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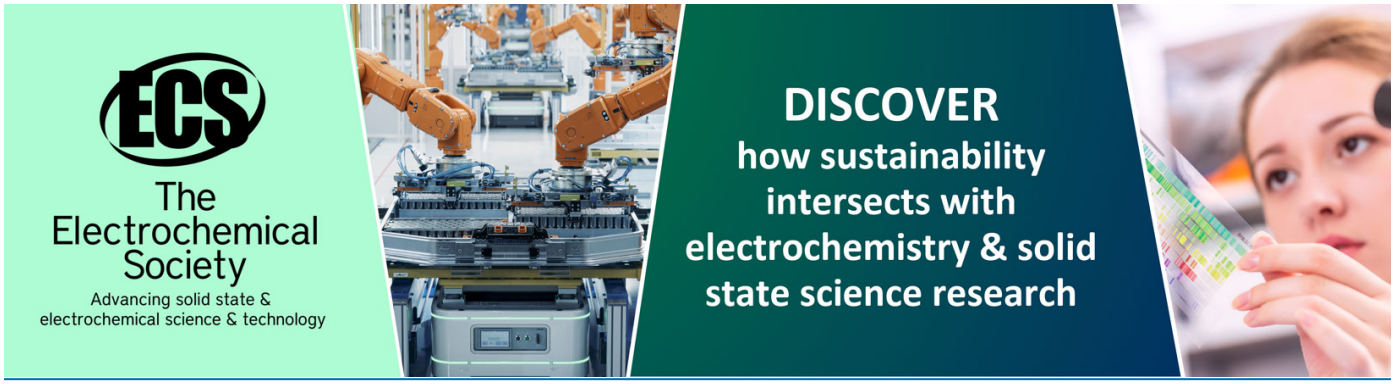

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Improving the optimization methodology for the structure of agrolandscapes

K Y Zotova and E V Nedikova

Voronezh State Agrarian University named after Emperor Peter the Great, 1, Mitchurina, Voronezh, 394087, Russia

E-mail: nedicova@emd.vsau.ru

Abstract. The unstable economic situation of agricultural producers and the agrarian sector as a whole necessitates the search for methods of organizing production to ensure stabilization and a consistent improvement of the agricultural sector. The analysis of the territory as the basis of the agro-industrial complex is of great importance, and therefore, it is necessary to develop a combination of optimizing agrolandscapes aimed at improving the efficiency of agricultural production. In this regard, the authors improved the methodology for optimizing the structure of agrolandscapes based on determining the influence degree of the level of anthropogenic load on the ecological condition of the territory, which, in turn, directly depends on the ratio of agricultural lands of the agrolandscape and determining the share of each type of land on the growth of ecological and economic efficiency of the territory. Within the proposed methodology the cumulative impact of natural and anthropogenic factors was assessed using two agricultural enterprises of the Voronezh region as an example. It made possible to comprehensively assess the environmental effectiveness of the study area. This technique of optimizing the structure of the agricultural landscape of enterprises can provide the environmental and economic efficiency assessment of any agricultural enterprise in the Central Black Earth Region of the Russian Federation.

1. Introduction

The unstable economic situation of agricultural producers and the agrarian sector as a whole necessitates the search for methods of organizing production to ensure stabilization and a consistent improvement of the agricultural sector. The analysis of the regional territory and agricultural enterprise as the basis of the agro-industrial complex is of great importance. Therefore, it is necessary to develop a combination of optimizing agrolandscapes aimed at improving the efficiency of agricultural production.

Many agronomic scientists point out this in their works. V.V. Dokuchaev notes in the work Our Steppes Before and Now that it is necessary to analyse the changes in the agrolandscape from its appearance to its present state. In this case, it is necessary to consider the state of the surface of the water, vegetation, fauna and, of course, climate [1].

Lopyrev M.I. draws attention to the fact that before optimizing agrolandscapes, it is necessary to describe the corresponding ecological system in which optimization decisions are implemented. This is necessary to show the entire set of components that make up the design process, as well as to identify the relationship of environmental factors in agrolandscapes [2].

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2. Materials and methods

When analysing agrolandscape ecosystems it is important to consider the influence of both natural and anthropogenic factors which can have not only a positive effect on the agrolandscape but also a negative one, thereby causing great damage to the territory.

Many factors cause a destructive effect, but the main and most dangerous for the agrolandscape are the natural types of erosion is water and wind.

Water erosion occurs mainly on the slopes, from which melt waters and heavy rains wash off the upper fertile soil layer. This leads to the formation of ravines, ravines, and very soon the area begins to lose its fertile qualities.

As for wind erosion, it occurs mainly in areas with large open spaces and represents the weathering of fertile soil particles in areas not protected by vegetation. Wind erosion is capable of capturing large areas, it is especially dangerous for dry land masses.

As a rule, the manifestation of natural soil erosion is largely due to climatic features of this region, but at the same time, human activities in growing crops can significantly accelerate natural processes.

In this regard, it is important to carry out a combination for the preservation of the upper fertile layer by conducting agroforestry activities that contribute to the optimization of the agroecosystem.

The ecosystem agrolandscape has a high level of diversity of natural and man-made components organically interconnected. In the ecosystem of the agrolandscape there are relatively independent cycles and exchanges of substances and energies, which includes whole objects: field, forest, meadow, etc., as well as a set of individual links representing elementary elements: road and forest belt, meadow and field, etc. ..

Frome the above, it is possible to optimize agrolandscapes based on an analysis of the territorial potential involving the systematization of indicators which characterize the possibilities of its productivity considering the diversity of natural and anthropogenic factors.

Natural components of the agricultural environment are indicators that affect the livelihoods of people, the state of the environment, in our case, the agricultural environment, as well as the development of agriculture, industry, recreational activities, etc., while not changing while human activity. These indicators include: the climatic norm of soil formation, the complexity of the soil structure, the diversity of the agricultural landscape, the forest cover of the territory, the degree of diversity of the agricultural landscape, the fragmentation of the territory, the density of the hydrographic network, and the tension of the relief.

Anthropogenic components, unlike natural ones, are variable, depending on the level of load. As well as natural, anthropogenic factors can be considered through indicators representing various forms of activity of human society, leading to a change in the environment of other species or directly affect their lives. Anthropogenic factors include: the plowing of the territory, the afforestation of arable land, the specific length of forest strips, the concentration of animal husbandry, the development of the territory, the coefficient of technogenic fragmentation, the coefficient of technological disturbance of the land [3, 4, 5].

3. Results

The systematization of the above indicators determines the degree of their influence on a particular territory. Then, based on determining the maximum permissible values, the state of the territory is evaluated, and then the question of the need for land transformation is decided.

For greater clarity, we calculate these indicators on the example of typical farms of the Voronezh region located in different climatic zones. For the forest-steppe it is Spring peasant farm of the Verkhnekhavsky district of the Voronezh region; for the steppe it is Stepnoye agricultural enterprise of the Podgorensky district of the Voronezh region [6]. The production directions of the presented typical farms are crop production. We will consider the values of the indicators of the farms before land management to optimize the structure of agricultural landscapes and after their implementation. The main evaluation criteria are natural indicators and changing anthropogenic indicators such as afforestation of arable land, specific length of forest strips, etc. (table 1).

Table. 1. Territorial assessment of typical agricultural enterprises of the Voronezh region.

Indicators	**Values of farm indicators**			
	Spring peasant farm		**Stepnoe agricultural enterprise**	
	before	**after**	**before**	**after**
Natural:				
climatic rate of soil formation	0.9	0.9	0.8	0.8
soil structure complexity	0.8	0.8	0.7	0.7
variegated land	0.9	0.9	0.8	0.8
forest cover	0.5	0.5	1.0	1.0
degree of landscape diversity	0.9	0.9	0.9	0.9
division	0.6	0.6	0.6	0.6
hydrographic network density	0.9	0.9	0.6	0.6
terrain tension	1.0	1.0	0.7	0.7
Average value %	*81*	*81*	*76*	*76*
Anthropogenic:				
plowing	1.0	1.0	0.7	0.5
arable land	1.0	0.5	0.6	0.3
specific length of forest strips	0.8	0.3	0.6	0.3
livestock concentration	0.3	0.3	0	0
development of the territory (from);	1.0	1.0	0.7	0.7
technological fragmentation coefficient	0.8	0.8	0.8	0.6
coefficient of technological disturbance of land	0.3	0.3	0.6	0.3
Average value %	*74*	*60*	*62*	*45*

4. Results

The systematization of the above indicators determines the degree of their influence on a particular territory. Then, determining the maximum permissible values allows to evaluate the state of the territory and then make the decision about the need for land transformation. The state of the territory is asessed on the basis of the average aggregate value of the above indicators, by determining the difference between natural and anthropogenic values [7].

Then, based on the obtained values of aggregate indicators, we determined the influence level of natural and anthropogenic components on the state of the agricultural landscape by identifying the level of load on the territory. On the basis of the average aggregate value of indicators, it is first necessary to determine the level of the territorial tension, and then to identify the need for optimizing agricultural landscapes. In addition to above, it is necessary to rely on the total ecological and economic effect that occurs at different ratios of areas transformed anthropogenic and natural ecosystems of the agricultural landscape. According to Odumov, an appropriate ecological balance arises at a ratio of 40% of anthropogenic and 60% of natural ecosystems [2]. That is, the higher the value of natural indicators of the agrolandscape, the closer to the permissible level of load on it.

For a more detailed determination of the load level in the territories, we consider it appropriate to use the following gradations of the values of the combined influence of factors:

- when the average aggregate value of natural and anthropogenic indicators is less than 5, the level of load on the agricultural landscape is considered dangerous, since in this case the indicators of anthropogenic components prevail, i.e. anthropogenic indicators make up more than 53% of the total aggregate value taken as 100%, which is not permissible in the agricultural production;

- with an average aggregate value from 5 to 4.9, the value of the load level is critical, that is, here the value of natural indicators is quite low-requiring work to optimize the agricultural landscape;
- at the value of the average cumulative impact from 5 to 14.9, the value of the load is significant, and, as in the above cases, it requires to reduce the level of anthropogenic factors on the agricultural landscape, it required to optimize the lands of the agricultural landscape;
- values from 15 and above are acceptable, since in this case the ratio of agricultural landscape factors is optimal for conducting agricultural production in the territory of the agricultural landscape [8, 9].

As in table 1, natural indicators in each of the considered farms are slightly different. As for anthropogenic indicators, it should be noted that the indicators of forest square of arable land and the total extent of forest bands decreased in both farms as a result of land management works to optimize the structure of agricultural landscapes, but apart from the General changes there are changes in the coefficient of anthropogenic fragmentation and technological factor of disturbed lands of Sreppnoe Agriculurial prodaction in Podgorensky district of Voronezh to acquire. This indicates that the optimization of the territory of agricultural landscapes should be based on the design of protective forest strips, field roads, the formation of crop rotation arrays [10, 11].

5. Conclusion

Thus, we indicated the following changes in the level of load on the territory of the agricultural landscape. Total original values before land operations to optimize the structure of agricultural landscape of Vesna Peasant farm area in Verkhnekhavsky district of Voronezh region corresponds to a significant level of load, as well as Stepnoe Agricultural production in Podgorensky district of Voronezh to acquire. After work on the optimization of agricultural landscapes, we obtained the aggregate value of indicators for the Spring peasant farm and for Steppnoe Agricultural production overgrowth. These indicators correspond to the permissible level of load on the territory of the agricultural landscape [12].

Thus, the effective management of agricultural production in the territory requires scientifically based techniques and methods of optimizing agricultural landscapes, so we proposed an algorithm of actions to improve the optimization methodology for the structure of agricultural landscapes, which is divided into three stages:

- at the first stage, to optimize the territory of agricultural enterprises, it is necessary to formulate a goal determining the structure of the agricultural landscape;
- in the second stage to select possible management options optimally it is necessary to quantify the critical indicators consider the ecosystem of the agricultural landscape, a classification and rationing of indicators and factors determining the environmental performance of agricultural landscapes;
- the third stage is the formation of a block diagram of all subsystems during optimization: determination of the dependence of the ecological state of the territory of the agricultural landscape and analysis of options for its optimization.

Thus, the improvement of the methodology for optimizing the structure of agrolandscapes is based on assessing the territory of agrolandscapes by systematizing its indicators, both natural and man-made, determining their value and identifying the value of the intensity level will further increase the efficiency of agricultural production.

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region, the Program envisages the development of this system in the farms of the Voronezh region as a pilot project.

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