

Landscape structure of the territory of the sanctuary Bakhteevskie Uvaly (The Volga Upland, Russia)

Andrej Astashin^{1,3}, *Aleksej Bazarov*², *Mihail Badin*¹, *Natal'ya Vinokurova*¹, *Ol'ga Vatina*¹

¹ Kozma Minin Nizhny Novgorod State Pedagogical University (Minin University), 603950, Ulyanova, 1, Nizhny Novgorod, Nizhny Novgorod Region, Russia

² Research Center "Povolzh'e", 31/1, Goncharova str., Ulyanovsk, 432063, Russia

³ Nizhny Novgorod state engineering and economic university, 606340, Oktyabrskaya St., 22a, Knyaginino, Nizhny Novgorod Region, Russia

Abstract. A map of the landscape structure of the territory of the state nature sanctuary of regional significance Bakhteevskie Uvaly is presented. The research area is located in the eastern part of The Volga Upland in the landscape zone of the steppe (the northern steppe subzone). The vegetation cover and flora of the Bakhteevsky Uvaly nature sanctuary, despite the high anthropogenic pressure on the natural ecosystems of the Starokulatkinsky district, have preserved high floral and phytocenotic biodiversity, and rare, endemic and relict species have been preserved on the territory of the protected area, reference steppe and forest communities. That is why the nature sanctuary Bakhteevskie Uvaly was organized here. Taking into account the landscape features of the territory is necessary both for the rational organization of economic activity and for the implementation of environmental protection and scientific goals. The research based on the results of field work, carried out in 2021, remote sensing data, thematic maps and literary sources. Spatial data processing is performed using QGIS. As a result of the research the landscape structure of the territory was established, the degree of anthropogenic disturbance of landscapes and the main threatening factors within the researched area were established.

1 Introduction

The Bakhteevskaya forest-steppe is one of the centers of biodiversity in the southern regions of the Ulyanovsk region [1]. The main objects of protection of the nature sanctuary: unique steppe landscapes, bayrak broad-leaved forests, a complex of rare species of animals and plants are widely represented on the nature sanctuary. Due to the complexity of the task of landscape zoning, its implementation requires the consolidation of the efforts of specialists of various profiles - geographers, geomorphologists, geologists, soil scientists, botanists, zoologists, which greatly complicates the process. In view of this, detailed landscape maps are currently being carried out on limited territories [2] and, as a rule, for solving specific economic or scientific tasks [3, 4, 5].

2 Materials and methods

The work was carried out, based on the results of field research, conducted by the authors on the territory of the reserve in 2021. In the course of the work, the following research methods were applied: descriptive, cartographic, GIS analysis [6-7], analysis of literature and stock materials, statistical, expeditionary, remote researches, landscape analysis [8-9], comparative geographical, geographical zoning.

In the course of the work were used maps: topographic, maps of pre-quaternary [10] and quaternary deposits [11], satellite images.

3 Results

The research area lies in the northwestern part of the Volga Upland in the center of the Ulyanovsk region in the Starokulatkinsky and Radishchevsky districts. In accordance with this scheme, the nature sanctuary "Bakhteevskie Uvaly" lies in the steppe zone, the northern steppe subzone, within Volga landscape region [12]. The lithogenic base is represented by deposits of the Cretaceous system (chalk, marls, clays, flakes), in the center on the hills are remnants of Paleogene deposits (sandstones, flakes, trepels, clays), small-scale scattered areas of Neogene deposits (sands, loams, boulders, crushed stone, gravel, pebbles) [10]. Quaternary sediments are represented by eluvial-deluvial deposits of the Neopleistocene (loams, clays, sands, soil), rocks of pre-Quaternary age are exposed on watersheds, alluvium on floodplains of streams, and proluvium in ravines [11]. The relief is characterized by large height differences: 185 m.

Within the reserve are represented such relief forms, as plakor, a slope at the beam, a terrace, a terrace ledge, a beam, a furrow, a pothole, a ravine, a floodplain of a small river.

The hydrographic network is not rich. In the north-eastern part of the reserve flows the Berezovka River, in the south-eastern – the streams of Bely and Badaev. Skeletal sod-carbonate soils and leached chernozems are represented in the research area on the slopes at the beams, alluvial-sod soils on the floodplain of the Berezovka River, in ravines and gullies – soils of the ravine-girder complex.

On the territory of the nature sanctuary reference forest-steppe and steppe natural complexes are still preserved. In the course of field research, landscape descriptions were performed on a network of key points laid down in such a way as to cover all representative types of stows. The result of the work was a map of the landscapes of the studied territory (figure 1).

1. The forest landscape of plakor under coniferous forests on skeletal chernozems covers the central and southern parts of the reserve Bakhteevskie Uvaly. The lithogenic basis of the landscape is formed by sandstones, flakes, marls and clays of Paleogene age, which either come to the surface or are blocked by a low-power thickness of eluvial-deluvial undifferentiated deposits of the Neopleistocene (sands, loams, sandy loams). The relief is gently sloping, it consists of plateaus and watershed slopes, dunes, hollows and the tops of ravines are common. There are no hydrographic network objects. The soil cover is represented by skeletal chernozems. Vegetation is represented by mixed pine and broad-leaved communities, was subjected to logging in the twentieth century, pine forests were planted on the site of the cuttings.

Stows:

- 1.1. Fresh watershed under linden community on chernozem soils.
- 1.2. Plakor under a pine community on leached chernozems.
- 1.3. Plakor under oak community on sod-podzolic soils.
- 1.4. The dividing slope under the pine culture on chernozem soils.

- 1.5. The dividing slope under the birch community on leached chernozems.
- 1.6. The dividing slope under the maple community on sod-podzolic soils.
- 1.7. A watershed slope, complicated by beams, under the fringe pine community on leached chernozems.

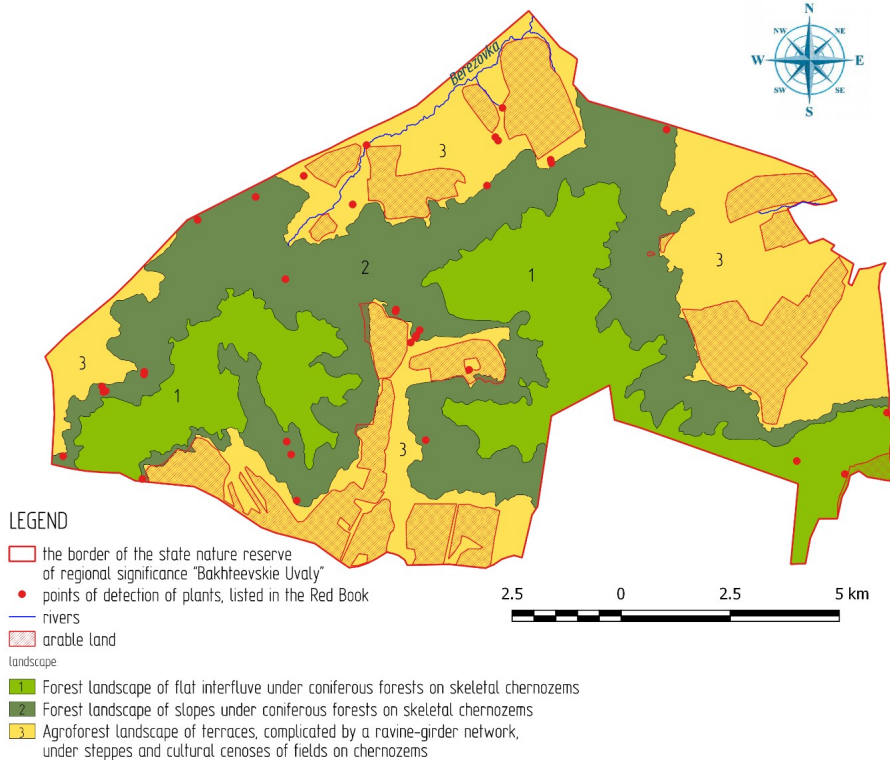


Fig. 1. Landscape map of the nature sanctuary "Bakhteevskie Uvaly".

2. The forest landscape of slopes under coniferous forests on skeletal chernozems borders the forest landscape of the plakor under coniferous forests on skeletal chernozems and extends from the western edge of the reserve to the eastern one. The lithogenic base is represented in the upper parts of the slopes by sandstones, shingles, marls and clays of Paleogene age, in the middle and lower parts by white and yellow chalk of the Cretaceous system. Quaternary formations are represented by eluvial-deluvial undifferentiated deposits of the Neopleistocene (sands, loams, sandy loams); in ravines and gullies – proluvial and deluvial deposits. A characteristic feature of the relief of this landscape is a wide representation of ravines, gullies, deluvial plumes, and removal cones. There are no hydrographic network objects. The structure of the soil cover is dominated by strongly washed skeletal chernozems. The composition of vegetation is dominated by pine, oak and maple communities, some of which were cut down – small-leaved forests formed in their place.

Stows:

- 2.1. Local watershed under the oak-lily community on sod-carbonate soils.
- 2.2. Slope under a pine community on chernozem soils.
- 2.3. Slope under pine culture on chernozem soils.
- 2.4. Slope under an oak community on chernozem soils.
- 2.5. Slope under the rocky chalky steppe with a community of *Stípa capilláta* on sod-carbonate soils.

- 2.6. Slope under the linden community on chernozem soils.
- 2.7. The slope under the maple community on chernozem soils.
- 2.8. Slope under birch community on chernozem soils.
- 2.9. Slope, complicated by beams, under the steppe on sod-carbonate soils.
- 2.10. Slope under aspen community on chernozem soils.
- 2.11. The bottom of the beam under the steppe on the soils of the ravine-beam complex.
- 2.12. The top of the remnant under a pine community on chernozem soils.

3. Agroforest landscape of terraces, complicated by a ravine-girder network, under steppes and cultural cenoses of fields on chernozems. The lithogenic basis is represented by marls, clays and sands of the Cretaceous system; small areas are represented by Neogene-aged sands, overlain by eluvial-deluvial clays, loams and sandy loams of the Neopleistocene; alluvial deposits are confined to the floodplains of streams. The relief of this landscape is crossed by a network of ravines and valleys of small rivers and streams; landslide processes are manifested on the slopes. The structure of the soil cover is dominated by residual carbonate and leached chernozems. The vegetation cover is dominated by steppe and meadow communities, which, due to the high fertility of the soils, are often often replaced by agricultural crops.

Stows:

- 3.1. Gently rolling-hilly plain under the steppe on sod-carbonate soils.
- 3.2. Gently rolling plain under a meadow on sod-carbonate soils.
- 3.3. Sloping plain under an oak community on chernozem soils.
- 3.4. Sloping plain under the edge community on chernozem soils.
- 3.5. Slope, complicated by hollows and gullies, landslide terraces under birch community on sod-carbonate soils.
- 3.6. The shore of the pond under the coastal-aquatic community of *týpha angustifolia* on alluvial-turf soils.

4. Discussion

The nature sanctuary is in the central part an array of pine and pine-deciduous forests on local watersheds and slopes of the eastern edge of the Volga upland. On the periphery of the reserve, forests are replaced by meadow-steppe communities, heavily plowed, despite environmental restrictions.

The main objects of the nature sanctuary are forest-steppe landscapes, including pine and mixed forests, grasslands, mixed grass and stony steppes, associated species of flora and fauna. The landscapes of the nature sanctuary are extremely rich in rare plant species. During the course of field research in the summer period of 2020-2021, 39 places of growth of 35 plant species, listed in the Red Book of the Ulyanovsk region were identified, including 10 species in the Red Book of the Russian Federation. The landscapes are experiencing serious anthropogenic pressures, that contradict the nature protection regime of this protected area (table 1).

The plowing of territories is carried out everywhere, the total plowing of the nature sanctuary is 18% (figure 2). This is a gross violation of the nature protection regime of the reserve, which, moreover, has serious proportions. In addition to the violation of soil and vegetation cover and the destruction of the habitat of animals, plowing carries the risks of the development of planar and linear erosion, that is, it creates the risks of significant destruction of the soil cover of the territory and changes in the microrelief. The realization of these risks will entail irreversible changes in the morphology and functioning of landscapes.

The agroforest landscape of terraces, complicated by a ravine-girder network, under steppes and cultural cenoses of fields on chernozems it is most severely disturbed by plowing (43% of the area of this landscape has been plowed) due to attractive conditions for agriculture - fertile soils and relatively small slopes. At the same time, the reserve is of great importance for the conservation of biodiversity, as evidenced by a significant number of plant species, listed in the Red Book of the Ulyanovsk region and Russia (table 1).

Table 1. Quantitative values of anthropogenic disturbance of landscapes of the territory of the nature sanctuary Bakhteevskie Uvaly.

Landscape	Landscape area, km ²	The area of arable land within the landscape, km ²	Percentage of disturbed landscape territories, %	The number of discovered plant species listed in the Red Book
1. The forest landscape of plakor under coniferous forests on skeletal chernozems	35.14	0.44	1.25	3
2. The forest landscape of slopes under coniferous forests on skeletal chernozems	49.53	0.31	0.62	21
3. Agroforest landscape of terraces, complicated by a ravine-girder network, under steppes and cultural cenoses of fields on chernozems	62.07	25.93	41.77	11

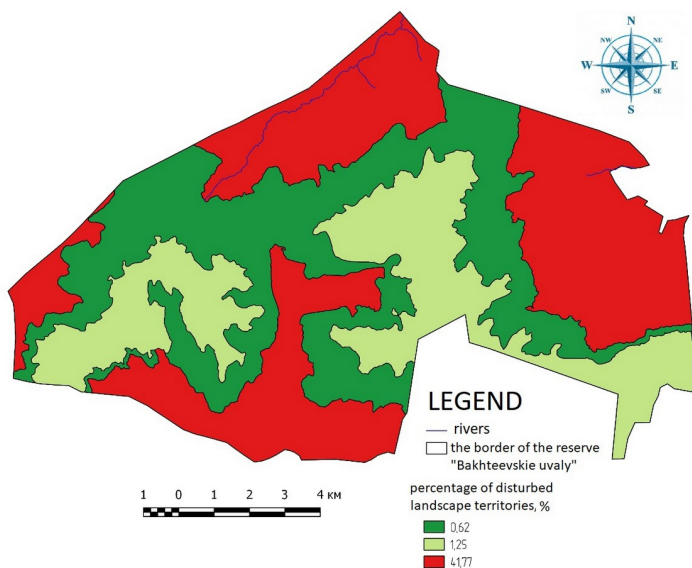


Fig. 2. Quantitative values of anthropogenic disturbance of landscapes of the territory of the nature sanctuary Bakhteevskie Uvaly.

A comprehensive survey of the nature sanctuary "Bakhteevskie Uvaly" showed, that the landscapes of the reserve, as a whole, have preserved their identity and contain a large number of rare, endemic, relict and protected species, which fully justifies the functioning of the protected area.

5 Conclusion

The nature sanctuary "Bakhteevskie Uvaly" has a great landscape-forming importance, being the center of conservation of the reference steppes, upland pine forests, as well as the southern variant of oak and pine-oak forests of the Volga upland, which are of key importance in the formation of natural complexes of this area. The protected status for this territory is relevant and necessary, as it allows to prevent the degradation of steppe and forest ecosystems under the influence of anthropogenic pressure.

In order for the sanctuary to effectively perform its environmental functions, it is necessary to monitor compliance with the environmental regime, first of all, the prevention of plowing. In addition to the functions of biodiversity conservation (for which it is necessary to preserve all types of plant communities represented on the territory of the reserve), this territory performs important water-regulating functions, which requires the preservation of existing forests and the exclusion of steppe areas from agricultural use. The results of the research can be used by environmental, scientific, and educational organizations [13].

References

1. G. V. Vinyuseva, Bulletin of the Ulyanovsk State Agricultural Academy 3(27) 45-49 (2014)
2. A. E. Astashin, M. M. Badin, I. Yu. Krivdina, O. E. Vatina and O. N. Pashkin, IOP Conf. Ser.: Earth Environ. Sci. 1045(1) 012001 (2022)
3. S. V. Bakka, N. Y. Kiseleva, A. A. Shestakova and O. V. Birykova, IOP Conf. Ser.: Earth Environ. Sci. 817(1) 012010 (2021)
4. K. Michałowska and E. Glowienka, The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences **37** 10171020 (2008)
5. I. S. Makeev, M. V. Sidorenko, V. P. Yunina, N. Y. Kiseleva and S. V. Bakka, IOP Conf. Ser.: Earth Environ. Sci. **1010(1)** 012148 (2022)
6. T. Okayama and T. Okano, Landscape Research Japan Online **9** 74-82 (2016)
7. A. K. Fitzsimmons, Journal of Geography **78(6)** 230-236 (1979)
8. N. A. Tymchuk and Yu. I. Potasheva, IOP Conf. Ser.: Earth Environ. Sci. **839** 022074 (2021)
9. Jochen A G Jaeger, Landscape Ecology **15(2)** 115-130 (2000)
10. Geological map of pre-quaternal formations (Sheet N-38-XX (Novospasskoye)) scale 1:200 000 retrieved from <http://www.geolkarta.ru/>
11. Geological map of Quaternary formations (Sheet N-38-XXX (Novospasskoye)) 2002 scale 1:200 000 retrieved from <http://www.geolkarta.ru/>
12. A. G. Isachenko Landscape researches and physico-geographical zoning (Higher School, Moscow, USSR, 1991)
13. V. A. Malinin, F. V. Povshednaya and A. V. Pugachev, Vestnik of Minin University **10(1)** 2 (2022)