Theoretical background of road landscape zoning

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Abstract. The article considers the main study, methodological provisions in the field of road landscape zoning, as well as the theory and practice of physical and geographical zoning. A new definition of the road landscape is proposed including the main taxonometric units of road landscape zoning, accept the road landscape and road micro landscape. The relationships between various physical and geographical units and the “monosystem model” of the natural complex are analyzed. An assessment is given of the degree of influence of the components of the geographical environment and the engineering structure, which made it possible to determine territorial complexes with varying complexity of road construction conditions. The problem of ensuring ergonomic and aesthetic requirements and changes in the natural complex as a result of the inclusion of an engineering structure in it are also considered. Since the geographical environment and the engineering structure were considered as the object of study, respectively, as a model for the study we chose a set of information about the geographical environment and the design of the engineering structure. One of the important issues of road-landscape zoning is touched upon - the problem of classification of territorial complexes. The recommendations are given on the use of statistical methods of study while substantiating the role and influence of the characteristics of components in the system “Geographical environment - engineering construction”.

1. Introduction

The road zoning is under intensive development, the main studies are being conducted to study the patterns of changes in the design characteristics of subgrade soils, which are formed under the influence of climate, topography of surface and underground waters.

The basis of road zoning is the theory and practice of physical-geographical zoning, which involves a reasonable identification of physical-geographical regions and its similar characteristics, which would show the existing deep connections between individual components, complexes, processes and phenomena, the
history of the development and formation of complexes, given a deep analysis of natural resources, qualitative and quantitative [1].

A comprehensive study of local territories (landscapes and microlandscapes) and its assessment from the perspective of complex road construction, violation of the natural equilibrium, species qualities of the territory of the landscape design goals of wood motor roads is road landscape zoning.

The main methodological position on which studies on road-landscape zoning are based is the recognition of the existence of territorial differences and physical-geographical complexes. Each complex includes different components - rocks, relief, atmosphere, surface and underground waters, soils, vegetation, wildlife, which are also different in its qualitative and quantitative characteristics. Road zoning is under intensive development, the main studies are being conducted to study the patterns of changes in the design characteristics of subgrade soils, which are formed under the influence of climate, topography of surface and underground waters.

2. Material and methods
Based on the fundamental study conducted by landscape experts [2, 3], we can argue that physical-geographical complexes have the following properties:
• relatively homogeneous and heterogeneous; homogeneous ones are smaller complexes. These are dynamic systems. Dynamism is observed in time and space; it is characterized by continuity and discontinuity. Continuity is expressed in a continuous spatial distribution; discontinuity is in the existence of natural complexes with properties of relative integrity;
• regional physical and geographical complexes have individuality, are characterized by territorial integrity and unity of the structure;
• physical and geographical complexes have a longline structure, which is expressed in the presence of components located one above the other.
Thus, the physical-geographical complex “is a dynamic system, limited in space and possessing the dialectic unity of its components” [4].
The main object of study of road-landscape zoning is natural (altered by human activities) complexes - road landscapes and road microlandscapes.
In road design, such terms as “landscape space”, “road landscape”, “transport landscape” are now widely used.
The landscape space is a local area directly adjacent to the road, characterized by landforms, vegetation, water spaces, settlements, agricultural land, accessible for viewing from a moving car. Babkov V.F. puts a similar concept into the term “road landscape”, proposing, for the purpose of tracing, to classify landscapes according to geomorphological features and vegetation as a first approximation [5]. Transport landscape in the definition of S. Treskinsky is the most favorable territory for the laying of roads [6].
We believe that each of these definitions is one-sided, in particular, landscape space; road landscape characterizes the species qualities of the territory, transport landscape - the engineering and economic aspect of design.
Considering landscape design as a system that provides communication, economic, agroeconomic, environmental requirements, we offer the following definition of road landscape. There is a regular and typical repetition of the same interconnected combinations of components on this territory. These are microclimates, landforms, geological structure, soils, human activities, predetermining the principles of landscape tracing and the design of wood transport roads.
Given there is a linear nature of road construction, the main unit of road landscape zoning, in our opinion, should be considered as a micro landscape, which is characterized by uniform location conditions, microclimate, hydrological regime, vegetation, and one type of soil.
The road-landscape zoning should be considered as a system that provides landscape design with initial data; therefore, its tasks include:
• assessment of complexes from the perspective of road construction production (design, construction, operation), protection of the rational use of natural resources and the environment; development of
structural and dynamic models of complexes;
• identification on this basis of individual complexes of road landscapes and road micro-landscapes;
• determination of its planned position; mapping of road landscapes and micro-landscapes;
• classification of selected road landscapes in relation to the tasks of landscape design of wood motor roads.

The road-landscape zoning is of an applied nature and should be developed based on the theory and practice of physical-geographical zoning, which has now become the basis of many sectors of the national economy, in which the problem of a comprehensive study of natural conditions and a long-term forecast of human activity rises.

V.V. Dokuchaev discovered natural geographical zoning, which currently forms the basis of the general scientific theory of physical and geographical zoning, in 1898 – 1900. He also characterized large natural complexes - natural zones. Later, in 1913, Berg L.S. showed that each zone is composed of smaller units, which he called geographical landscapes.

Geographers reject the position of “infinity” of the physical and geographical division of the territory. The practice of territorial studies has established the presence of the “simplest” (indivisible) physical-geographical unit - microlandscape.

Geographers call a complex of facies as a natural boundary. Moreover, the territory on which there is a certain set of tracts, and therefore the facies forming typical and regular combinations, is called landscape.

The relationships between different physical and geographical units can be illustrated in the form of a diagram (Figure 1).

Each complex has a certain structure and is a multicomponent system Preobrazhensky V.S. [7] proposed a “monosystem model” of a natural complex consisting of a number of interconnected components (Figure 2).

![Figure 1. The scheme of subordination of physical and geographical units (according to A. Isachenko) [56].](image)
Figure 2. Monosystem model of a natural complex (according to Preobrazhensky V.S.)

Each natural complex should be considered:
- as the environment in which the engineering structure is included and the degree of influence of the characteristics of the components of the geographical environment determines the complexity of road construction, and in connection with it the principles of tracing and design, ensuring primarily the cost-effectiveness of design decisions;
- as a system in which components interact in close connection with each other and with neighboring complexes, it changes in space and time. The violation of natural relations entails a very complex change in the natural complex, which to provide and direct for the benefit of man is the most important task of modern design.

Evaluation of the degree of influence of the components of the geographical environment and the engineering structure allows us to determine territorial complexes with varying complexity of road construction conditions; the allocation and mapping of complexes using this assessment are called engineering landscape zoning.

Figure 3. Changes in the natural complex as a result of the inclusion of an engineering structure.

The degree of disruption of ties makes it possible to appreciate the influence of the engineering structure on the territorial complex and, based on this assessment, carry out landscape-ecological zoning, the results of which to develop measures to protect the rational use of natural resources.

The task of ensuring ergonomic and aesthetic requirements determines the need for designing roads to consider and evaluate the geographical environment as the territory on which the engineering structure is located, and the features of the terrain, vegetation, and human economic activity determine the principle of optical tracing, spatial design of forest roads.
Therefore, road-landscape zoning includes the allocation and mapping of territorial complexes according to the degree of complexity of the conditions for road construction (engineering and landscape zoning), the degree of disturbance of natural balance (landscape-ecological zoning), and the type of territory (architectural and landscape zoning). Figure 4 presents a scheme of road landscape zoning.

![Figure 4. The structural diagram of road-landscape zoning.](image)

One of the important issues of road landscape zoning is the problem of classification of territorial complexes. We believe that the main road taxonometric units for road landscape zoning are road landscape and road micro landscape. When designing an engineering structure, it is necessary to take into account the general laws of the geographic environment, which are quite clearly visible in landscapes, and the particular features that appear in local areas (for example, the height of the snow cover, the type of terrain according to the degree of moisture, etc.).

The proposed system of units of road-landscape zoning meets the requirements of the subordination of territorial complexes. The general characteristics of the components of the geographical environment — climate, topography, physical and geological processes and phenomena, soils, human activities, objects to be protected, and unique natural complexes — are studied and mapped in the process of regional zoning at the landscape level. An assessment of the degree of influence of the characteristics of the landscape components on the complexity of the construction of a forest motor road is the starting point for the further regionalization of these territories (landscapes) at the level of micro landscapes.

The study of the degree of influence of an engineering structure on the geographic environment is possible only by assessing the changes occurring in the micro-landscapes within which a forest road is laid.

The set of micro-landscapes that form certain visual-emotional characteristics of the landscape is also closely related to the assessment of the species characteristics of the landscape.

Thus, the proposed system of taxonometric units meets all the requirements of landscape design of wood motor roads.

The main method for studying complex systems is its modeling. Bocharov M.K. notes, “The advisability of applying the modeling method is that full-scale objects are not always amenable to direct measurement (examination) or require extremely labor-consuming and expensive long-term work” [8].

While studying the geographical environment for the purposes of tracing and landscape design of roads, modeling allows you to establish the structure and dynamics of the development of the geographical environment and on this basis to predict and plan the degree of its influence on the engineering structure and its interaction with the natural environment.

The object of study is geographical environment and engineering construction; accordingly, the model will be a combination of information about the geographical environment and the design of the engineering structure.

The relationship between real objects and its models can be represented in the form of the following diagram, Figure 5. Here the relationship diagram is between objects and its models. The connections indicated in the diagram by odd numbers are obvious: 1 - collection and processing of information and development of a model of the geographical environment; 3 - development of a project on this basis; 5 - construction of the facility; 7 - the influence of the engineering structure on the geographical environment; feedbacks: 6 - the influence of the geographical environment on the engineering structure; 4 - adjustment of the project during the construction process; 2 - development of a model of the geographical environment in relation to the requirements of the engineering structure.
Figure 5. The structural scheme of road landscape zoning.

The main means of studying the geographical environment for road purposes is mathematical modeling, in particular, the development of structural and dynamic models of landscapes and microlandscapes that reflect the complexity of road construction and the degree of disturbance of natural balance.

In its most general form, the sequence of creating models of the geographical environment is carried out by determining the influence of the characteristics of the components of the geographical environment on the complexity of road construction (engineering assessment); determining the impact of the engineering structure on the components of the geographic environment (environmental assessment).

To justify the role and influence of the characteristics of the components in the system “Geographical environment - engineering construction”, in our opinion, the most acceptable are statistical methods of study, such as correlation analysis, regression analysis. These methods make it possible to determine the most significant characteristics of the geographical environment and to develop on its basis structural models of road landscapes and microlandscapes that reflect the complexity of road construction.

The characteristics of the components of the landscape and microlandscape are unstable, varying in time and in space. The climatic characteristics and the degree of human economic activity, vegetation, and a number of others are most susceptible to change. To determine the calculated values of these characteristics in practice we widely used methods of probability theory, expert assessment. Therefore, for example, American experts [9-12] used long-term planning changes in the territorial balance and the value of forest land.

3. Results
The maps reflecting the spatial position and assessment (engineering, environmental, species) of road landscapes and micro-landscapes are the final product of road-landscape zoning.

The linear nature of road construction determines the need for a regional assessment of the natural and industrial conditions of road construction, as well as an assessment of local territories. Thus, there is a need to create two types of maps: cartographic diagrams of road landscapes and cartographic diagrams of road microlandscapes.

The maps of road landscapes are used for a general assessment of natural conditions and economic activities in the survey area and are used for planning road construction.

The maps of road micro-landscapes are compiled into the territory between the reference points of the road route and are used to assess the planned position of micro-landscapes with varying degrees of complexity of road construction, the value of natural resources, and the species qualities of the territory in the vicinity of the road.

The practice of physical-geographical zoning and the experience of road zoning allow us to outline two methods for compiling cartographic diagrams of road landscapes and microlandscapes.

4. Conclusion
To justify the role and influence of the characteristics of the components in the system “Geographical environment - engineering construction”, in our opinion, the most acceptable ones are statistical methods of study, such as correlation analysis, regression analysis. These methods make it possible to determine the most significant characteristics of the geographical environment and to develop on its basis structural models of road landscapes and microlandscapes that reflect the complexity of road construction.
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