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Environmental Aspects of Land Management

Elena Zatsepina
State University of Land Use Planning, Chair of Russian and Foreign Languages
Moscow, Russia
myshila@mail.ru,
https://orcid.org/0000-0001-7598-9595

Vladimir Kosinsky
State University of Land Use Planning, Chair of Land Use Planning
Moscow, Russia
kosinskij1@mail.ru,
https://orcid.org/0000-0003-2617-0879

Larisa Petrova
State University of Land Use Planning, Chair of Land Use Planning
Moscow, Russia
l_petrova.08@mail.ru,
https://orcid.org/0000-0003-4339-521X

Olga Sorokina
State University of Land Use Planning, Chair of Land Use Planning
Moscow, Russia
sorokinaoa81@gmail.com,
https://orcid.org/0000-0002-6149-1195

Ilya Fomkin
State University of Land Use Planning, Chair of Land Use Planning
Moscow, Russia
fomkin.i@mail.ru
https://orcid.org/0000-0001-6134-8340

***Abstract* – According to strategic planning documents, sustainable development of the Russian Federation, life of quality and health care can be provided only through preservation of natural systems and the environment as a whole. Compliance with environmental requirements, special treatment and land use conditions is of special significance for the most productive use of farms and farming lands, which ensures maximum satisfaction of economic interests of both landowners and land users. Based on the study of l statistical measures characterizing the use of agricultural land in the municipalities of the Moscow region, the article considers the economic and environmental efficiency of land use. Information base of the study is made up of statistical data and analytical materials of federal and regional executive authorities of the Russian Federation. Analysis of different-sized indicators characterizing land use in five areas of activity has allowed grouping municipalities of the Moscow region and identifying the areas with high, medium and low degree of land use efficiency. The research results include a number of recommendations for planning and organization of agricultural land rational use in municipalities, providing for the solution of socio-economic problems, ensuring environmentally-oriented economic growth and preservation of the environment.**

Keywords: planning of sustainable development level of agricultural development; agricultural lan; land management economic and environmental efficiency environmental safety

I. Introduction

Involvement of vast areas in the economic use leads to degradation of ecosystems, emergence of irreversible changes on a regional and global scale, and endangers the very existence of man. Numerous conferences, forums, a number of regulatory legal documents and target programs adopted in recent decades at both the world and regional levels, testify to the relevance of the above-mentioned problem for humanity.

Russia as the largest state in the world occupies a special place in global environmental processes and is one of the main stabilizing forces in the sphere of protection and restoration of the natural environment on the planet.

Strategic goal of the Russia's state policy on environmental development consists in solving socio-economic problems for ensuring environmentally-oriented economic growth, preservation of favorable environment, biological diversity and natural resources to meet the needs of present and future generations, implementation of the right to favorable environment, strengthening the rule of law in the field of environmental protection and safety [1, 2].

Protection of land and the environment in the process of planning and implementation of a particular activity involves finding ways of reduction and prevention of any losses caused by anthropogenic impact, prevention of soil deterioration (exhaustion, destruction, pollution, etc.), as well as harmful effects on surrounding areas [3, 4, 5, 6].

Russian and foreign experience shows that land management aimed at dealing with legal, socio-economic, organization-territorial, and what is more important, environmental problems, is a real mechanism for rational use of land [1,6].

The research aim is to reveal the connection between economic efficiency of using the Moscow region municipalities' lands and their environmental status, and to work out recommendations on rational land use, which would provide socio-economic development of regions and environmental safety of the country as a whole.

II. Materials and Methods (Model)

The study is based on the method of principal components, which enables simultaneous processing of different-sized indicators. This method allows reducing dimension of the studied space and compressing the information, which results in the possibility of visual interpretation of econometric models [7].

At the first stage, we have compiled an array of statistical indicators of the Ministry of Agriculture and Food

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of the Moscow region for 2005-2018, which are efficient for characteristics of land use in accordance with 5 criteria:

- extent of agricultural development of the territory;

- level of impact of agricultural products on the landscapes;

- degree of ecological disturbance of agricultural land;

- profitability of land;

- yield of main crops (in the Moscow region).

These groups of indicators characterize both the level of land use in the Moscow region, and the effectiveness of the previously conducted land management. At the same time, the economic and environmental efficiency of land management is studied in the article from the viewpoint of sustainable development and increasing the level of productivity of agroecosystems.

Matrix of values of indicators can be presented in the following mathematical form:

$$X_{n\times m} = \begin{vmatrix} X_{11} & X_{12} & X_{1j} & X_{1m} \\ X_{21} & X_{22} & X_{2j} & X_{2m} \\ X_{i1} & X_{i2} & X_{ij} & X_{im} \\ X_{n1} & X_{n2} & X_{nj} & X_{nm} \end{vmatrix}$$

where i – municipality number,

j – indicator number,

Xij – size of the j-th indicator in the i-th municipality,

n – number of municipalities,

m – number of indicators.

Next, the background (best) values for each indicator of economic and environmental efficiency are determined according to the available statistical data with the aim to move to the relative values of the indicators (formulas 1 and 2):

$$x_{ij}rel = \left(x_{ij} - x_{backj}\right), \quad (1)$$

$$x_{ij}rel = \left(x_{backj} - x_{ij}\right), \quad (2)$$

where i = 1,2,..., n; j = 1,2,..., m.

Due to the fact that the main indicators have different measure units, their scaling requires determining the standard deviations (formula 3):

$$W_j^2 = \frac{1}{n-1}\sum_{i=1}^{n} x_{ij}rel^2, \quad (3)$$

The scaled and centered factors are denoted by t_{ij}:

$$t_{ij}\begin{pmatrix} i = 1,2,\dots,n \\ j = 1,2,\dots,m \end{pmatrix}, t_{ij} = \frac{x_{ij}rel}{W_j}, \quad (4)$$

As a result, an information matrix of standardized values of indicators of economic and environmental efficiency of land management has been formed.

The initial matrix has been processed with the help of software complexes SPSS and Stat Soft Statistica. Factor weights vj and factor load matrix A =||a_{ij}| have been obtained.

At this stage, the dimension of the studied space is compressed, while leaving those main components for which the dispersion values are greater than unity, and whose share in the total dispersion is the largest. These are F_1, F_2, F_3, F_4, F_5. They condition 74% of the total variance.

Then, significant weight coefficients $\tilde{a}_{ij}$ satisfying the condition $\left|\tilde{a}_{ij}\right| > 0{,}6$ have been selected for each main component.

Thus, a unique minimum number of characteristics that explain each component as much as possible has been selected for each of the five main components from all the characteristics of the districts of the Moscow region (table I).

TABLE I. SELECTED SIGNIFICANT WEIGHT FACTORS

Characteristics of municipalities	**Principal components**				
	F₁	***F₂***	***F₃***	***F₄***	***F₅***
Share of agricultural land	0.775			0.363	
Ploughness of the territory	0.801			0.320	
Application of organic fertilizers		0.755			-0.295
Application of mineral fertilizers		0.769			
Agrochemical melioration		0.699			0.404
Specific weight of eroded soils	0.661				
Coefficient of erosion hazard of crop structure	0.650		-0.566		
Share of wetlands	-0.648				
Share of waterlogged lands	-0.652				0.489
Share of lands with low phosphorus content	-0.485		0.415	0.314	
Share of lands with low potassium content	-0.723			0.315	
Share of lands with low humus content			0.511	-0.593	
Share of lands with high soil acidity			0.640		-0.343
Cost of gross production per 1 hectare of arable land		0.778			
Grain yield			0.506	-0.317	
Potato yield	0.743				
Vegetables yield					0.397

Results of numerical modeling show that the dimension of the studied features has decreased on average from 17 to 6, which greatly simplified the econometric model. Based on Table I, the main components have been named:

- F_1 and F_4 – level of artificial soil fertility;
- F_2 – level of agricultural chemicalization;
- F_3 and F_5 – level of natural soil fertility.

III. Results and Discussion

Analysis of the semantic values of main components shows that the effectiveness of land use in the municipalities of the Moscow region depends on the following factors: degree of agriculture intensification (38%), agricultural chemicalization (19%), natural soil fertility (17%). Accordingly, 26% falls for weather and climatic conditions, as well as other factors, which could not be estimated statistically.

On the basis of the selected main components and weight coefficients, a complex indicator of the municipality has been determined (formula 5):

$$E = \sum_{j=1}^{M} v_j F_j \quad , (5)$$

Value of the complex criterion is calculated for each municipality, and this indicator can be both positive and negative. Negative values correspond to high economic and environmental efficiency of land use for a given time period, and positive values – to low one. In accordance with the differentiated value of the complex criterion, the municipalities of the Moscow region should be divided into three groups.

Thus, some territories of the region (14 municipalities) are characterized with low efficiency of land use; in 24 urban districts, agricultural land is used with average efficiency; and 26 municipalities of the region are characterized by high economic and environmental efficiency of land use. More than half of agricultural lands in the Moscow region (57%) are characterized by low efficiency and significant anthropogenic load on the environment, which has resulted in reduced resistance of ecosystems to negative impact and contaminated agricultural products.

Analysis of economic and ecological efficiency of land use in municipalities for the period of 2005-2018 shows that in the districts with agriculture being the most developed (south of the Moscow region), high yields are obtained through the use of large amounts of organic and mineral fertilizers and the exhaustion of soil, more fertile than in other parts of the region.

According to the Ministry of Economy of the Moscow region, the total share of agricultural production by the Domodedovsky, Leninsky, Kolomensky, Stupinsky municipal districts in the total volume of agricultural production in the region amounts to 24%. The Zaraisky, Kashirsky, Ozersky, and Lyuberetsky municipal districts are also among major producers in the agricultural sphere. High anthropogenic load in these municipalities has led to the degradation of landscapes. A significant increase in the share of eroded lands (from 15% to 20%) has been marked in these territories. Environmental disadvantage of the products grown in the south of the Moscow region is the result of a high level of soil chemicalization.

Municipalities with high economic and environmental efficiency (group 1) are characterized primarily by industrial orientation, developed due to the proximity to the regional center and the natural conditions unsuitable for agricultural development. In this regard, the efficiency indicator does not reflect the high natural fertility of soil, but the low level of agricultural development and long-term efforts to improve soil quality.

Thus, this group of municipal districts exemplifies the dual essence of the indicator of economic and environmental efficiency of land use. In a good ecological environment, the total share of agricultural production by municipalities with a high level of economic and ecological efficiency of land use in the total volume of agricultural products is 21%, which is half below the total level of the 3rd group of municipalities. This suggests that it is difficult to obtain high economic results while maintaining ecological balance.

The average economic and environmental efficiency of agricultural land use has been revealed in the districts with sufficiently high economic indicators and the most stable agricultural landscapes. The Odintsovsky, Dmitrovsky, Sergievo-Posadsky, Ramensky, Lukhovitsky, and Shchelkovsky municipal districts are characterized with above-average economic indicators. As for the group of indicators characterizing the extent of environmental disturbance of these territories, it has consistently low values resulting from the most favorable natural conditions.

The current condition and promising areas of land use, their distribution by ownership forms, categories and types of land are directly related to the peculiarities of economic development and environmental management of the region, as well as to intra-economic differentiation.

Urbanization processes have a decisive influence on the organization of land use in the Moscow region.

When planning the use of land in the territory of the Moscow region, effectiveness of certain measures related to rational use of land in public production, taking into account different types of efficiency (economic, environmental and social), is the first aspect to be evaluated [8, 9, 10].

Ensuring high economic and environmental efficiency of land use in the Moscow region requires, first and foremost, creating conditions for the inclusion of all land resources in land turnover, which provides a contribution to developing the economy, increasing the budget of the municipalities due to the receipt of payments for the land. Another important factor is represented with the GDP growth associated with the ecological state of land, optimization of production and its territorial location, improvement and development of land ownership and land use, improvement of land turnover, mortgages, more progressive and intensive use of land in compliance with environmental requirements.

IV. Conclusion

The planning of land use and conservation is the most important goal for any land management system, since it determines the prospects for sustainable land use. It serves as a means of implementing a country's land policy, as well as linking national, regional and local interests in the rational use and protection of land.

Land use should be carried out in ways that ensure the preservation of ecological systems, the ability of land to be a means of production in agriculture and forestry, the basis for economic and other activities.

Maximum economic and environmental effect in the planning and organization of land rational use can be achieved through the following measures:

– study of environmental, agronomic and reclamation status of all lands in the region, which will allow identifying lands that are irrationally used, not used for the intended purpose, unreported, or illegally occupied. This will allow municipalities of the Moscow region for the increase in the regional tax base, differentiation between cadastral and market value of land, assessment of land tax, losses, including lost profits;

– involvement of irrationally used and unused arable lands in active agricultural turnover will increase the domestic gross yields and the revenue from commercial crops sale, and ensure stability of animal husbandry forage;

– development of land turnover by improving the quality of land, preserving and increasing the fertile layer of soil cover will improve the efficiency of land use in the municipalities;

– improvement of the structure of acreage and land by means of natural and agricultural zoning will allow locating them on more suitable land plots for increasing crop yields;

– prevention of damage and losses by preventing land degradation processes and their withdrawal from agricultural use.

Availability of such information will help municipalities effectively manage land resources, make decisions on the allocation and protection of especially valuable lands, develop state programs on land reclamation, soil fertility increase, on support for agricultural producers aimed at development of agro-industrial complex in the district, determine the most priority areas of investment in agricultural production.

The legal status of land in economics is ambiguous: on the one hand, land is the main means of production in agriculture and forestry, which should be intensively used, and on the other hand, land is a natural component which should be used carefully. Therefore, the rational use of land should be cost-effective and environmentally safe.

Organization of specially protected natural areas is one of the most effective measures to counteract the processes of biota degradation. However, in the conditions of increasing technogenic pressure, isolated, often very small areas of specially protected areas are not able to stabilize the ecological situation and preserve the existing species diversity.

Today, economic and social progress of the territory is inseparable from environmental development, which implies not only the improvement of economic activity technologies, but also the tightening of environmental restrictions.

Restoration of disturbed landscapes along with establishment of a system of specially protected areas with strict regimes of land use is required for preservating ecological balance in the areas of the greatest impact on the natural environment caused by the city of Moscow and municipalities of the Moscow region. This will allow for systemic formation of an ecological structure of the territory for the purpose of stabilization and improvement of ecosystems functioning in the Moscow region (Fig. 1).

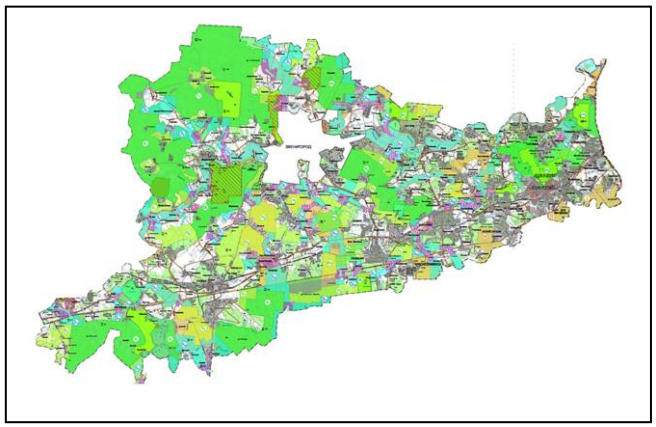

Fig.1. Ecological structure of the municipality

In the conditions of orientation toward economic growth, geopolitical, socio-economic and environmental interests of the Russian Federation require significant development of the land management system by including the land and property complex in circulation, since land management is the main mechanism for planning and organizing the rational use of lands and their protection both at the regional and state level. Land management involves the variance and alternativeness of promising directions in the use of land.

References

[1] V.V. Vershinin, A.A. Murasheva, V.A. Shirokova, A.O. Khutorova, D.A. Shapovalov, and V.A. Tarbaev, "Solutions of the agricultural land use monitoring problems," in International Journal of Environmental and Science Education, vol. 11, no. 12, pp. 5058-5069, 2016.

[2] E.P. Semenova, and V.A. Shirokova, "Assessment of the adverse effect objects as a starting point for ecological reform," in Current aspects of natural resource management problem solving, Moscow: State University of farming, pp 431-437, 2018.

[3] S.N. Volkov, "Land use planning in state programs and high-priority national projects in development of the agroindustrial complex and other fields of the economy," Moscow: State University of land use planning, 2017.

[4] A.A. Tsarenko, I.V. Schmidt, and V.A. Tarbaev, "Current aspects of cadastral relations in the monitoring system of land and rural areas," in Journal of Environmental Management and Tourism, vol. 8, no. 1 (17), pp 116-122, 2017.

[5] O.Y. Voronkova, E.M. Akhmetshin, I.N. Sycheva, R.N. Shpakova, E.Y. Pashkova, and A.L. Poltarykhin, "Economic mechanism of regulating land relations in the agricultural sector of Russia," in European Research Studies Journal, vol. 21(4), pp. 280-291, 2018.

[6] S.N. Volkov, D.A. Shapovalov, and P.V. Klyushin, "Solutions of problems in defining indicators of agricultural land within the framework of activities for the implementation of the concept of monitoring development in the Russian Federation," in GeoConference SGEM, vol. 17(52), pp. 819-828, 2017.

[7] K.L. Lidin, M.G. Meerovich, E.A. Bulgakova, V.V. Vershinin, and T.V. Papaskiri, "Applying the theory of informational flows in urbanism for a practical experiment in architecture and land use," in ESPACIOS, vol. 39, no. 1(12), 2018.

[8] V.A. Shirokova, A.O. Khutorova, A.F. Gurov, R.S. Shirokov, and Y.D. Yurova, "Environmental monitoring of small rivers of the Moscow region (the case of the river Osetr)," in GeoConference SGEM, vol. 18, pp. 355-362, 2017.

[9] P.V. Klyushin, T.S. Lukyanova, V.A. Shirokova, A.O. Khutorova, and S. V. Savinova, "Current state of boggy territories in the Meshchyora national park," in 18thInternational Multidisciplinary Scientific Geo Conference SGEM2018, vol. 18, iss. 2.1, pp. 775-782.

[10] V.A. Shirokova, A.O. Khutorova, A.F. Gurov, R.S. Shirokov, and Y.D. Yurova, "Environmental Assessment of Anthropogenic Effects on Recreation Zones Osetr River in the Moscow Region," inBaltic Geodetic Congress (BGC Geomatics), pp. 181-185, 2018.