Environmental requirements in land management of land use facilities

A Varlamov, O Gvozdeva and R Zhdanova

Department of Land Use and Cadastre, State University for Land Management, 15, Kazakova St., Moscow 105064, Russia

Abstract. The authors of the article studied the role of arranging the territory on an ecological and landscape basis as a set of measures aimed at the use of a certain territory (part) of a land use facility to meet the needs of population and production based on the use of landscape and environmental research and design methods. Based on the example of Kantemirovsky district of the Voronezh Region the system of the ecological framework development of the territory of the region as an integral part of ecological and landscape arrangement of the territory of the region is shown. The work presents the beam-field agricultural landscape “Vysochanovsky” with the introduction of the ecological and landscape system in the agricultural enterprise Druzhba of Kantemirovsky district of the Voronezh Region. The work is based on the study of domestic scientists among which are V.V. Dokuchaeva, D.V. Novikova, A.A. Varlamova, M.I. Lopyreva, A.G. Bogdanov.

1. Introduction

The main condition for the contribution of land assets to the economic growth and sustainable development of the country is the application of land use management methods aimed at the extension of national wealth and well-being of the society while maintaining environmental potential.

The strategic goal of modern land management is the organization of rational use and protection of land resources based on optimizing multi-structured land use, meeting the requirements of its spatial, economic, environmental sustainability, creating safe living conditions for the population and carrying out economic activities, increasing the efficiency of agricultural and forestry land use. The landscape plays an important role in the ecological, natural and social fields. It is considered a basic component of the natural and cultural heritage. Besides, it contributes to the growth of the well-being of the population, serves as the main spatial resource for the development of many economic sectors related to the territory.

2. Materials and methods

Based on the analysis of qualitative state of land resources and environment, the presence of the territorial organization or arrangement of the economic complex it can be concluded that it is necessary to take into account the natural and social and economic component in the process of ecological-landscape arrangement of the territory of land use facilities.

The most important principle of the land use is the obligation to preserve the ability of landscapes to reproduce their useful properties and preserve natural mechanism of reproduction, i.e. social and economic functions - the landscape plays a role aimed at meeting a particular need of society. At the same time, the contradictions between the nature and society may arise and become aggravated, especially since in modern conditions the society’s dependence on the state of the natural environment does not decrease, but only increases [1].
The ecological and landscape organization of the territory allows us to take into account and regulate the following functional groups of the needs of society related to landscapes [1]:

**Figure 1.** Functional groups of society’s needs taking into account the ecological-landscape arrangement of the territory

The results of the impact of human activities on the landscape can be described with the following indicators:

a) changes in the structure, state, functioning of the landscape;

b) changes in the current landscape development dynamics;

c) disruption of the course of natural cycles and trends of natural self-development;

d) changes in response to man-made loads;

e) environmental restrictions (Figure 2).

The origin of the scientific theory of ecological-landscape arrangement of the territory is associated with the name of V.V. Dokuchaev, who proposed a systematic landscape-ecological approach to the use of land and other natural resources.

The experience of ecological-landscape arrangement of rural areas abroad has shown the following:

- the priority is given to measures for the development of the land use system and the ecological-landscape arrangement of rural areas;
- the basis for the development of the land use and the ecological-landscape organization of the territory is a set of land management activities and landscape planning;
- the protection of natural environment and the development of land use are becoming an independent branch of research, design and project development, and even a policy direction;
- the development methods of land use, ecological and landscape arrangement of its territory and organization of these activities can be applied in the development of land management digrams and projects [2–4].

An information and logical model of the sequence of actions and the composition of research and design activities carried out for each stage of work indicated in the model (Figure 2) is appropriate for design on the ecological and landscape basis.
Figure 2. Information and logical model of the sequence of actions in the development of measures for the protection of land-use facilities (by D.V. Novikov). Milestones: 1 – Evaluation of the processes that have caused modern changes of land and other natural resources conditions, 2 – Identification of the problems regarding land and other natural resources management when planning environmental activities, 3 – Development of recommendations regarding strategies of land and environmental management in the region, 4 – Development of several complex strategy aimed at land and environmental management in the region.

Therefore, the main areas of integrated solution of problems of rational use and protection of land resources of the region are the following:

- development of a strategy for the development of the economic complex, the restoration and preservation of natural resource potential, the increase in land productivity and the protection of landscapes in all territories;
- the establishment of prerequisites for sustainable development and ecological rehabilitation of territories, etc.;
- establishment of conditions for the development of ecological balance, development of infrastructure, a combination of various forms of management of land-use facilities;
- development of the territories of the region based on the establishment of rational use and land protection;
- optimization of the existing land use system by improving the structure of land, the rational structure of crops, the abandonment of monoculture;
- the development of ecological landscape organization of the territory [5].

3. Results and discussion

The introduction of sustainable land use mechanism as an integral part of economic mechanism of environmental management includes the following: establishment of differentiated land payments; economic incentives for rational land use; application of economic sanctions for a significant reduction in soil fertility and for violation of land legislation; introduction of monetary compensation for temporary conservation of land, measures of economic incentives for improving the ecological condition
of land and increasing soil fertility, stimulating the production of environmentally friendly agricultural products [6, 7].

The introduction of adaptive land-use systems of the Voronezh Region based on the ecological and landscape arrangement of the territory will allow annually preventing the environmental losses (55 million tons of soil, 1.5 billion m$^3$ of water, 7.1 million tons of nutrients) and increase agricultural productivity by 40-50%.

The main blocks of the ecological framework at the level of administrative district are the shelter-protection and water-regulating forest belts. Under the conditions of a dissected relief the linear blocks of the ecological framework should occupy all the areas that are free from the land used, taking into account the location of arranged elements of the territory, i.e. fields, work sites, roads. The system of development of the ecological framework of the territory of the region as an integral part of the ecological and landscape arrangement is shown by the example of Kantemirovsky district of the Voronezh Region. The elements of the ecological framework should be supplemented on the basis of the projects of ecological and landscape arrangement of the territory of specific agricultural enterprises to assess the condition of each land mass and its further use [8].

The ecological frame of the territory of Kantemirovsky District of the Voronezh Region represents a single network with a minimum number of breaks and includes both a natural network and agricultural landscapes. The area of the environment stabilizing lands included in the ecological frame makes up 75.32% of total area of the region, which makes it possible to carry out environmental protection, compensating and sanitizing functions in this area.

Besides, to justify the design decisions when drafting land management diagrams, the value of prevented environmental and economic damage, the productivity index of agricultural landscape, the coefficient of ecological diversity of the territory, the indicators of reduction of soil volume loss, the loss of humus and nutrients, the reduction of proportion of agricultural land subject to various negative effects are calculated.

The production and economic results should be assessed in terms of the amount of agricultural production required by the society and obtained from one unit of a land area while maintaining and increasing the soil fertility, including: an increase in crop yields, reducing the cost of production, increasing the net income and profits; increasing the annual economic effect [9].

When implementing the actions provided by the ecological framework, the agricultural landscape shifts into the state of stability at $K = 1.39$ from the state of destruction at $K = 0.28$ (the ratio of the area of stabilizing land to destabilizing) in Kantemirovsky district of the Voronezh Region.

The coefficient of natural protection of the territory, as the ratio of the area of landscapes with environment stabilizing functions to the total area of the region shifts to sustainable ($K = 0.65$) from the critical level ($K = 0.49$).

The agricultural enterprise area was 10,000 hectares. The area of arable land was 6,000 hectares. The forest cover of the territory was 17%, including arable land under the forest belts, i.e. 5%. Forest stripes and processing were performed in a horizontal manner. The average area of seedling plot was 20-40 ha. The crop rotations were introduced. The soil fertility amounts to 5.5% of humus. The grain yield during the drought in a family farm of Bogdanov was 32.5 centner/ha in 2010; in the Voronezh Region it was 7 centner/ha. The survey of the territory was made from a satellite in November 2010 (Figure 3).

In 2014, the middle-stabilizing (improving) sites amounted to 75.32% (576.85 ha), whereas in 1975, it was 35.75% over an area of 296.01 ha (Figures 4 and 5). The destabilizing (worsening) lands made up 42% on the area of 347.53 hectares in 2014 and 64.2% on the area of 531.57 hectares in 1975. In 2014, the area within the landscape was 924.38 hectares (2014), 827.58 hectares (1975).
Figure 3. Landscape and ecological (adaptive) arrangement of agricultural system in agricultural enterprise Druzhba, Kantemirovsky district, Voronezh Region

The territory is arranged on an ecological and landscape basis with the purpose of establishment of conditions for mobilization of natural resources and the use of the adaptive potential of crops, conducting economically efficient, socially-oriented and environmentally friendly agriculture, stabilizing nature management and land use by creating environmentally sustainable agricultural landscapes, eliminating degradation and pollution of lands.

Figure 4. Beam-field agricultural landscape “Vysochanovsky” before introduction of ecological and landscape system into agricultural enterprise “Druzhba”, Kantemirovsky district, Voronezh Region (1976)
Figure 5. Beam-field agricultural landscape “Vysochanovsky” with the introduction of ecological and landscape system into agricultural enterprise “Druzhba”, Kantemirovsky district, Voronezh Region (fragment)

Figure 5 shows the beam-field agricultural landscape “Vysochanovsky” with the introduction of the ecological and landscape system in the agricultural enterprise Druzhba of Kantemirovsky district of the Voronezh Region (actual fragment). Farming has become sustainable.

In the framework of Kantemirovsky district of the Voronezh Region the family farm of Bogdanov corresponds to 50 and 65 points of yield in terms of fertility in the district (Figure 6).

Figure 6. Territorial arrangement of ecological and landscape system of farming by A. Bogdanov
The analysis of data implies that the yields from the family farm of A.F. Bogdanov were 1.8 times higher than the average. As a result of the measures taken in the surveyed Vysochanovskaya section in the agricultural enterprise Druzhba of Kantemirovsky district of the Voronezh Region, the tendency towards stabilization of the humus horizon thickness and its increase has changed. The humus content in the study area increased by 0.24% [9]. The water regime of soils has changed as a result of which the desalinization process of salt marshes to solonetz and in different degrees of saline soils has occurred. The plant cover has undergone significant changes. The water-cut plants were not marked, which indicates the absence of water erosion. The herbage density has changed from 60% to 85% of the projective cover.

4. Conclusion
In the Kantemirovsky district of the Voronezh Region, when implementing measures provided by the ecological framework, the agricultural landscape shifts into the state of stability at $K = 1.39$ from the state of destruction at $K = 0.28$ (the ratio of the area of stabilizing land to destabilizing).

As a result of the measures taken in the surveyed Vysochanovskaya section in the agricultural enterprise Druzhba of the Kantemirovsky district of the Voronezh Region, the tendency towards stabilization of humus horizon thickness and its increase has changed.

For more than 40 years of study of landscape farming there has been stored enough information to think that the farming system of agricultural enterprise Druzhba can be taken as a proven ecological example for the Voronezh region. Its general ecological principles can be used throughout the Central Black Soil Region and in some other regions with similar environmental conditions.

References
[1] Galchenko S A, Varlamov A A and Bogdanova O V 2018 Theoretical and methodological foundations for formation of sustainable land management system IOP Conf. ser. Materials Science and Engineering 012141
[2] Pakhomova N V and Richter K K 2001 Economics of nature management and environmental protection (Moscow: DECA)
[3] Zelepugin A D, ed 2011 Scientific basis of land use management (Voronezh)
[4] 1998 Economics of land use and management (Voronezh: Voronezh state agrarian University)
[5] Antropov D V, Zhdanova R V and Gvozdeva O V 2016 Influence accounting of zones with special conditions of use of territories in the development of effective system of agricultural land use Int. Agricultural J. 4 15–7
[6] Misra A K, Prakash O and Ramasubramanian V 2004 Forewarning powdery mildew caused by Oidium mangiferae in mango (Mangifera indica) using logistic regression models Indian J. of Agricultural Sciences 74(2) 84–7
[7] Pankratz A 1983 Forecasting with univariate Box – Jenkins models: concepts and cases (New York: John Wiley & Sins)
[8] Girusov E V, ed 2007 Economy and ecology of nature management (Moscow: unity-Dana)
[9] Kvasov A Yu, Lopyrev M I, Shevchenko V E, Stekolnikov K E, Pokusaev V V and Bogdanov A G 2014 What should be a sustainable high-yielding agriculture. Kantemirovsky experiment: experience and opportunities (Voronezh)