

ECOLOGICAL AND ECONOMIC JUSTIFICATION OF THE INVESTMENTS' EFFICIENCY IN THE INTEGRATED DEVELOPMENT OF TERRITORIES

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ABSTRACT

Intensive human economic activity has led to decrease in the natural resource potential of territories and qualitative changes in the natural environment surrounding a person: a violation of the spatial and functional structure of natural systems, a decrease in the biological diversity of flora and fauna, a deterioration in the quality of water and land resources, a decrease in the ecological and economic sustainability of technical and natural systems and the quality of human life. Ensuring the sustainable functioning and development of territories is possible due to the complex arrangement of the territory (scientific organisation of the territory). It is the optimisation of the land using structure that will restore disturbed ecosystems to standard values, increase biological diversity, environmental sustainability and economic efficiency of landscapes. One of the limiting factors in the implementation of this measure is the lack of an effective mechanism for assessing the effectiveness of investments in land development. All this indicates the need to develop proposals for the development of methodological approaches to assessing the environmental and economic efficiency of investments in land development, taking into account the shortcomings that we identified when analyzing existing approaches to assessing the effectiveness of investment projects of social significance. At the same time, it should be noted that ensuring sustainable development of territories is impossible with the existing nature-intensive concept of economic development. A new approach to solving this problem is needed, which should:

- be based on a deep study of socio-economic and environmental problems, a retrospective analysis of the state of landscapes and a long-term forecast of the expected consequences of the impact of human activity on the state of individual components of the considered territory and the landscape as a whole;
- it aims to ensure the socio-economic and environmental safety of Russia.

The purpose is to develop proposals for the development of a methodological approach to assessing the environmental and economic efficiency of investments in



the integrated development of territories which are aimed at ensuring the socio-economic and environmental security of Russia.

Keywords: *landscaping, scientific organisation of the territory, ecological effect, complex reclamation, efficiency*

INTRODUCTION

At present, all efforts to improve the environmentally sustainable development of territories are reduced mainly to combating the consequences by introducing the best available technologies (developing measures to reduce air emissions and discharges into water bodies, combating soil erosion, etc.), and not to clarify the reasons for the development of degradation processes and the development of preventive measures aimed at increasing the overall usefulness of the territory, taking into account inter-landscape connections. In addition, during solving these issues, such an important problem as the degree of disturbance in the structure of natural landscapes due to the transformation of forest and meadow ecosystems with high biodiversity into cultural landscapes as a result of economic activity falls out of sight. The research results showed that agriculture made a significant contribution to the violation of the structure of natural landscapes use due to the high degree of plowing of land (constituent entities of the Russian Federation included in the Central, Southern, Volga, North Caucasian, Ural federal districts). In these regions, the existing degree of disturbance in the structure of the natural landscape exceeds the permissible value of the anthropogenic load on the natural environment by 1.5 ... 2.5 times, and this, in its turn, led to a violation of one of the basic laws of nature - the Le Chatelier-Brown principle, such as the spontaneous destruction of natural ecosystems in the regions under consideration. The real way out of this situation is to abandon a pure consumer approach to the use of natural resources, reduce the technogenic impact on the natural environment and restore disturbed ecosystems to the extent necessary to maintain the sustainability and further development of natural landscapes and society. At present, the general opinion is that this problem should be solved through a comprehensive arrangement of the territory (scientific organisation of the territory). Optimisation of the structure of land using will restore disturbed ecosystems to standard values, increase biological diversity and ecological and economic sustainability of landscapes. One of the limiting factors in the implementation of this measure is the lack of an effective mechanism for assessing the effectiveness of investments in land development. And the existing approaches to assess the effectiveness of investments, set out in [1], are universal and do not sufficiently take into account the specifics of various sectors of the economy.

This is especially true for agriculture, which acts in two forms: on the one hand, it ensures the country's food security, on the other hand, it has a significant impact on the state of the environment. The absence in this document of a mechanism for accounting of environmental and social factors does not allow an objective assessment of the economic efficiency of investments in land development, which is a significant drawback of the regulatory document in the field of integrated investment support. These issues are not fully resolved in the departmental

regulatory and methodological document [2], the significant disadvantages of which are:

- the assessment of the productivity of agricultural crops is carried out without taking into account the reclamation regime of agricultural lands and their ecological state;
- the list of reclamation measures proposed for taking into account when assessing the economic efficiency of an investment project is a set of measures, and not a system of interrelated and interdependent measures that function as a whole;
- when assessing the effectiveness, it is assumed that the complete restoration of the disturbed natural environment is achieved when carrying out environmental protection measures;
- It is proposed to determine the system of performance indicators without taking into account the assessment of the environmental sustainability of the natural system;
- when assessing the effectiveness of investments, preference is given to the economy, rather than the environmental factor (one of the laws of nature is violated - the principle of simultaneous efficiency and safety – don't harm!).

There are also significant drawbacks in the proposed approaches to assessing the effectiveness of investments, set out in domestic and foreign works [3-17], the main of which are:

- lack of a system of indicators and models that would allow assessing possible long-term environmental consequences from the implementation of an investment project;
- lack of mechanisms for assessing the impact of the degree of disturbance in the structure of the natural landscape on the change in the land reclamation regime and the value of ecosystem services as a result of economic activities;
- lack of a systematic approach to the analysis of economic and natural processes in the implementation of reclamation measures.
- lack of a mechanism for taking into account the permissible degree of disturbance in the structure of the natural landscape when assessing the effectiveness of investments;
- lack of a systematic analysis of the reasons for the deterioration of the state of the main components of the landscape, etc.

All this indicates the need to develop proposals for the development of methodological approaches to assessing the environmental and economic efficiency of investments in land development, taking into account the shortcomings that we identified when analyzing existing approaches to assessing the effectiveness of investment projects of social significance. At the same time, it should be noted that ensuring sustainable development of territories is impossible with the existing nature-intensive concept of economic development. A new approach to solving this problem is needed, which should:

- be based on a deep study of socio-economic and environmental problems, a retrospective analysis of the state of landscapes and a long-term forecast of the expected consequences of the impact of human activity on the state of individual components of the considered territory and the landscape as a whole;
- it aims to ensure the socio-economic and environmental safety of Russia.

METHODS AND METHODOLOGY

The methodology for assessing the environmental and economic efficiency of investments in the development of territories is based on the accumulated knowledge about the functioning of techno-natural systems, a systematic approach to the analysis of economic and natural processes, as well as the principles of sustainable development and environmental management.

As a criterion for assessing the effectiveness of investments in integrated development of territories, it is proposed to use the increase in net discounted income:

$$\Delta \mathcal{M} = \sum_{t=0}^{T_p} (\Delta B_t + \Delta \mathcal{E}_{1t} + \Delta \mathcal{E}_{2t} + \Delta \mathcal{E}_{3t} + \Delta \mathcal{E}_{4t} + \Delta \mathcal{E}_{5t} + \Delta \mathcal{E}_{6t} - \Delta M_t - K_t)(1 + E_H)^{-t} > 0$$

where

$\Delta \mathcal{M}$ is the increase in net discounted income from the implementation of a set of measures for land development for the estimated period of time, rubles;

ΔB_t - increasing in proceeds from the production and sale of products on ameliorated lands in the year t of the billing period, rubles;

$\Delta \mathcal{E}_{1t}$ - the value of the prevented environmental effect formed by reducing erosion processes as a result of agroforestry and agrotechnical measures in the year t of the settlement period, rubles;

$\Delta \mathcal{E}_{2t}$ is the environmental effect generated by saving water resources in the year t of the billing period, rubles;

$\Delta \mathcal{E}_{3t}$ is the ecological effect of reducing the volume of discharge of collector-drainage waters as a result of land development in the year t of the settlement period, rubles;

$\Delta \mathcal{E}_{4t}$ - the ecological effect of reducing the area of the disturbed system and increasing the biological diversity of the landscape in the year t of the settlement period, rubles;

$\Delta \mathcal{E}_{5t}$ is the economic effect formed due to tax receipts to the budgets of all levels in the year t of the billing period, rubles;

$\Delta \mathcal{E}_{6t}$ is the increase in the multiplier effect in the construction sector, rubles;

ΔM_t - increase in production costs per year t of the billing period, rubles;

K_t - investments in complex development of territories in the year t of the billing period, rubles;

E_n - discount rate.

RESULTS AND DISCUSSION

The results of the research showed that a special place among the main environmental problems of our time is occupied by changes in the structure of natural landscapes, an increase in the areas of disturbed ecosystems and a reduction in biological diversity, the main reason for the emergence of which is the transformation of natural ecosystems into cultural landscapes. All this indicates that the planned measures for the development of land should be aimed at preventing negative processes, namely, at reducing the areas of intensively used lands due to reforestation in areas where forests were previously cut down, transforming a part of arable land with slopes above 5 degrees into natural and semi-natural landscapes (in this territory, the ecological damage exceeds the economic effect due to the development of degradation processes), the elimination of abandoned lands in order to restore the operation of the Le Chatelier-Brown principle, that is, to stop the spontaneous destruction of natural ecosystems. When substantiating the size of the reduction in the area of intensively used lands, the ecological significance of various lands and the permissible degree of disturbance of the landscape structure are taken into account, the value of which does not exceed 0.15 for the conditions of the Northwestern, Siberian and Far Eastern districts, for other federal districts - 0.3 ... 0, 4 [18], [19], [20]. Solving the issues of optimizing the spatial and functional optimization of the structure of natural landscape use, on the one hand, should not infringe on the interests of economic activity (decrease in the production of agricultural and other products due to the reduction of arable land on the territory with slopes above 5 degrees), and on the other hand, not a single one. the type of activity cannot be justified if the economic effect from it does not exceed the caused environmental damage. In the event that the interests of the economy and nature do not coincide, it becomes necessary to find a compromise, but preference is always given to the conservation of nature, since it is nature that is a long-term factor in human habitation in the territory under consideration. In this regard, along with the optimization of the land structure, it is necessary to carry out a set of reclamation measures, including agrotechnical, agroforestry, biological, chemical and hydrotechnical reclamation on the remaining arable land in order to increase the productivity of land.

The basis for determining the increase in proceeds from the production and sale of agricultural products is based on the empirical dependence of the yield of agricultural crops on reclaimed land, which allows taking into account the main factors of life and development of plants, natural and climatic factors, the actual state of agricultural land, the farming system and the soil reclamation regime. The magnitude of the environmental effect (prevented environmental damage), formed



by reducing erosion processes as a result of agroforestry and agrotechnical measures, is determined by the following formula:

$$\Delta \mathcal{E}_1 = \Delta S \cdot u \cdot k \cdot F_{a1m}, \quad (2)$$

where:

$\Delta \mathcal{E}_1$ - the value of the prevented environmental effect formed by reducing erosion processes as a result of agroforestry and agrotechnical measures, rubles;

ΔS - change in soil fertility due to agroforestry and agrotechnical measures, in shares of the original ;

u - cadastral value of land, rubles /ha;

k - an indicator that takes into account the type of land (for arable land, this indicator is 2.2);

F_{a1m} - the area on which agroforestry and agrotechnical activities are carried out, ha.

A special role in land development is assigned to hydrotechnical reclamation (irrigation and drainage of lands) as an integral part of complex reclamation. It is hydrotechnical reclamation that is an event that improves the environmental, social and economic conditions of the area under consideration. It should be noted that irrigated and drained lands should be used for vegetable crops, as hayfields and pastures, as well as for the cultivation of perennial grasses.

The basis for determining the environmental effect formed by saving water resources is based on additional costs associated with preventing or compensating for possible negative consequences as a result of land reclamation (irrigation), or saving financial resources (when using environmentally friendly irrigation standards for agricultural crops). The method for calculating the ecological effect is described in detail in [18].

The magnitude of the environmental effect from a decrease in the volume of discharge of collector-drainage waters as a result of land development is formed by reducing fees for negative impact on the environment as a result of the transition from the traditional irrigation regime, which is based on the principle of complete satisfaction of plants in water, to an ecologically safe water regime.

Comprehensive land development provides for a change in the existing structure of land in the landscape by reducing the areas of arable land located on an area with slopes of more than 5 degrees by converting them to hayfields and pastures and eliminating abandoned lands. Justification of the need to change the existing structure of land in the landscape, which is made by comparing the existing degree of disturbance in the structure of the landscape with the permissible values of this indicator. The assessment of the existing degree of disturbance in the structure of natural landscapes is carried out using an integral indicator, the value of which is determined by the ratio of intensively used lands to the total area of the

region (landscape). The implementation of the above measures will contribute to a reduction in the area of the disturbed ecosystem, an increase in biological diversity, as one of the indicators characterizing the ecological and economic sustainability of the agricultural landscape and landscape in general, an increase in the value of ecosystem services in the territory under consideration, and this, in turn, will affect the improvement of the quality life of the population. The amount of increase in environmental damage formed due to changes in the area of the disturbed system and the biological diversity of the landscape without comprehensive land improvement and in the developed area is determined by the following formulas [18], [20]:

$$\Delta\mathcal{E}_4 = Y_{\text{III}_1} - Y_{\text{III}_2}, \dots \dots \dots (3)$$

$$Y_{\text{III}} = F_{\text{H}\mathcal{E}} \cdot \beta \cdot F_{0\mathcal{E}} \cdot \mathcal{U}, \dots \dots \dots (4)$$

$$F_{\text{H}\mathcal{E}} = a \cdot K_{\text{H}\mathcal{E}} + b \cdot K_{\text{H}\mathcal{E}}^2, \dots \dots \dots (5)$$

where

$\Delta\mathcal{E}_4$ is the ecological effect of reducing the area of the disturbed system and increasing the biological diversity of the landscape, rubles;

Y_{III_1} and Y_{III_2} - environmental damage resulting from changes in the area of the disturbed system and the biological diversity of the landscape without carrying out a comprehensive arrangement of land and in a developed area, rubles;

$F_{\text{H}\mathcal{E}}$ - the area of the disturbed ecosystem, %;

β - coefficient taking into account the change in biological diversity as a result of plowing the natural landscape;

$F_{0\mathcal{E}}$ - the area on which the complex of measures for the arrangement is carried out, hectares;

\mathcal{U} - ecological and economic assessment of agricultural land, rubles / ha;

a and b - coefficients;

$K_{\text{H}\mathcal{E}}$ - the existing degree of disturbance of the landscape structure.

The amount of tax receipts to the budgets of all levels is determined in accordance with the current legislation of the Russian Federation [20]. At the same time, it should be noted that when implementing a complex of reclamation measures, the budgets of different levels will receive taxes not only from direct participants in the investment project, but also from the construction complex. The reason for this is the large volume of construction and installation and other types of work performed during land development. Research results have shown [18] that the amount of tax revenues is 20% of the investment in the project.

The above approach to assessing the ecological and economic efficiency of investments in integrated land development makes it possible to take into account

the diversity of climatic, socio-economic and ecological conditions of natural landscapes and agricultural landscapes, to substantiate the level of anthropogenic load on the landscape and the composition of measures for the reproduction of natural resources, as well as to estimate the value prevented damage (effect) from their implementation by increasing the biological diversity and productivity of agricultural land, improving the state of ecosystems, reducing the pollution of surface and ground waters, improving the quality of life of the population living in the territory under consideration, etc.

Below are the results of assessing the economic efficiency of investments in land development located in the constituent entities of the Russian Federation of the Central Federal District. The constituent entities of the Russian Federation, which are part of the Central Federal District, are located in forest, forest-steppe and steppe natural and climatic zones and have a high natural resource potential.

The research results made it possible to form a set of reclamation measures to improve the environmental sustainability of the territory and the efficiency of land use in the region under consideration, including:

- reforestation;
- prevention and control of soil erosion by planting field-protective forest plantations, carrying out agrotechnical measures and transforming a part of arable land into semi-natural landscapes;
- transformation of abandoned arable land into hayfields and pastures;
- reconstruction of reclamation systems.

Table 1 shows data characterizing the types and volumes of planned reclamation activities in the Central Federal District.

Table 1. *Planned system of reclamation measures, million hectares*

Events	Scope of events
Restoration of forest ecosystems	4,2
Prevention and control of soil erosion and deflation	11,7
including:	
shelter plantings	1,4
agrotechnical measures	4,3
tinning of arable land with slopes $> 5^0$	10,9
Transformation of abandoned arable land into hayfields and pastures	3,9
Reconstruction of reclamation systems, incl.	0,8
irrigation	0,4
drainage	0,4

The selection of priority reclamation measures in the complex land development is carried out by determining the social effectiveness of their implementation. Table 2 shows the results of calculating the social efficiency of a complex of land reclamation measures for the development of the territory of the Central Federal District.

Table 2. *The results of calculating the social efficiency of investments in land development, million rubles.*

№	Indicators	Indicator values, taking into account discounting for the estimated period of the project
1.	Outflows (item 2 + item 3 + item 4)	Outflows (item 2 + item 3 + item 4)
2.	Off-budget investments	10452
3.	Budget investments	86520
4.	The total increase in annual costs	104804
5.	Tributaries (item 7 + item 8)	370233
6.	The additional amount of proceeds from the sale of agricultural products obtained through the implementation of reclamation measures, excluding value added tax	131014
7.	An increase in the ecological effect due to the prevention of water and wind erosion of soil, saving water resources, reducing the volume of discharge of collector-drainage waters into water bodies, reducing the area of disturbed lands and increasing the biological diversity of the landscape	239209
8.	Increase in net present value (item 6 - item 1)	168447

The above results of calculating social efficiency allow us to conclude that the complex of measures for the development of land in the constituent entities of the Russian Federation that are part of the Central Federal District is highly effective (net discounted income for the calculation period in the considered district is a positive value).

CONCLUSION

As conclusion, generalisation of the available materials and numerical experiments performed using the developed models for the ecological and economic assessment of the effectiveness of investments in the development of territories made it possible to develop a set of measures to reduce the anthropogenic load on the natural landscape of the Central Federal District, increase biodiversity, increase the environmental sustainability and economic efficiency of the landscape. The research results have shown that the proposed set of reclamation measures for the development of the territory of the region under consideration will provide: an increase in crop yields from 60 to 80 ... 85% of the climatically provided yield; increase in biological diversity by 25 ... 30%; reduction of water pollution by 50 ... 55%; an increase in the moisture content of the territories by 5 ... 7%; reduction of the area of damaged systems by 15 ... 20%.

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