© LYDIA N. VDOVYUK[1], MARIA K. POLUSHINA[2]

[1]Cand. Geogr. Sci., Associate Professor, Department of Physical Geography and Ecology
Institute of Earth Sciences, Tyumen State University (Tyumen)
[2]Post-graduate Student, Department of Physical Geography and Ecology,
Institute of Earth Sciences Tyumen State University (Tyumen)

Fizgeo@yandex.ru, polushinamk@ya.ru

UDC 911. 52(075.8)

APPLICATION OF A LANDSCAPE METHOD FOR EXAMINING THE ECOLOGICAL STATE OF AN AGRICULTURAL AREA (the case of the Ishimskiy district, the Tyumen region)

SUMMARY. In this article the connection between landscape structure, directions of economic use of land, and ecological situation in the Ishimskiy district has been considered. Methods of ecological mapping are offered. The analysis of the ecological status of the territory landscape has been made. Ecological evaluation of landscape of the area used in agriculture is provided. The evaluation of landscape ecological status of the Ishimskiy District's land has been conducted by studying landscape differentiation factors, landscape morphological structure features, and the nature of variations influenced by a certain branch of agricultural industry. The systematization of the Ishimskiy district's landscapes and the connection of agricultural and natural areas with a certain kind of landscape are studied. The analysis of the land structure according to the landscape type is given. Negative consequences of irrational agricultural land management of the Ishimskiy district are listed. The conditions of gullying formation are considered, areas of the biggest gully system development are described. Ecological problems of the area of the Ishimskiy District are shown on the map. Recommendations on creating efficient approaches to environmental management are given.

KEY WORDS. Landscape morphology, landscape cartography, ecological state.

Nowadays the landscape-ecological assessment of territories used in agricultural production (farming and animal breeding) is an ongoing issue. The direction of its use and the nature of anthropogenic transformation are determined by the differences in the natural potential of landscapes. Varying from place to place, and over time, natural and anthropogenic factors create a certain landscape-ecological environment which requires an adequate assessment. The studies of this kind have the essence of an applied science. The aim of applied landscape studies is to implement the theoretical principles and methods of teaching about a landscape to the solution of national economic and other practical tasks dictated by the needs of society. The objectives of the study include determination of the ecological status of landscape complexes created in consequence of the cumulative impact of both natural and socioeconomic processes. To solve these problems it is advisable to apply informational technologies.

The informational basis of the study is landscape maps, zoning schemes, and textual characteristics of natural complexes [1], [2], [3], [4], [5].

The analysis of a landscape-ecological status of the territory should be based on certain principles. They, above all, should include (taking into consideration the level of study):

The principle of a leading factor that allows to focus on the nature of the structural organization and the specifics of landscape potential of the region of one or another taxonomic level;

The principle of complexity which is a simultaneous account of both natural and socioeconomic characteristics of the territory [5].

The basis for the implementation of these principles can be a special complex zoning and a large-scale landscape mapping of key areas.

Our studies were made within the Ishimskiy District which being a part of the agricultural zone of the south of the Tyumen Region occupies one of the leading places.

The assessment of the landscape-ecological condition of the district territory was carried out by studying the landscape differentiation factors, the characteristics of the morphological structure of the landscapes, the nature of changes under the influence of this or that type of agricultural production. The studies have shown significant differences in the properties of natural landscapes and in the nature and the extent of anthropogenic changes as well [3].

The structure of agricultural production of the studied territory is characterized by a considerable diversity which is a direct consequence of a complex morphological structure of landscapes that serve as a peculiar standard of the north forest-plain landscapes of the West Siberian Plain (Table 1).

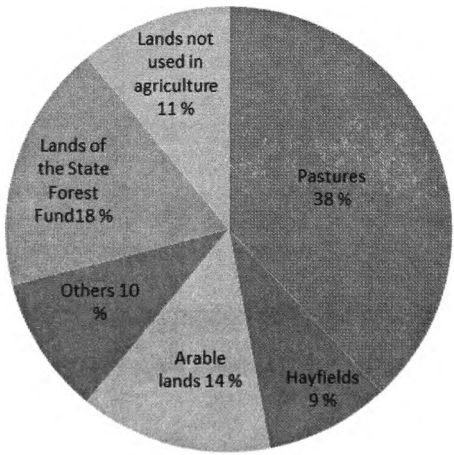
Table 1

The taxonomy of landscapes of the Ishim District

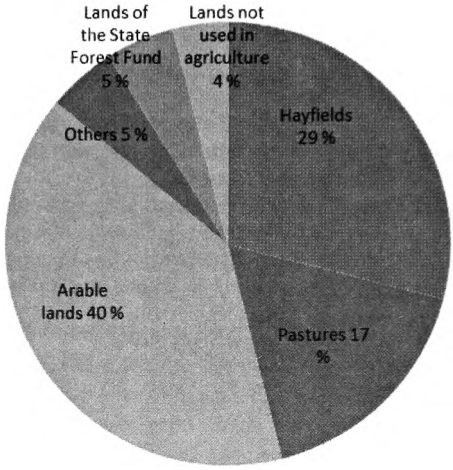
The kind of a landscape	The type of a landscape
1	2
1. Lacustrine (pre-quaternary) plains with a cover of loesslike loams	1.1. A loamy plain with gently rounded water catchments separating the plain and a plowed meadow plain on leached black earths and rare broad-grassy birch forests in valleys on gray forest solodized soils; 1.2. A gently undulating clay plain with plowed plain meadows on meadow black earth solodized soils and aspen-birch broad-grassy forests on dark gray forest solodized soils; 1.3. An undulating loamy plain with a forb-grass meadow plain with patches of marsh-root-sagebrush vegetation on meadow black earth alkaline soils (much plowed); 1.4. A flat with depressions clay plain with birch stone berry forests in depressions and a plowed meadow plain on meadow black earth soils on the sites between depressions; 1.5. A flat with depressions loamy plain with a plowed meadow plain on the meadow black earth soils, with sagebrush-fescue groups on meadow black soil with saline soils of varying degrees; 1.6. A flat with depressions clay plain with birch outlier forests on gray forest solodized soils with saline-alkaline groups in depressions;

1	2
2. Lacustrine-alluvial plains	2.1. A gently sloping loam plain with ravines and aspen-birch broad-grassy forests and meadow glades on gray forest solodized soils; 2.2. A gently ouval clay plain with a plowed meadow plain on meadow black earth soils with sparse birch grassy forests in the valley on gray forest soils; 2.3. A flat with depressions plain with upland meadows on meadow soils in combination with wet meadows and sedge-willow swamps in depressions on meadow-swamp soils; 2.4. Flat clay lowlands with reed-plantain-saltwort groups on saline soils and alkaline soils on meadow sites and sedge-reed swamps on peaty gley soils; 2.5. Flat smooth and small tussock herbal shrub-grass, sometimes with pine and birch swamps with peat-gley soils;
3. Alluvial plains	3.1. A gently ouval with large manes loam plain with plowed meadow plain on leached black earth and meadow clack earth soils with gully forests in the valley; 3.2. Flat fens with a combination of sedge-bluejoint, sedge -reed and reed floodplains on meadow and marsh, and sometimes alkaline soils; 3.3. A flat with ruffed sites floodplain with forb-grass and grassy meadows with shrub thickets on floodplain meadow soils

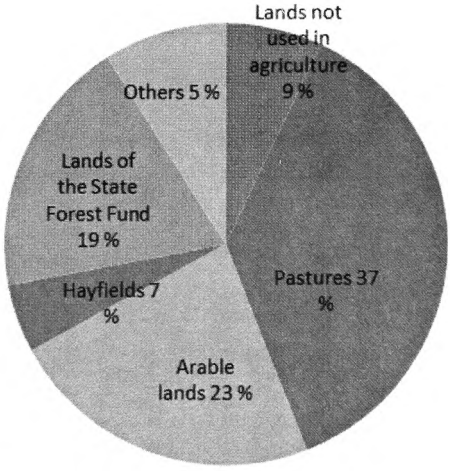
All types of landscapes are distributed among three kinds, each of which takes a certain geomorphological level with a varying degree of drainage. Each kind of landscape is characterized by its own set of agricultural and natural lands (Fig. 1).



A)



B)



C)

Figure 1. The structure of land areas by kinds of landscapes:

A) lacustrine (pre-quaternary) plains with a cover of forestlike loams;
B) lacustrine-alluvial plains;
B) alluvial plains.

The analysis of Figure 1 shows that land areas are distributed unequally by kinds of landscapes. Thus, the lacustrine (pre-quaternary) plains with a cover of forestlike loams are characterized by the predominance of pastures (37%) and arable lands (23%). Mainly pastures (38%) and arable lands (14%) are associated with the lacustrine-alluvial plains. A share of arable lands has been reduced due to the prevalence of low relief forms with a high hydromorphic degree. On alluvial plains, in contrast, arable lands (40%) and hayfields (19%) dominate, and besides plowed lands are located mainly in the northern part of this kind of landscapes, as well as on the ancient alluvial terraces, while hayfields are located in the southern part. This location of arable land is due to the presence of fertile land, favorable for cultivation, as well as the proximity of the district center, where the gardening sector is widespread.

Since the most fertile soils are leached black earth soils, meadow black earth soils and gray forest black earth soils, to a greater extent they are plowed (1.1*; 1.2; 1.4; 1.5; 2.2; 3.1). In natural conditions plain meadows and birch forests correlate with them.

As it is known any of natural components can be subjected to the anthropogenic transformation, but under the influence of plowing and overgrazing the most susceptible to changes is vegetation and soil cover.

When plowed, soils are exposed to degradation and the natural vegetation cover is completely replaced by cultivated vegetation.

Among the negative consequences of unsustainable agricultural use due to the reduction of the natural landscapes area are the reduction of cenotic diversity and the disappearance of a number of unique communities (for example, within the Ishimskiy District virgin grass-forb plain meadows described at the beginning of the 20th century by A. Gordyagin no longer exist). As a result, new types of ecosystems with a large share of weeds are being created.

The lands located within the undulating loamy plains with forb-grass (with halophytes) meadow plain on meadow-black earth alkaline soils and sloping loamy plains with aspen-birch broad-grassy forests and meadow glades on gray forest solodized soilsFor grazing and mowing are primarily used for grazing and mowing.

Surface soil sealing which happens due to grazing leads to either the increase of its capillarity, the intensified evaporation of moisture and desiccation, or (on waterlogged soils) to waterlogging and salinity [8].

In the vicinity of human settlements pastures turn into failure under the excessive grazing.

Unlike grazing, mowing can play a positive role in the development of geosystems, contributing to an increase in their species diversity, a systematic change of plant groups, and the development of a turf process. Among the negative effects there can

* The numbers of tracts are listed in Table 1.

be mentioned is the decline in the value of grass, as some part of plants (especially loose-bunch grasses and beams) does not manage to disseminate and drops out of the grass. In addition, there is a depletion of soil with nutrients [7].

In the processes of haying and grazing natural vegetation cover is modified, soils undergo more or less significant changes.

The territory is included in the zone of a potential danger of joint water and wind erosion [9], and increasing anthropogenic pressure and a continued unsystematic use of lands do not contribute to the cessation of degradation of the soil and vegetation cover. In plowed areas runoff increases (1.1; 1.5; 2.1). The process of soil cultivation leads to an increased soil salinity, sputtering and loss of nutrients, which is most important for flood plains. On the territory of the district about 17% of arable land has a low humus content (1.3), 42% of cultivated soils have a low content of available phosphorus and 4% – exchangeable Potassium [7].

Plowing inclined surfaces and ouval slopes (1.2; 3.1) leads to the appearance of planar flushing processes and strengthens the processes of gullying. Favorable for gullying geological and geomorphological and meteorological conditions occur precisely under conditions of destruction of natural vegetation, especially in areas adjacent to settlements along a network of unimproved field roads and in the hollows of livestock farms discharge and household waste.

The greatest development of gully networks is typical of the territory of denudation plains confined to the water catchment drained surfaces, and erosion processes occur everywhere due to the fact that more than 60% of area is plowed. On the one hand, this is due to the spread of easily washed cover deposits, intense torrential rain falls and snow melting. But in natural conditions these factors are blocked by an anti-erosion powerful factor – tree and shrub and herbaceous vegetation (2.2). When the economic development starts, especially when the territory is plowed, the destruction of the land cover takes place (1.4) [8].

Thus, within the Ishimskiy District, as well as throughout the forest-plain zone, there is the emergence of a complicated ecological situation connected with the agricultural use of landscapes, which requires an optimization of reclamation measures aimed at the protection of the environment.

One of the effective measures is the establishment of an ecological frame, which includes tracts of forests and shrubs along floodplains (a water protection zone), tracts of forests of the State Forest Fund, conservation areas and others. Ecological frame elements are unevenly distributed throughout the Ishimskiy District, so they do not fully perform their environmental function (Figure 2). In such a situation, the main effort should be made to establish rational environmental methods.

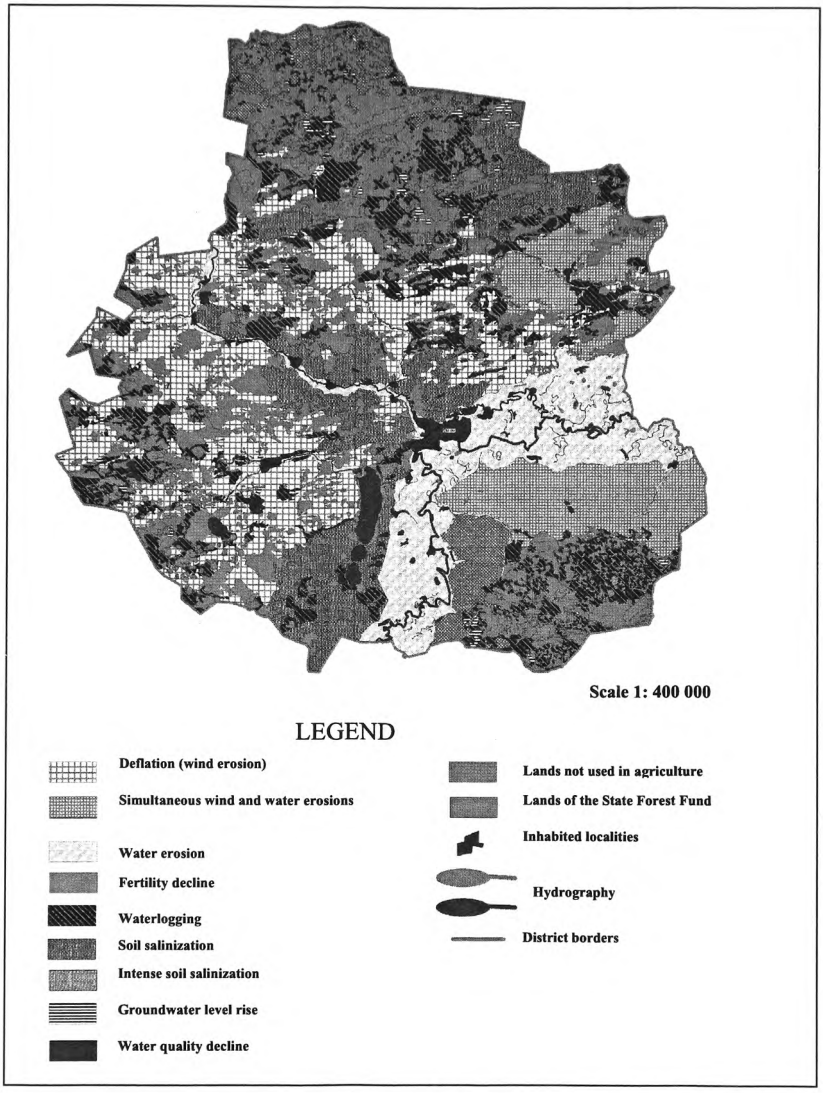


Figure 2. Ecological problems of the Ishimskiy District

REFERENCES

1. *Atlas Tjumenskoj oblasti (vyp. 1)* [Tyumen oblast atlas, (Issue 1)]. State Department of Geodesy and Cartography, Moscow — Tyumen, 1971. (in Russian).

2. *Atlas Tjumenskoj oblasti (vyp. 2)* [Tyumen oblast atlas, (Issue 2)]. State Department of Geodesy and Cartography, Moscow — Tyumen, 1976. (in Russian).

3. Kochurov, B.N. *Jekodiagnostika i jekologo-hozjajstvennyj balans territorii* [Ecodiagnostics and ecological-economical balance of the territory]. Moscow, 1999. 86 p.(in Russian).

4. Nikolaev, V.A. *Problemy regional'nogo landshaftovedenija* [Problems of regional landscape science]. Moscow, 1979. 160 p. (in Russian).

5. Sturman, V.I. *Jekologicheskoe kartografirovanie: Uchebnoe posobie* [Ecological mapping: Teaching guide]. Moscow, 2003. 251 p. (in Russian).

6. Isachenko, A.G. *Metody prikladnyh landshaftnyh issledovanij* [Methods of engineering landscape studies]. Leningrad: Nauka, 1989. 222 p. (in Russian).

7. Gvozdeckij, N.A. Landscape research and natural zoning for agriculture // Landscape science: theory and practice. Issues of geography. Collection 121. Moscow, 1982. Pp. 91–100. (in Russian).

8. *Geojekologicheskie problemy stepnogo regiona* [Geoecological problems of steppe region] / Ed. by Corresponding Member of RAS A.A. Chibaleva. Ekaterinburg, 2005. 378 p. (in Russian).

9. Krjahtunov, A.V., Mihal'chenko, A.K. Krjahtunov A.V., Mihal'chenko A.K. *General'naja shema protivojerozionnyh meroprijatij v Tjumenskoj oblasti* [General scheme of erosion prevention in Tyumen oblast] / Russian Academy of Agricultural Sciences. Siberian branch. Novosibirsk, 1995. 160 p. (in Russian).

10. Kochurov, B.I. Landscape sustainability and conservation in agriculture // *Prirodnye kompleksy i sel'skoe hozjajstvo. Voprosy geografii. Sb. 124* [Natural Complexes and Agriculture. Issues of Geography. Collection 124]. Moscow, 1984. Pp. 42–50.(in Russian).