Application of landscape planning approach for study of peculiarities of territorial organization and territorial development

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Abstract. Forming of economic-geographical environment for innovative development is closely related to landscape and resource characteristics of a territory. It is revealed through a system of related characteristics that should geographically fully and accurate describe the nature, economy and population of the territory and express its state through a special assessment indication function of all natural and economic factors. Such task is solved on empirical data and the principles of the geosystem theory by Sochava, indicative and landscape planning approach, methods of interpretation mapping, comparative geographical analysis, geoinformation and math modeling. A landscape typological map is considered as an invariant basis for the analysis of the territory, reflecting the spatial distribution of geosystems of different types and allowing to derive new knowledge and create thematic maps of different content for solving applied problems. Features of the geographical environment and its impact are taken into account through the introduction of quantitative environmental corrections using the methodology of polisystematic stratification. A unified database with a grid of natural and economic units of the landscape map is created for the area of the Selenga river delta for analysis of the territorial organization peculiarities and local development. The assessment indication function is calculated on the geosystem database and characterizes the features of the territorial organization with the definition of individual indicators of economic development for each unit of the study area.

1. Introduction
Study of the territorial organization formation of society taking into account the natural environmental factors is relevant due to a number of reasons. They include the activation of natural and socio-economic changes and transformation of geographical environment including visible changes in the physical and geographical characteristics of the territory and the so-called “invisible” changes associated with socio-economic conditions such as processes intensification, compression of space, globalization, subjective perception of the environment and land use, etc. In addition, there is a current governor policy tendency of inclusion of territories with limited favorable development factors and living conditions into the economic activity. It is both areas of new development and environmentally significant protected territories. From this side they are natural testing plots for applying different scientific approaches for the optimal organization of the socio-economic space. Knowledge of the regularities of the territorial organization formation of society is the basis for the appropriate and objective analysis of the socio-economic development, assessment of relevant changes and their
possible consequences for the development of territories and natural resources, working out measures to regional inequality reduction. Also studying territorial organization gives the information about the causes of regional differences which often have objective in nature associated with the peculiarity of some local geographical and historical factors of development.

Peculiarities of the territorial organization formation of the society are basis of the innovative development and closely related to natural, landscape and resource characteristics [1, 2]. Despite the constant interest to studying the territorial organization [3, 4], the modern geographical science does not have the knowledge of objective material foundations of its existing, its role in the management and development of regions. Thus, there is a lack of a logical description of this phenomenon for reproducing the structure, mechanisms and historical stages of its formation.

This problem can be solved on the basis of the long-term landscape and economic-geographical research carried out at the Sochava Institute of Geography SB RAS using the principles of the geosystem theory by V B Sochava [5], methods of the landscape planning [6], geoinformation modeling and interpretation mapping [7, 8], and comparative geographic analysis based on the homotopic similarity principles [9]. In terms of these theoretical approaches landscape-typological and land cover maps are considered as an invariant basis for study of the territory and reflecting the spatial distribution of various types of geosystem environments as well as deriving new knowledge and creating the thematic maps with different contents for solving applied problems. At the same time we have to understand that the nature and society laws do not depend on the characteristics of the local or regional geographical environment. This environment must be taken into account by special objective methods through the introduction of environmental coefficients. These and other rules of the geosystem analysis are also generalized in the polysystem stratification methodology [10, 11] applied to study the features of the territorial development.

2. Models and methods
The main methodological basis of the research is landscape planning approach [6] which is in a natural way integrated into the overall territorial planning for decision-making purposes at the different hierarchical levels. Moreover, for studying of territorial development peculiarities indicative planning is gaining acceptance as one of the modern state-of-science procedures for working out the strategy of socio-economic development for the territory [12, 13]. The indicative planning is a method to manage the socio-economic development of a territory, and a mechanism for coordinating the interests and activity of the state and of independently operating economic entities under conditions of a harmonious combination of state- and marked-based regulation. The indicative planning mechanism is based on developing a system of indicators of socio-economic development and includes defining nation-wide priorities, goal-setting, forecasting, budgeting, programming, and other procedures of reconciling decisions at different levels [13].

The main notions of the indicative planning are the “indicators” and “regulators” [12, 13]. The indicator represents an integral indicator that quantitatively determines the qualitative characteristics of the socio-economic process, the state. Indicators are used to determine the parameters of the boundaries within which the system will be stably functioning and evolving. By the system of indicators is meant a preventive tool designed for comprehensive, systematic analysis of the planned activity and utilization of the results from this analysis in order to draw up the strategy of territorial development. To the regulators there correspond special mechanisms of sustaining an optimal functioning of the systems through which the influence on the object (management of the object) is effected.

These main categories can be instructively described by methods of mathematical modeling, which makes it possible to objectively draw up, from indicative models, recommendatory guiding plans and forecasts of territorial development. The indicators \( x = (x_i) \), and the regulators \( a = (a_i) \) are functionally related in the form of an indicative function \( f(x) \) that can be presented as
The value of the function \( f(x) \) is an integral indicator that depends on many variables \( x_i \) and model coefficients \( a_i \) determined by statistical methods based on actual empirical data [14]. The model of the indicative function (1) makes it possible to solve various evaluation problems, in particular to use \( f(x) \) for the indicative and landscape planning. In terms of the landscape planning \( f(x) \) is a function of significance, \( b(a) \) is a function of sensitivity, and the variables \( x_i \) and coefficients \( a_i \) in the indicative model called indicators and regulators respectively.

In the landscape planning, by the “significance” category is meant the degree of correspondence of the state of a component (characteristic) of the natural environment to the adopted standard state. The correspondence is determined by the optimality of realization of the priority function of land utilization for each natural component and is assessed from a set of potential of territorial objects. By the “sensitivity” category is meant the ability of a given natural component to change its properties under the influence of the economic activities: external impacts with respect to the components. Sensitivity assessment also depends on the natural goal function of land utilization, i.e. is related to “significance”. Such connections of the notions make it possible to regard the landscape planning assessment procedures as particular cases of the indicative planning. This permits the methods and results obtained for each area to be used in solving other problems.

Territorial units with different values of the significance and sensitivity in the space can be categorized in terms of the landscape planning (figure 1 [15]). The slant parallel lines correspond to different actions.

Each group of the goals of land utilization is characterized by its set of the significances and sensitivity value. Their totality determines the resulting potential of development of the territory which, ideally, tends toward self-development, or a maximization of the significance with a minimization of the sensitivity function. In the figure 2 this corresponds to the points (1;0); (2;0); (3;0); (4;0).

In the process of a correlation analysis of the indicators using the model of the indicative function (1), it was confirmed that lands with the best indicators of utilization (the highest significance) correspond to territories with the least sensitivity for most of the indicators. Consequently, the effectiveness of the present utilization of lands, and the prospects of utilization of the territory depend on the resulting value of significance and sensitivity of a set of geographical factors (natural components, and economic utilization of landscapes). The landscape planning technique decomposes the resulting indicative function of action into two independent mutually complimentary parts.

\[
f(x) = \sum_{i=1}^{n} a_i x_i + b(a).
\]
(significance + sensitivity) thus determining the limitations on the economic utilization of lands, where even highly potential lands, having high sensitivity to anthropogenic loads, must be assigned to protected territories.

3. Results and discussion
The geoinformation approach was used in the case study of the area of the Selenga river delta to implement a stepwise technique of the landscape planning in the context of economic units in order to determine the indicative functions (assessments) of each unit from the set of their properties, with implications for particular and integrated goals of territorial development, and indicators of target-oriented land utilization (figure 2).

| Indicative function – planning stage | Indicate | Indicators | Regulators |
|------------------------------------|---------|------------|------------|
| Component-wise assessment of the functions of significance and sensitivity | Significances and sensitivities | Characteristics of economic units | Particular sensitivities |
| Component-wise assessment of the goals and measures of territorial development | Goals and measures | Component-wise functions of significance and sensitivity | Types of utilization and disturbance |
| Assessment of integrated goals of territorial development | Integrated goals of development | Component-wise goals and measures of territorial development | Priorities of conservancy measures |

**Figure 2.** Schematic diagram of the indicative analysis in the landscape planning

The following algorithm is implemented for calculation of the indicative function (1) for the research: 1) collection, preparation and systematization of information and the geoformation database creation based on the net of natural and economic cells (“videl”) of the landscape map; 2) formation of the attributes of the landscape and socio-economic characteristics matched with the certain cells; 3) indicators calculation and comparison obtained results with expert data; 4) visualization of the calculation results in the form of thematic evaluation maps. Analysis of the peculiarities of territorial organization and territorial development was carried out on the basis of the landscape map for the Selenga river delta with the determination of the individual indicators for each group of the landscape cells including both the natural characteristics and variants of their states changed by human activity.

Each stage calculates an analytical or logical indicative function on the basis of the indicates obtained at the preceding stage, and special regulators. The input receives the data on characteristics of economic units, and sensitivity coefficients inferred from these characteristics, and expert assessments on the basis of regression equations. The equations and coefficients are used to refine the assessments made by experts from the data on the state of lands itemized as components of geosystems (species and biotopes, soils, waters, and landscapes). Geoinformation mapping of the assessment results provides a means to develop potential maps for significance and sensitivity for the planning territory. The indicators of significance and sensitivity are transformed to indicates of the component-wise goals and measures of territorial development, with due regard for the present land utilization and disturbance which serve at the second stage as regulators of the indicative function of assessment. At
the third stage, the particular directions are used to infer the integrated goals of development, with due regard for the regulators determined by the priorities of conservancy measures. Maps of integrated goals are the result of indicative planning, based on knowledge of the natural potentials of lands and their economic development. They determine the recommended types of land utilization, and the measures allowable for each of the natural-economic units, which provides a basis for organization of the economic activities and monitoring.

Based on the above mentioned indicative function model (1) and landscape planning methods, the results of the landscape-indicative analysis is performed for the model territory of the Selenga river delta with the calculation of the significance and sensitivity indicator value (figure 3). The empirical calculated values of the indicators are compared with expert evaluations [6].

![Figure 3. Landscapes. Significance and sensitivity. Significance level (A): 1 – limited; 2 – low; 3 – medium; 4 – high. Sensitivity level (B): 0 – no assessment; 1 – low; 2 – medium; 3 – high.](image)

**Figure 3.** Landscapes. Significance and sensitivity. Significance level (A): 1 – limited; 2 – low; 3 – medium; 4 – high. Sensitivity level (B): 0 – no assessment; 1 – low; 2 – medium; 3 – high.

The landscape-indicative analysis of the Selenga river delta area showed that lands of regulated utilization usually have high significance and low sensitivity, both having a high potential of development. Lands with recommended extensive development are characterized by lower significance, increased sensitivity, and by a moderate potential of development. Finally, for lands of low significance it is planned to carry out a variety of land improvement measures, in accordance with their indicator characteristics (figure 4).

4. **Conclusion**

The proper indicators of the significance and sensitivity for each group of landscape units including both natural characteristics and options for their changed states under the influence of economic activity are determined using this indicative model (1) and the landscape planning approach. On the base of the evaluated significance and sensitivity indicators the existing shortcomings in the use of the territory can be identified. It is the basis for working out of recommendatory measures and reorienting the type of land use in the studied area.
Figure 4. Landscapes. Goals of territorial development: 0 – settlements; 1 – nature reserve regime; 2 – preservation of present status and abandonment of separate types of utilization; 3 – preservation of existing extensive utilization; 4 – regional ecological framework of a territory; 5 – extensive development, with local conservation and rehabilitation of disturbed landscapes; 6 – regulated extensive development; 7 – regulated intensive development; 8 – improvement to be later assigned to the category of extensive development; 9 – improvement to be later assigned to the category of regulated extensive utilization; 10 – radical improvement.

It can thus be stated that methodologically, the idea of the landscape planning is a particular variant of indicative territorial planning which on the objective model basis relates two additional properties of territorial systems: the significance and sensitivity. This makes it possible, on the one hand, to extend the ideology of the landscape planning, and, on the other hand, to apply mathematical analysis results in validating the statistical and expert methods of the landscape planning and use it for study of the geographical, environmental and historical peculiarities of the territorial organization of society. By synthesizing the principles of indicative and landscape planning, and mathematical modeling methods, it was possible to develop new approaches to analyzing physical-economic-geographical information at different territorial scales and apply the results for improving of territorial development strategies.

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