

# Formation of Sustainable Land Management Based on Landscape Planning in the Middle Irtysh Area

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**Abstract**—In order to ensure a stable state of agricultural land use, it is necessary to consider the connection between agricultural land use and nature management, coordinating them with other types and systems of nature management of the organized territory. Sustainable, balanced land use is formed in different ways. One approach of solving this issue is the landscape planning. The article discusses the methodological provisions for establishing the significance and sensitivity of landscapes, as a necessary stage of landscape planning. For the first time, an attempt has been made to apply the theory of landscape planning for a specific municipality in the Middle Irtysh area. According to our own methodology, criteria for the significance and sensitivity of landscapes have been developed, including the following indicators: types and categories of lands, types of landscapes. As a result of the study, it was revealed that medium-significant landscapes with an average sensitivity to anthropogenic impacts prevail, which makes it possible to differentiate the impacts on landscapes and land use regimes. The result of scientific research is the improved methodological approaches to assessing the significance and sensitivity of landscapes to anthropogenic impacts and a set of specialized maps with allocation of areas ranked by the significance of landscapes, sensitivity of landscapes and the challenge of land and nature management.

**Keywords**—*landscape, land use, sustainability, significance of landscapes, landscape sensitivity, landscape planning.*

## I. INTRODUCTION

Landscape planning makes a particular relevance on the basis of its main goal: the formation of a long-term action plan for the protection of nature, landscape care, meeting the needs of recreational facilities and in production for sustainable development. This action plan should contribute to maintaining the natural balance, diversity, uniqueness and beauty of the landscape, the diversity of species and the implementation of measures for the protection, protection and arrangement of landscapes. Agro-landscape refers to territories with environmentally significant characteristics, performing both production and environmental, resource-reproducing and environment-stabilizing functions. The need for landscape planning comes from the fact that landscape science can be introduced into agricultural production practice.

The study sets the goal of developing landscape planning parameters for sustainable agricultural land use in the Middle Irtysh on the example of the Cherlaksy municipal district of the Omsk region based on an assessment of the significance and sensitivity of landscapes to anthropogenic impacts.

The theoretical and methodological basis of the study was the work of Russian and foreign authors in the field of landscape planning, as well as thematic materials of periodicals. To solve the tasks in the experiment, general scientific methods of analytical, structural and comparative analysis were used, as well as statistical research methods.

## II. LITERATURE REVIEW

Land relations: agricultural, legal and territorial - cannot exist separately, therefore, land management in the land use management system should become a lever for the management of decisions made and their implementation. However, on the other hand, land management is not ready for such a mission, since there is no theoretical basis [1].

As narrated by A.N. Antipov, methods corresponding to landscape planning were initially used in Estonia and Lithuania. The landscape approach was used in the design of specially protected natural areas. At the same time, the designers wanted to combine planning with landscape systems of various levels [2].

The most developed actual system of landscape planning is the German system. In Germany, landscape planning appeared at the end of the 19th century as a solution to the problem of environmental degradation. The federal law of year 1967 defines landscape planning as a landscape care tool. Strong traditions have landscape planning in Austria. Measures for the protection of landscapes are developed and implemented, first of all, by local authorities, on the initiative “from below”.

In Russia, landscape research methods were described in the works of D.L. Armand, A.N. Antipov, A.G. Isachenko, Yu.M. Semenov, E.Yu. Kolbovsky and other well-known researchers. The first Russian experience in developing an environmental zoning scheme using the experience of German scientists was done for the Baikal Territory with the development of a two-volume publication “Guide for Landscape Planning”.

In the article “Landscape planning as a tool for environmental management (on the example of the Baikal region)” 2006, A.N. Antipov, Yu. M. Semenov [3], the main result of the work was the theoretical and methodological developments of Russian and German specialists, which allowed increasing knowledge of landscape planning.

Landscape planning is considered as a contribution to the stabilization of social and economic relations, taking into account the unique features of the existing landscape of a

particular territory. Landscape planning is understood as rational land use in connection with social, cultural, economic and political conditions in a certain place.

One of the main goals of landscape planning is to create conditions for sustainable land use and rational nature management with the observance of the functions of natural landscapes [4].

In Russia, along with favorable prerequisites, there are also obstacles to the implementation of landscape planning in practice. In many regions of Russia, the following problems exist:

- Lack of complete regional development;
- Insufficient regulatory framework for landscape planning;
- Concentration of power and resources in developed regions;
- Paradoxical situations in which the most anti-environmental industries are the most profitable.

Therefore, as many scientists point out, it is possible to form models of environmentally sustainable development only at the regional level with the best result. Moreover, in order to include landscape planning in territorial planning, it is important to adopt the following principles:

- It is necessary to analyze the state of the region in the field of environmental management, taking into account the environmental prerequisites that exist in the widespread environmental system;
- Determine the prospects of environmental management in a particular region, taking into account the interests of the population;
- Analyze proposals for the development of the region and identify possible conflicts in land use;
- Assess the competitiveness of the region nationwide.

The legal regime of land is determined by the category of land and permitted use in accordance with the zoning of territories. Functional zoning contains the economic functions of the territory, for example, residential; industrial; agricultural; recreational; environmental protection; environmental protection [4]. The methods of landscape planning in land management make it possible to carry out functional zoning of lands, assess their potential, while dividing them according to their purpose, taking into account sensitivity to anthropogenic stresses, quality, and modern use. Given the natural and ecological prerequisites for spatial planning, the most significant natural components of the environment are landscapes, soils, surface and groundwater, species and biotopes.

Suitability of soils is analyzed in terms of their potential use in agriculture. The assignment of certain landscapes to a certain category of suitability is carried out according to a number of quantitative indicators (fertility, heat and moisture supply, degree of salinization, waterlogging, erosion, washout, etc.) [5].

The organization and conduct of land management is influenced by such natural factors as climate, topography, soil, vegetation, and hydrology. In each natural zone they are different, and this must be taken into account when

organizing and conducting a complex of land management works, and therefore landscape planning. E.Yu. Kolbovsky argues that for the sustainable development of agricultural land use, ecological and landscape organization of the territory where the natural substance (landscapes) is primary and secondary means of production (agro-landscapes) is important [6].

The landscape approach in relation to land management involves the placement of agricultural land. Sustainability of lands and landscapes is also achieved by the fact that in order to conduct agricultural production, the organization of the territory preserves the diversity of lands in accordance with the uniqueness and properties of the tracts represented in the landscape.

Landscape methods in land management help determine the relationship of objects - natural systems and types of land management. At the highest levels of management, specially protected natural areas are formed that have high environmentally stabilizing abilities. At the regional level, land planning is planned, and at the level of rural districts - tracts. Projects of on-farm land management cover such taxonomic units of landscapes as facies and stows [7].

A.V. Drozdov indicates that the most effective in solving the problems of landscape planning can be a municipality: a rural settlement, at the level of which it is possible to combine two streams of interests: "from below" (from the population) and "from above" (from the authorities) [8].

At the local level, whether it is a separate agricultural organization or the territory of rural self-government, a stable, highly productive and recreationally significant agro-landscape will be formed due to landscape design. The implementation of land management projects created without taking into account the requirements of landscape planning led to the degradation of agro-landscapes, as well as to the general impoverishment of the rural landscape and the development of desertification.

Any land management should be preceded by landscape design, including the functional zoning of the territory with an indication of environmentally significant factors, both valuable and dangerous to humans and their economic activities. In general, it can be assumed that in Russia the levels of landscape planning will have to come in line with the accepted levels of urban planning.

The most promising way to solve the problem of unsustainable agricultural land use is the introduction of landscape planning - a tool that takes into account both landscape-ecological and socio-economic approaches to land use.

For other types of planning, landscape planning is the basis for the assessment and development of environmental measures. The need for landscape planning is great, but so far ambiguous for state authorities and for rural workers.

### III. RESEARCH METHODOLOGY

The methodology for determining the sensitivity and significance of landscapes is one of the main stages in landscape planning. It contributes to the rational distribution of the anthropogenic load on landscape complexes. This approach can significantly reduce environmental restoration costs. The determination of the sensitivity and significance of landscapes is necessary to determine the prevailing

environmental conditions and protect natural resources in the process of their use. The significance of the landscape and its components is understood to mean their role in ensuring the functioning of the landscape for man and his activities. The sensitivity of the landscape - this concept is close to the concept of “dynamism”, i.e. the ability of the landscape to change its structure and properties under anthropogenic impact.

To study the significance and sensitivity of landscapes, the territory of the Solyansk rural settlement of the Cherklasky municipal district of the Omsk region with a total area of 32877 hectares was chosen. The presence of fertile soils, and, in turn, profitable agricultural organizations, makes the Solyansk rural settlement a leader in the agricultural activity of the region, but soil depletion cannot but affect the indicators of economic activity of farms.

The study assessed the significance and sensitivity of the landscapes of Solyansk settlement. The significance of biotopes and soils is presented in table I.

TABLE I. SIGNIFICANCE OF BIOTOPES AND SOILS BY A.V. DROZDOV [4]

Component	Target function	Criteria	Significance
Biotopes	Ability to reproduce the living conditions of plant and animal species	Initial (potential) and existing environmental conditions are almost identical	High
		Existing state of the environment is approaching potential or can be restored	Medium
		Current state of the environment is significantly different from the original	Low
Soils	Bioproduction ability or fertility	For agricultural land (by type of land)	
		Significant humus and water reserves	High
		Average reserves	Medium
		Low reserves	Low

In the Solyansk rural settlement, the existing state of the environment and soils is rated as average significance. Landscaping is low. The soil cover is represented by chernozem, chernozem-meadow and meadow soils. Covering loams and clays serve as parent rock material. The significance of the bio-production ability of soils for agricultural land is estimated as low, due to insignificant reserves of humus and moisture.

The sensitivity of landscapes to anthropogenic influences is determined on a scale: high, medium, low according to the behavior of the morpholithogenic basis of landscapes on anthropogenic influences.

Thus, the degree of sensitivity of landscapes of Solyansk rural settlement to anthropogenic impacts is low. Assessment of the state of the environment in the categories of value and sensitivity is obtained from the features of the landscape components and is aimed at organizing further stages of the study.

The term “sustainability” implies the system feature that maintains quality predetermination. The sustainability of

natural systems depends both on the dynamic properties of the systems themselves and on the influence of external factors. Using a scale of indicators of the potential sustainability of landscapes to agricultural impact and ranking indicators by their intensity or severity, given that a number of indicators are divided by the degree of manifestation of phenomena into groups, the degree of sustainability of a number of soil-landscape indicators is established: relief form; slope steepness; landscape drainage; particle size distribution of the soil; type of water regime; thickness of the humus horizon (A + AB); humus content; salinity (salt content in the upper horizon,%); projective cover [9].

**IV. RESULTS**

The resulting total points are proposed to be divided into five groups, as suggested by I.V. Orlova [9], depending on the total amount of points, expressed as a percentage: group 1 — stable landscapes (81–100%), group 2 — relatively stable (61–80%), group 3 — unstable (41–60%), the 4th group - unstable (21-40%), the 5th group - extremely unstable (less than 21%).

Similarly to the example of assessing the significance and sensitivity of landscapes of the Solyansk rural settlement, a map of land and nature management directions of the Cherklasky municipal district of the Omsk region was created for the following components: climate, surface water, soil, landscape diversity, the presence of objects of historical and cultural heritage. The following land and environmental management system is proposed (Table II, III):

- Preservation, refusal of use;
- Preservation, extensive use;
- development, extensive use;
- improvement, maintenance;
- development improvement.

TABLE II. SIGNIFICANCE AND LANDSCAPES SENSITIVITY OF CHERLAKSKY DISTRICT

Gradation	Square, ha	Specific weight, %
<i>Significance</i>		
High	125600	29.4
Medium	208858	48.8
Low	93470	21.8
<i>Sensitivity</i>		
High	179900	42.0
Medium	247300	58.0
Low	-	-

TABLE III. DIRECTIONS FOR LAND USE OF CHERLAKSKY DISTRICT

Directions of land and environmental management	Square, ha	Specific weight, %
Preservation: - refusal of use	104300	24.4
Preservation, - extensive use	32850	7.7
Development: - extensive use	196448	45.9
Improvement: - preservation	76300	17.8
Improvement, - development	18030	4.2
District's total square	427928	100

- the goal of “conservation” is adopted where the territory has the highest value and higher sensitivity. Sites requiring special protection in the Cherlaksy district include forests, the Stepnoy nature reserve of regional importance, the Verkhneilinsky natural complex, the Irtysh River, and plains of natural vegetation in the lowlands.
- the goal of “improvement” is set in areas that have received a low rating, with high sensitivity, for particularly vulnerable areas where the development of negative processes is manifested. As a rule, this is arable land and pasture. This also includes landscapes with grasses and meadows, shrubs on elevated elements of the relief. Additionally, a geo-botanical map, a map of prevailing land use, a map of degraded and distressed lands are involved [10];
- the goal of “development” is adopted in areas of medium importance and medium sensitivity. Attention is given to assessing sustainability as one of the indicators of sensitivity. These are sites with significantly altered terrain components. This includes all territories of residential and industrial zones, transport infrastructure, quarries and agricultural processing enterprises. To stabilize and increase the sustainability of landscapes, it is recommended to increase the area of forest plantations (forest reclamation) and water treatment.

In the Cherlaksy district, landscapes with high and medium significance prevail (29% and 49%, respectively), while 42% of landscapes are highly sensitive and 58% medium sensitive. Based on this, we offer 46% of the territory for development and extensive use and 24% for the conservation and abandonment of use.

From the data obtained, it was concluded that the agricultural landscapes in the Cherlaksy district of the Omsk region are mainly unstable to anthropogenic impact; they require a special approach in carrying out economic activities.

**V. PRACTICAL SIGNIFICANCE**

Landscaping refers to new areas in land management. However, the landscape approach was inherent in land management activities for a long time. Consideration of local natural, environmental conditions is one of the highest priority land management requirements. Activities developed on the basis of landscape planning will help to maintain the natural balance, biological diversity and sustainable development of the region.

Landscape planning approaches related to the determination of the sensitivity and significance of landscapes allow us to differentiate anthropogenic loads in relation to each plot of land and establish the appropriate mode of use.

**VI. SUGGESTIONS AND RESULTS OF IMPLEMENTATIONS**

Based on an existing methodology developed by A.N. Antipov, created his own methodology for assessing the significance and sensitivity of the territory. The significance criterion consists of the following indicators: types and categories of lands, types of landscapes, are presented in tables IV and V. Each type of land, taking into account the degree of change and importance, receives an appropriate score, after which groups are formed according to similar characteristics.

**TABLE IV. LAND CLASSIFICATION BY THE ANTHROPOGENIC IMPACT DEGREE**

Preservation gradation	Grade	Land types and categories
Very low	0	Industry, transport, communication, settlement lands; distressed lands
Low	1	Hydromelioration lands
Medium	2	Arable land; areas of intensive logging; pastures and hayfields used irrationally
High	3	Perennial plantations, recreation areas
Very high	4	Haymaking areas; forest
Highest	5	Conservation areas and lands not used in agricultural activities

The structure of land use determines how the distribution and redistribution of anthropogenic pressures occurs over the territory and, ultimately, the real and not potential sustainability of landscapes. In this case, the establishment of the degree of conformity of the land use structure (economic specialization) to the landscape structure is important for the subsequent justification of the choice of development goals for the territory.

**TABLE V. LAND CLASSIFICATION BY THE DEGREE OF SIGNIFICANCE OF LANDSCAPE TYPES**

Significance gradation	Grade	Landscape types
Very low	0	Presence of dangerous natural processes and phenomena (mudflows, landslides, ravine formation, suffusion). Inaccessibility and impassability of territories. Steep slopes disposed to denudation and erosion. Lowland marshes and wetlands.
Low	1	Anthropogenic objects that reduce the landscape and the “usefulness” of natural landscapes (industrial facilities, logging, burning, etc.). Deforested and man-made areas.
Medium	2	Variety, contrast (landforms), aesthetic appeal. Steep and gentle slopes with dark coniferous and light coniferous forests. Swamps.
High	3	Craft opportunities. Steep and gentle slopes, watersheds with small-leaved and light coniferous forests.
Very high	4	Water bodies. Availability, infrastructure. Residential areas.
Highest	5	Unique territories and objects

Compared with other types of anthropogenic landscapes, agro-landscapes are closest to natural landscapes in their properties. From here follows the relevance of landscape research for agricultural land use. Based on the two tables, a general analysis of the significance of the components of the territory under consideration is made. As an experiment, a landscape distribution scheme was compiled according to significance (Fig. 1).

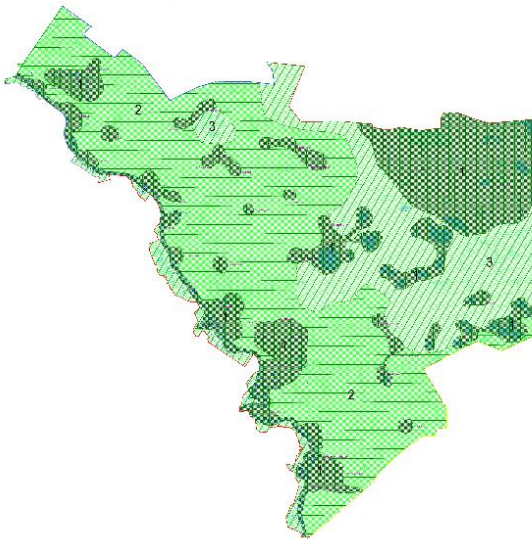


Fig. 1. Scheme of landscape distribution by their significance using the example of Cherlaksy district of Omsk region. Symbols: 1 - highly significant; 2 - average; 3 - insignificant.

Based on the established indicators of significance for the development of cartographic material, samples were made for each landscape section. In this case, first of all, areas of landscapes with high, then with medium significance and, further, low-significance landscapes were selected.

The sensitivity criterion consists of the following indicators: types and categories of land (as well as the significance criterion), type of changes in the environment. Each type of land, taking into account the assessment of the ecological state, receives a corresponding score, after which the land forms homogeneous groups, is presented in table VI, VII. The distribution of landscapes by sensitivity is shown in Fig. 2.

TABLE VI. IMPACT INTENSITY SCALE

Impact gradation	Grade
High impact	0
Medium impact	1
Moderate impact	2
Low impact	3
Insignificant impact	4
No impact	5

TABLE VII. LANDSCAPE SENSITIVITY SCALE

Sensitivity	Grade
High sensitivity	0 - 3
Medium sensitivity	4 - 7
Low sensitivity	8 - 10

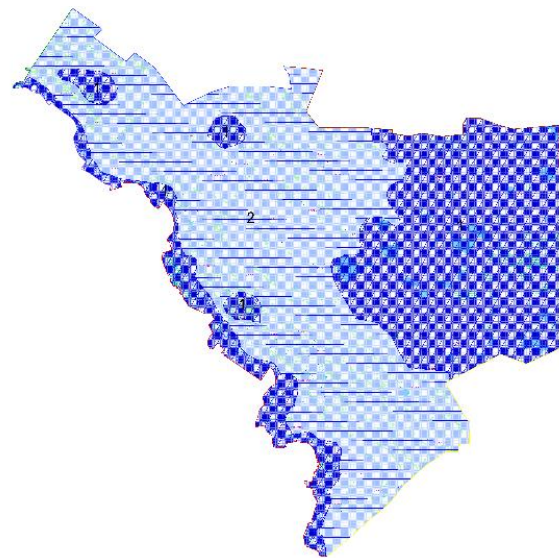


Fig. 2. Scheme of landscape distribution by sensitivity. Symbols: 1 - highly sensitive; 2 - medium sensitive.

The result of the experiment is a set of specialized maps for the use of land depicting zones by type of land and nature management goals in the territory of the Cherlaksy municipal district of the Omsk region. The most high-quality way to create maps is the use of GIS technologies [11]. In total, three main types of land and environmental management goals are identified: conservation, development, and improvement.

We believe that the following land and nature management system is optimal for the Middle Irtysh Region:

- Preservation, refusal of use;
- Preservation, extensive use;
- Development, extensive use;
- Improvement, maintenance;
- Improvement, development.

VII. CONCLUSION

The proposed landscape planning methods can be used as a tool for developing a territorial planning scheme as part of achieving a strategy for sustainable development of regions. Landscape planning takes into account the natural features and uniqueness of landscapes, the environmental significance of its components and will allow land users to conduct agricultural activities without harming the natural landscape.

Based on the results of assessing the significance and sensitivity of landscapes, a land and nature management scheme was created for the Cherlaksy municipal district of the Omsk region. It was revealed that landscapes with high significance occupy 29% of the total area of the region and 49% are with average significance. At the same time, 42% of landscapes are highly sensitive and 58% are medium sensitive. Based on this, 46% of the territory is proposed for development and extensive use and 24% - for the conservation and refusal of use. The land and nature management scheme demonstrates the territorial and environmental-economic structure of agricultural land use, the distribution of land between land users, regardless of ownership. The scheme is a territory zoning with dedicated

zones and subzones. Goals of use for further development, modes of use and necessary measures are established for each zone. Events are developed with the aim of rational use of agro-landscapes and solving the environmental and economic problems of the region [12].

The sustainability of natural systems depends both on the properties of the systems themselves and on the characteristics of the impact of external factors. The ranking of impact factors by severity made it possible to create a scale of indicators of potential landscape resilience to anthropogenic impact and assess landscape resilience to agricultural use. Therefore, an attempt of setting the theory of landscape planning for the further formation of sustainable land use and the rational use of agro-landscapes into practice was made for the first time for the conditions of the Middle Irtysh area.

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