The state of agrolandscapes of the forest-steppe zone of the Krasnoyarsk Territory

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Abstract. The landscape concept should give a fundamental assessment of the intensification extent of agricultural prospects. A detailed agroecological examination of all components of the natural-territorial complex, the creation of simulation models of their dynamics and the adoption of optimal decisions based on the results of forecasts should be carried out. The purpose of landscape analysis of natural resources is a comprehensive assessment of climatic, soil, plant and animal factors, establishing the relationship of landscape components with farming systems. Any landscape in the process of its development is exposed to impacts, and its stability has its limits. The stability threshold, expressed through the preservation by the landscape of its parameters and properties, and the critical impact quantities are determined in each case. General criteria for the natural stability of geosystems are their high organization, intensive functioning and geosystems functions balance, including biological productivity and renewability of vegetation cover. These qualities are determined by the optimum ratio of heat and moisture and are expressed by the development of soil cover, and ultimately, soil fertility. Landscape-ecological analysis of the territory makes it possible to establish the composition of agricultural and non-agricultural land, taking into account the heterogeneity and stability of a particular landscape, the occurrence of geochemical and biological processes in it, as well as to link the system of agriculture, land reclamation and specialization of the agricultural organization. The main element of Novosyolovo district landscape is agricultural land; the lands of the forest fund are the second largest area of natural geosystems. The degree of change in agrolandscapes is estimated on the basis of the existing structural and functional organization of agricultural lands, their quality state. It was established that plowing is low and it does not exceed the allowable limit, the forest cover of the district is close to optimal.

The general principles for the protection of natural geosystems (landscapes) should be observed for any type of economic activity. When designing agrolandscapes, it is necessary to take into account the properties of geosystems as complex natural formations, to know their structure, the state of landscape elements and their determining factors.

As is known [1, 2, 4, 6, 9], landscape protection is an optimization task, since in this case a search is made for the ways of rational (optimal) use of the landscape to determine the means of effective use of landscapes components and elements, to justify possible use cases, to identify natural and socio-economic restrictions on use.

Any technological solutions, processes should ensure the conservation of environmental and resource-reproducing abilities of landscapes. Landscape transformations in agrolandscapes should not
lose environmental and resource-reproducing abilities when performing the functions assigned to them in subsequent periods of time. Optimization of the use of the territory is aimed at working out activities preventing the negative consequences occurrence.

Development of land use projects should take into account the state of all components (soil, water, biota, etc.) and provide for subsequent changes to these components. The presence of individual landscape features and their diversity predetermines a differentiated approach to the organization of individual parts of the geosystem in order to realize their maximum profit potential, without violating environmental requirements.

When optimizing agrolandscapes, it is important to know the degree of human impact on the landscape, its structure, condition, cycles of matter and energy in the course of economic activity.

The correlation of natural and anthropogenic elements of the landscape, the structure of agrolandscapes (agricultural lands), the structure of agricultural holdings, agroecosystems and their ability to maintain the stability of agrolandscapes are given on the example of Novoselovo district of the Krasnoyarsk Territory. The structure of the land fund of Novosyolovo district is presented in table 1.

### Table 1. Distribution of the land fund of Novosyolovo district by category.

| Categories                              | Area  |
|-----------------------------------------|-------|
| Total area                              | 388066|
| Agricultural land                       | 248206|
| Settlements’ land                       | 2890  |
| Land for industry and other purposes    | 735   |
| Lands of specially protected areas      | 15    |
| Forest fund land                        | 89134 |
| Water fund land                         | 40841 |
| Land stock                              | 6245  |

The table shows that the main element of the landscape of Novosyolovo district is agricultural land which occupies 64% of the area of the district. The second largest element of natural geosystems is the forest land. The presence of a man-made water body, the Krasnoyarsk reservoir, caused 10% of Novoselovo district area to be under water, the surface of which forms a water fund. The land area of these named categories is 378.23 thousand ha or 97% of the district area.

The anthropogenically transformed territory of the district includes agricultural land, land of populated areas, acres for industry and other special purposes, as well as land of the water fund (artificial sea), which altogether occupy 292.7 thousand hectares, or three quarters of the territory of the district (75.4%).

The anthropogenic and technogenic component of the district’s territory is man-made elements, namely engineering structures, complexes of local and linear objects, settlements, lanes of roads, artificial reservoirs and other objects of the geographical envelope. To these objects we also attribute territories occupied by arable grounds, hayfields, pastures, disturbed lands (quarries, ravines, areas of deforestation, artificial reservoirs) that change the hydrological regime of the territory. All such areas with significant transformation by economic activity are adequate to the “anthropogenic landscape” definition.

At the same time, natural complexes that meet the definition of “cultural landscape”, i.e. cultivated by man, but used by him without significant negative phenomena, for example, arable land not subject to erosion and deflation, hayfields and pastures that have not undergone regression, reduced productivity and biodiversity have preserved on the territory under analysis. [3].
The degree of change in agrolandscapes was estimated on the basis of the existing structural and functional organization of agricultural lands, their quality condition. The structure of agricultural land is dominated by agricultural grounds (table 2).

Arable land accounts for 41% of the agricultural land and 53% of the agricultural grounds. The second place in the structure of agricultural land is occupied by pastures, which share reaches 26%, i.e. a quarter of the category’s area and increases to 33% of the agricultural grounds. The total area of arable land and pastures is 67% of the category’s area and 86% of the agricultural grounds. The remaining 11% of the agricultural grounds is occupied by idle field and hayfields, the total area of which is 27251 ha. Perennial plantations account for only 57 hectares.

| Types of grounds                                    | Area     | %  |
|-----------------------------------------------------|----------|----|
| Total area                                           | 248206   | 100 |
| Agricultural grounds                                 | 194579   | 78  |
| Arable land                                          | 102525   | 41  |
| Idle field                                           | 6233     | 3   |
| Perennial plantations                                | 57       | -   |
| Hayfields                                            | 21018    | 8   |
| Pastures                                            | 64746    | 26  |
| Non-agricultural grounds                             | 53627    | 22  |
| Covered by woody-shrubby vegetation not included in the forest fund | 20095    | 8   |
| The share of the grounds for protective purpose      | 2050     | 1   |
| Covered by water bodies                              | 2495     | 1   |
| Building land                                        | 1252     | 0,5 |
| Covered by roads                                     | 2235     | 1   |
| Swamps                                               | 22340    | 9   |
| Disturbed lands                                      | 5210     | 2,5 |

Non-agricultural land accounts for 22% of the agricultural land. Non-agricultural land is dominated by swampy land (9%) and land covered by tree-shrub vegetation that is not part of the forest fund (8%). These types of grounds occupy 42,435 ha or 79% of the total non-agricultural grounds. Other non-agricultural grounds, as their share decreases, are arranged in a row: land under water bodies, under roads and buildings. In addition, as part of non-agricultural grounds, there are disturbed lands that need to be rehabilitated and returned to agricultural circulation.

Thus, judging by the share of agricultural land of the total area of the district (64%), Novosyolovo district belongs to the middle developed district. The use of other methods for assessing the ecological and economic balance of the territory also indicates the average anthropogenic transformation of the area under study (table 3).

Analyzing the table materials, in general, the plowing is low in the district and it does not exceed the permissible limit (40%) set by environmentalists. The forest cover of the area is close to optimal (30% of the area). At the same time, there is not enough area occupied by grassy vegetation (natural meadows). The latter, according to the evidence of botanists, underwent significant changes in the species composition, which is due to the excess of pasture capacity and digression of meadows as an element of the landscape.
Table 3. Assessment of the ecological and economic balance of Novoselovo district territory.

| Characteristics                      | Indicator                                      | Unit of measurement | Magnitude |
|--------------------------------------|-----------------------------------------------|---------------------|-----------|
| Agricultural development             | %                                             | 64                  |
| Plowing                              | %                                             | 26                  |
| Woodland                             | %                                             | 28                  |
| Share of meadows                     | %                                             | 24                  |
| Arable land: meadow: forest ratios   | %                                             | 26:28:24            |
| Environmental stability coefficient  | -                                             | 0.58                |
| Anthropogenic load factor            | point                                         | 3                   |
| Landscape stability coefficient      | -                                             | 2.20                |

If we turn to the data on the structure of agricultural land, it turns out that the share of arable land in the composition of the land in this category reaches 41%, i.e. considered optimal, however, with such a low level of plowing, three quarters of the arable land of Novosyolovo district appears to be subject to erosion and deflation mainly to a moderate and strong degree.

Such a contradiction between the optimal plowing of the territory and the high degree of erosion and deflation processes is explained by the lack of the necessary system of land protection of agricultural organizations [5, 7]. According to ecologists, the optimal ratio of land is not enough to maintain the sustainability of landscapes [8, 10]. Optimization of the ratio of grounds does not relieve agricultural producers of the obligation to comply with the rules of soil protection technology in arable grounds.

Agricultural development of the area under research disturbed the balance of the grounds, which led to a decrease in the environmental sustainability of agrolandscapes. The studied territory from an ecologically stable state to agricultural developing entered the category with a medium stable state after expanding the area of agricultural grounds and increasing anthropogenic pressure on the territory. Judging by the magnitude of the coefficient of anthropogenic load, the studied area from a state of negligible anthropogenic load went into gradation with the medium anthropogenic load. This indicates that the improvement of agrolandscapes should follow the path of reducing anthropogenic pressure.

The anthropogenic transformation of the studied area has reduced the sustainability of natural geosystems, but so far they have basically retained their functions. Disturbances in the functioning of landscapes (in the form of acceleration of certain processes) are observed only in certain parts of the studied area. The disturbances are mainly associated with changes in soil properties as a result of their erosion and deflation, changes in the species composition of grassy vegetation, and a decrease in the forested area. In some places where linear erosion is observed, the changes affected the initial parent rock (eluvial-deluvial loesslike loam).

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