations are the tasks the solution of which determines the strategy and tactics of the city's policy.

It is necessary to take into account the intensifying competition for all kinds of resources, and especially for human potential. During the COVID-19 pandemic, all possible forms of remote interaction have become particularly active: industrial, social administrative, and many others. In this regard, the city must meet not only the basic principles of sustainable development, but also have its own uniqueness and attractiveness, which will set it apart from similar.

The world is dynamic and unstable we are forced, with all the need for sustainable long-term strategic planning, to have tactical tools (means) to respond to crisis dynamics. One method is the exclusion of excessive technical detail from long-term documents and the concentration of program provisions on generalized principles and goals of development.

The Urban Planning Law of the Russian Federation [1, ст. 18] defines Territorial Planning Schemes and General Plans as the main documents of territorial planning. In the professional community there is a broad discussion of the need to replace these documents with the Master Plan. The main disadvantages of the General Plan include its static nature, which does not allow for accelerated development, time-consuming procedure for making changes, etc. The Master Plan is understood as a document of strategic-spatial planning, which contains a system of ideas about the external and internal conditions, priorities,

directions, and the expected results of socio-economic and spatial development of territories.

The basic principles of urban development include [5, 12] the following principles and approaches:

- openness – closedness of the city;
- compactness – dispersed city;
- diversity is the city's specialty;
- management (balance and priorities) – self-development of the city.

Finding the optimal balance between policies of urban development is the most important task requiring the development of scientifically sound methodologies and the formation of a unified methodology that allows not only to identify priorities, but also to ensure rapid changes in them with a clear definition of indicators of development of the territory of the city.

Below we will review existing theories in urban development and develop an approach to developing a methodology that provides a scientific and methodological basis for balanced and sustainable development.

Changes in the structure of society and economy during the XX century required a change in approaches to the description, assessment and development of cities. Urban planners have developed new theories of formation of the planning structure of the city. The use of accumulated experience is necessary for the development and creation of modern approaches.

One of the earliest such concepts is **the theory of central places**, which was developed in the early 1930s by the German scientist W. Kristaller [6].

The model of the planning structure of the urban planning system is represented as a crystal lattice - hexagonal cells without a gap. The centers of these cells become the nodes of a hexagonal lattice of higher order, and they become the nodes of a lattice of even higher order and so on up to the highest level with a single center (Fig. 1).

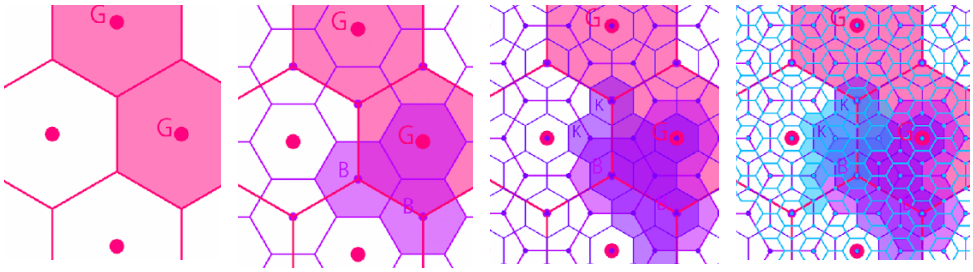

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Fig. 1. Crystal lattice of central place theory

The theory has a number of shortcomings that make it of little use in modern urban planning. However, it is interesting to us because it is one of the fundamental works, which proposes a hierarchical approach to describe the planning structure of the city.

Another landmark theory of the development of the planning structure of the city, developed in the twentieth century, is **the wave model of urban growth** [7].

The concept of wave-like urban growth was developed by G. Blumenfeld on the basis of classical models of urban structure, which formalized the general stable relationship between the size of the city and the nature of the distribution of population density:

concentric, developed by R. Park, E. Burgess; *sectoral*, by G. Hoyt; *multicore*, developed by C. Harris and E. Uhlmann (Fig. 2).

Classical models of urban structure operate with static models and do not provide information about the nature of the relationship between the growth of the city and the dynamics of settlement. Blumenfeld supplemented these studies with a dynamic picture of the spatial distribution of population density, based on the works of T. Hagerstrand, describing the mechanism of distribution of phenomena in the urban environment [8].

Blumenfeld concluded that in a city at any given time there is a zone of maximum growth, which can be defined as the "crest of urban expansion. The amplitude of population density fluctuations decreases with distance from the center of the city, similar to the propagation of fading waves on the surface.

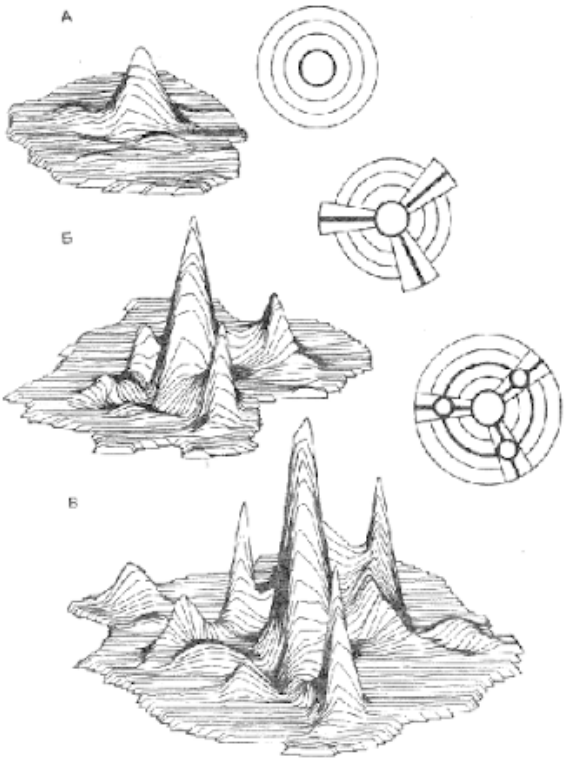

Fig. 2
Wave model of city growth:
A - concentric model
B - sector model
B - multi-core model

The content of the theory reflects the general nature of the spread of urban processes during the territorial expansion of the city. It seems that these processes are related to the maintenance of a certain *correspondence* between a sufficiently high transport accessibility and the degree of development of the territory.

It is the balance of the territory becomes the most important indicator of urban assessment [4]. The result of this assessment can be used both to determine the importance of this territory in the planning structure of the city, and to determine the directions of development of the individual territory, taking into account the strategic directions of the city, which are determined at the level of its leadership.

What should be the optimal strategy for urban development? The available urban planning experience and science do not tell us a universal answer to this question.

Among the many different strategies, there are those that provide for evolutionary or revolutionary approaches, extensive or intensive development of the city territory,

increasing the role of the central planning zone of the city or the development of polycentric system [9], etc. In addition, there is an approach that provides a complete rejection of strategic planning and the transition to a situational urban management [*Alain Berto - Order without Design: How Markets Shape Cities*]. This approach provides the measure of freedom and responsiveness that is necessary to ensure the evolutionary development of the agglomeration as a self-regulating system.

Despite the divergence of paradigms all these approaches are united by one common goal - ensuring sustainable development of the territory. Thus, one of the most important urban planning tasks is to ensure sustainable development of the territory, regardless of the choice of strategy to achieve it.

To solve this problem, it is necessary to use tools to assess the urban condition of the territory, which would allow you to monitor the state of the structural and functional organization of the territory on the aspects of sustainable urban development.

At the heart of *sustainable development* is improving human competencies to create a new environment and a forward-looking economy around us. We manage space so that it defines the individual.

We create necessary and sufficient conditions for the economy: we develop people, territorial, infrastructural and other resources, we apply planning and best practices. The market economy interacts with the created conditions.

We consider the intangible aspect of sustainable development as a potential for the harmonious development of man, environment and economy. And also as one of the tools that contribute to the implementation of project solutions.

2 Material and methods

It is proposed to consider the principle model of agglomeration in the context of aspects of sustainable development [10, 11]:

1. **Habitat** – space, nature, infrastructure;
2. **The economy** – resource extraction, resource production and processing, tertiary sector of the economy (goods and services);
3. **The society -** a person, society, relationships, local communities; in addition, **the aspect of intangible capital** - the level of education, the level of cultural development can also be considered as part of this aspect.человек, общество.

Urban assessment of the territory includes two stages.

Stage 1. Assessment of the territory according to certain aspects of sustainable development

The purpose of this stage is to *determine the degree of the territory's balance on a particular aspect* of sustainable development: environmental, economic and social. By a balanced territory we mean such a state of its urban planning organization, which is described by the absence of pronounced disproportions between the individual indicators characterizing the aspect of sustainable development.

The assessment involves a system of indicators that fully characterize the environmental, economic and social aspects.

The system of indicators is a hierarchical structure. The simplest units of assessment are *basic and calculated indicators*, the complex of which forms individual *system indicators*. Each system and each characteristic can be rolled up into comprehensive indicators. All complex indicators on the selected aspect of sustainable development can be summarized in a single evaluation index (Fig.3).

Baseline- an element of initial spatial, quantitative and qualitative parameters (data) on capital construction, linear and territorial objects, designed to assess the state of the urban environment. The data must be brought to a quality standard, verified and linked to vector calculation units in GIS. Baseline indicators can be formed in accordance with the Decree of the Government of Moscow from 26.10.2018 №1310-PP "On approval of the procedure for monitoring the implementation of the General Plan of the city of Moscow";

Calculated indicator - obtained by mathematical and/or spatial analysis of one or more baseline/calculated indicators;

System indicator is a numerical value (in points), reflecting the assessment of the state of characteristics inherent in a particular sectoral urban system, determined in accordance with the algorithm of interaction between the basic and calculated indicators;

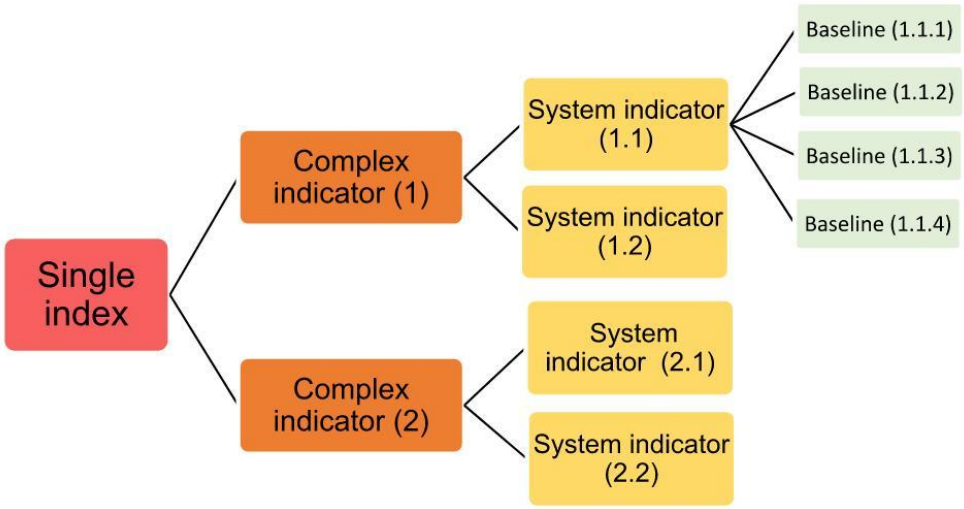

Fig. 3. Hierarchical structure of indicators

Composite indicator is the arithmetic average of system indicators (in points), reflecting the average state of the sectoral urban systems, necessary to identify the most acute problems of the territory.

Stage 2. Comprehensive assessment of the sustainability of the territory

The purpose of the second stage is to *determine the degree of compliance of the urban planning organization of the territory with the conditions of sustainable development*. The degree of overall sustainability of the territory is proposed to assess through the degree of compliance with each other states of urban planning organization, which describe different aspects of sustainable development.

The model for assessing the sustainable development of the territory is shown in Figure 4.

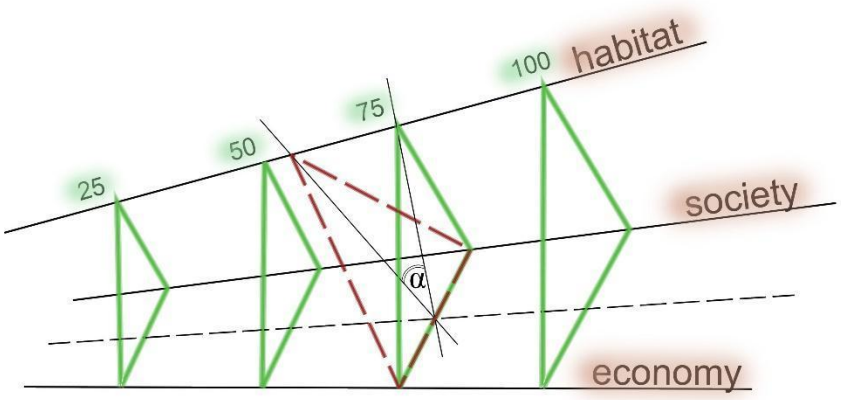

Fig. 4. A model for assessing the sustainable development of a territory based on the values of urban assessment indices

The theoretical model is an axis with the values of indices of urban assessment, allocated according to the aspects of sustainable development: environmental, economic and social.

According to the three arbitrary points on these axes the planes are formed, which describe the nature of the urban planning organization of the territory. It seems that the conditions of sustainable development are described by the planes, which are obtained with equal values of the indices, i.e. have the same and corresponding to each other conditions of development of certain aspects of sustainable development.

As an indicator capable of evaluating *the measure of deviation of the current conditions of urban planning organization of the territory from the conditions specific to sustainable development*, it is proposed to use the angle α, which is formed between the planes describing the corresponding conditions of urban planning organization.

The minimum value that the angle α can take is 0 degrees. The maximum value is 90 degrees.

The system of interpretation of the angle α is proposed, in which 5 ranks of assessment of sustainable development of the territory are distinguished: A+, A, B, C, D (Fig. 5, Table 1).

Table 1. Angle interpretation α

Angle α	0 – 10°	10 – 30°	30 – 50°	50 – 70°	70 – 90°
tg(α)	0 – 0.17	0.18 – 0.57	0.58 – 1.18	1.19 – 2.74	> 2.75
Evaluation	A+	A	B	C	D
Interpretation of Meaning	Sustainable development	Moderate disproportions	Expressed disproportionality	High disparities	Maximum disproportions

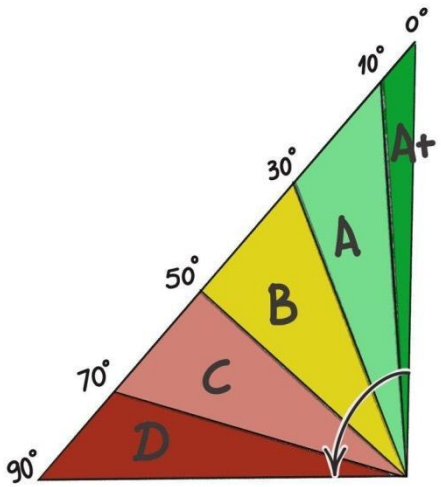

Fig. 5. Angle interpretation α

3 Results

Based on the results of the urban assessment and taking into account the city's development strategy, a development **policy for the area is formulated**.

There are different types of policies for urban areas:

- Preservation
- Development / Priority Development
- Protections / Priority Protections
- Non-intervention

As an indicator of **economic** development it is possible to use economic indicators of sustainable development, such as: the unemployment rate, the availability of housing, the unemployment rate, etc.

Indicators of **human** capital development on a city-wide scale are suitable as an assessment of societal development.

4 Discussion

Ensuring sustainable development of the territory is the goal of any city development strategy. The realization of this goal is impossible without monitoring of the urban development of the territory, as well as without the use of tools to assess the compliance of this condition with the conditions of sustainable development.

Proposed the concept of urban assessment of the territory, in which the principle model of agglomeration is considered in the context of the aspects of sustainable development: habitat, economy, society.

The assessment can include two stages. The first stage determines the degree of balance of the territory on a particular aspect of sustainable development. The second stage determines the degree of compliance of the urban planning organization of the territory with the conditions of sustainable development comprehensively.

The final stage is to determine how the urban condition of the area corresponds to the target levels of development, which are determined taking into account the various strategies for the development of the city.

5 Conclusions

In the course of further work on the urban assessment of the territory, the following tasks must be solved:

1. To develop a system of indicators to assess environmental, economic and social aspects of sustainable development - as a basic methodology for assessing scenarios of territorial development

It is necessary to clarify the composition of characteristics and evaluation systems describing one or another aspect of sustainable development. The system of indicators that can be used to calculate a single assessment index should include basic/calculated, systemic and comprehensive indicators.

2. Define spatial units of assessment

The limiter of the scale of the spatial unit is the required level of accuracy of measurements necessary to carry out the assessment of the balance of the territory. The choice of the spatial unit scale should be based on the composition of indicators of objective assessment of the urban environment after its specification, taking into account the objectives of the various stages of the study.

3. Provide for high convergence of the values of unified assessment indices on various aspects of sustainable development

The general interval of values for the single indices for various aspects of sustainable development is proposed - each of them varies in the range from 0 to 100 points. The implementation of a comprehensive assessment of the sustainability of the territory based on the correlation of the values of these indices requires a high convergence of their values. This is necessary for a correct interpretation of the assessment results.

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