Landscape structure of the territory of the state hunting sanctuary "Novocheremshansky" (Ulyanovsk region, Russia) as the basis of functional zoning of the territory

Andrej Astashin¹,²*, Galina Kamerilova¹, Aleksej Bazarov³, Valeriya Podkovyrina¹, and Ol'ga Vatina¹

¹ Kozma Minin Nizhny Novgorod State Pedagogical University (Minin University), 603950, Ul'yanova, 1, Nizhny Novgorod, Nizhny Novgorod Region, Russia
² Nizhny Novgorod state engineering and economic university, 606340, Oktyabrskaya St., 22a, Knyaginino, Nizhny Novgorod Region, Russia
³ Research Center "Povolzh'e", 31/1, Goncharova str., Ulyanovsk, 432063, Russia

Abstract. The article presents the results of researching the landscape structure of the territory of the state hunting sanctuary of regional significance "Novocheremshansky", based on the materials of field research, conducted in 2022, remote sensing data of the Earth, thematic maps, literary data, processed using the QGIS program. A floral list has been compiled, including 147 species in 51 families of 5 classes, of which 2 species are listed in the Red Book of the Ulyanovsk region. In the course of the research, 3 landscapes were identified, anthropogenic disturbance of natural complexes and the main threatening factors within the research area were established. On the basis of the landscape approach, a scheme of functional zoning of the territory has been developed, which is of interest to land users and environmental organizations.

1 Introduction

The use of the landscape approach in the territorial and functional organization of nature management is an effective and widely used technique in world practice. The landscape-typological map is considered as an invariant basis for the analysis of the territory, reflecting the spatial distribution of geosystems of various types and allowing to gain new knowledge and create thematic maps of various contents for solving applied problems [1]. Due to the obvious importance of the landscape-ecological approach, serious attention is paid to its study when training specialized specialists – geographers, biologists, ecologists, soil scientists, hydrologists, etc. [2].

The organization of protected areas and the maintenance of the environmental regime within them is a specific task, for which it is absolutely necessary to use a landscape approach for a number of reasons.

* Corresponding author: astashinfizgeo@yandex.ru
Firstly, protected areas, having the objective function of preserving and maintaining biological diversity and ecosystem processes [3, 4], requires both in the design and in the process of functioning, systematic accounting and organization of the preservation of all components of the landscape – from the morpholithogenic basis to the animal world.

Secondly, protected areas have serious social significance, supporting the natural resource base of the existence and development of indigenous communities. Forming the ecological framework of the territory, protected areas allow for the long-term economic use of adjacent territories. To fully implement these functions of protected areas, it is also necessary to use a landscape approach [5].

Thirdly, protected areas, being unique or, conversely, the most typical, representative areas of the territory, often have cultural significance [6], representing landscapes that have determined the specifics of the mentality, traditions, customs and even religion of the indigenous population.

Fourth, on the basis of the landscape approach, the most balanced organization of nature management within the boundaries of protected areas is possible, taking into account both the importance of the resources available within the protected areas for economic use and the ability of landscapes to withstand the long-term exploitation of these resources [7].

Due to all the factors, listed above, the use of a landscape approach is an effective tool for ensuring the sustainable development of any territory, including protected areas. However, the use of the landscape approach is still severely limited due to the lack of maps of landscape zoning of territories at the level of landscape types and tracts – that is, at the hierarchical level of landscape differentiation at which specific economic solutions are implemented. Landscape maps at the level of landscape types were created only for a few protected areas of the Ulyanovsk region [8, 9] and served as the basis for functional zoning. This paper presents a scheme of landscape differentiation of another protected area – the state hunting sanctuary "Novocheremshansky", and a map of functional zoning made on its basis.

2 Materials and methods

The purpose of the research: to develop a scheme of landscape differentiation of the territory of the state hunting sanctuary "Novocheremshansky".

The object of research: the territory of the state hunting sanctuary "Novocheremshansky".

Subject of research: landscape structure of the territory of the state hunting sanctuary "Novocheremshansky".

The work was carried out based on the results of field research, conducted by the authors on the territory of the reserve in 2022.

In the course of the work, the following research methods were applied: expedition, descriptive, cartographic, GIS analysis, analysis of literature and stock materials, statistical, expeditionary, remote studies, complex physico-geographical (landscape) analysis, comparative geographical, geographical zoning.

In the course of the work were used kinds of maps: topographic, quaternary and pre-quaternary deposits, satellite images of the researched territory.

3 Results

The reserve is located in the east of the Low Volga lowland plain, has an area of 5 640 hectares [10].

Pre-quaternary formations are represented by deposits of the Tatar tier of the upper Permian system (clays, siltstones, marls, dolomites and limestones, sandstone interlayers) [11].
Quaternary formations in the western part of the researched territory are represented by alluvial deposits of floodplains (sands, sandy loams, loams, clays, crushed stone and gravel) and marsh deposits, in the eastern part – alluvial deposits of the first and second above-floodplain terraces, as well as deluvial deposits (clays, loams, sandy loams, sands) [12].

The sanctuary occupies the eastern part of the valley of the Maly Cheremshan River, including low fluval terrace above floodplain and a wide floodplain.

The side of the valley is dissected by large gullies, the floodplain iscomplicated by ancient cuts, low ridges and depressions. In the southern third of the sanctuary, the embankment of the now dismantled railway stretches in the sublatitudinal direction.

In the western part of the researched territory flows the Maly Cheremshan River with numerous small ancient lakes and swampy areas on the floodplain. The southern border of the sanctuary runs along the riverbed of the Bolshoy Cheremshan River, into which the Maly Cheremshan River flows.

The territory of the sanctuary is occupied by gray forest soils [13], alluvial-turf and peat-swamp soils are common on the floodplains of rivers, in ravines and gullies – soils of the ravine-girder complex.

The zonal vegetation type is broad-leaved forests, but they are often reduced and replaced by pine crops or secondary small-leaved forests. Willow stands and black alder community are common along the floodplains of rivers.

Vegetation on the territory of the sanctuary naturally changes: on the second above-floodplain terrace, pine crops with the restoration of hazel linden are common; on the ledge of the second above-floodplain terrace – linden and maple trees with an admixture of birch, sometimes turning into birch trees; on the damp first above-floodplain terrace – black alder and birch, on the floodplain - black alder with an admixture of white willow and birch.

In accordance with the scheme of landscape zoning by A.G. Isachenko (1991) [14] the Novocheremshansky sanctuary is located in the forest-steppe zone (southern forest-steppe subzone) within the Lower Volga landscape region.

At the hierarchical level of landscape areas, the authors relied on the scheme, proposed by A.P. Dedkov and A.V. Stupishin [15], according to which the researched territory lies in the north of the Cheremshan landscape region of the Volga region.

The composition and spatial structure of more fractional units of landscape zoning – landscapes – were established by authors during field researches (Fig. 1, Table 1).

**Table 1.** The position of the territory of the Novocheremshansky sanctuary in the landscape zoning system of Russia.

<table>
<thead>
<tr>
<th>Physical-geographical zone: forest-steppe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical-geographical country:</td>
</tr>
<tr>
<td>Eastern European (Russian) Plain</td>
</tr>
<tr>
<td>Physical-geographical region:</td>
</tr>
<tr>
<td>Low Volga lowland plain</td>
</tr>
<tr>
<td>Province: Zavolzhskaya forest-steppe</td>
</tr>
<tr>
<td>Sub-province: Zavolzhskaya southern forest-steppe</td>
</tr>
<tr>
<td>Landscape area: Cheremshansky landscape area of the Volga region</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Landscapes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The forest landscape of the moist second over-floodplain terrace, complicated by beams, under the restoration of linden in the culture of pine on gray forest soils</td>
</tr>
<tr>
<td>2. Forest landscape of the damp first above-floodplain terrace under black alders and birch forests on gray forest gley soils</td>
</tr>
<tr>
<td>3. Forest landscape of a damp, complicated by low ridges floodplain under black alders and willows on alluvial-turf soils</td>
</tr>
</tbody>
</table>
1. The forest landscape of the moist second over-floodplain terrace, complicated by beams, under the restoration of linden in the culture of pine on gray forest soils occupies an elevated position, which is why it is dissected by deep beams and well drained. There are no water bodies. The soils are loamy gray forest. Due to the relatively light mechanical composition of the soils and good drainage, pine crops were planted on the site of the once reduced indigenous broad-leaved forests, the stand of which has already significantly fallen
out. In the second layer and in the young growth broad-leaved species are widely represented, primarily Tilia cordata Mill. In the shrub layer – common Corylus avellana (L.) H.Karst., Lonicera xylosteum L., Euonymus verrucosus Scop. In the herbaceous layer Carex pilosa Scop. is most common, along with which there are other nemorose species Pulmonaria obscura Dumort., Asarum europaeum L., Convallaria majalis L., Veronica chamaedrys L., Parus quadrifolia L., Stellaria holostea L., Polygonatum multiflorum (L.) All., Lathyrus vernus (L.) Bernh., Aegopodium podagraria L., Galium odoratum (L.) Scop.

In 2022, there was an outbreak of the number Lymantria dispar (Linnaeus, 1758), which led to almost complete destruction of foliage on trees and shrubs and very severe damage to herbaceous vegetation within the landscape. It is noteworthy that other landscapes of the sanctuary were almost not affected.

2. Forest landscape of the damp first above-floodplain terrace under black alders and birch forests on gray forest gley soils. The surface of the landscape is subhorizontal, low-lying, which is why it is poorly drained. The soils are gray forest loamy gley. Black alders with an admixture of birch are widespread, sometimes turning into birch forests. The grassy layer is dominated by communities of Filipendula ulmaria (L.) Maxim. and Phragmites australis (Cav.) Trin. ex Steud.

3. Forest landscape of a damp, complicated by low ridges floodplain under black alders and willows on alluvial-turf soils. The relief is complicated by ox-bow cuts with eutrophied ox-bow lakes, low ridges and swampy depressions. Soils are alluvial-turf gley. Dominated plant communities of Alnus glutinosa (L.) Gaertn. and Filipendula ulmaria (L.) Maxim., on the low ridges - floodplain oak forests.

The sanctuary, as an area with an important water protection and anti-erosion role, retains its significance. The landscapes of the reserve are reference. The forest lands disturbed in the past, which are the habitat of a number of rare plant species for the Ulyanovsk region, are being restored and perform their environmental functions.

All the main ecosystems of the sanctuary are unique reserves for typical rare and protected species, which increases their conservation status and determines the relevance and timeliness of the organization of the protected area.

The main condition for the preservation of the biota and ecosystems of the Novocheremshansky State sanctuary is the effective protection of forests, that have high water conservation value and ensure the fullness of springs and rivers as strategic reservoirs of pure fresh water.

To improve environmental protection work in the sanctuary, it is necessary:
- prevent any logging in protected areas and preserve large forests around lakes and swamps;
- to carry out all necessary fire-fighting measures in the necessary time to preserve forests and swamps from fires in problem areas;
- to prevent reclamation works that can harm lakes and swamps of protected areas;
- explain the rules of conduct to vacationers and tourists on the territory of protected areas;
- monitor and prevent the spread of Lymantria dispar (Linnaeus, 1758) caterpillars.

The authors have developed proposals for the organization of functional zoning of the territory of the Novocheremshansky sanctuary, based on the principles of a geosystem approach. The presented cartographic scheme of functional zoning (Fig. 2) is drawn on the basis of the scheme of landscape zoning of the territory of the sanctuary, made at the level of landscape types (Fig. 1), taking into account the existing regime of economic use of the territory, the degree of economic demand and anthropogenic disturbance.
The protected zone is proposed to include landscapes that are the habitat of rare plant species – *Nymphaea candida* J. PRESL and *Aconitum septentrionale* Koelle, included in the Red Book of the Ulyanovsk region. The remaining territories are proposed to be attributed to the zone of extensive traditional nature use (Fig. 2).

The network of dirt roads is poorly developed, most of them are no longer used. In the central part of the sanctuary, along the embankment of the former railway, traces of recent logging are pine forest wastelands overgrown with hazel and young growth of linden tree.
Separately, it is worth noting a major problem of this protected area: in 2022, there was an outbreak of the number of *Lymantria dispar* (Linnaeus, 1758) caterpillars, which led to almost complete destruction of foliage on trees and shrubs and very severe damage to herbaceous vegetation.

4 Conclusion

In the course of field research in the summer of 2022, a floristic list was compiled, including 147 plant species in 51 families of 5 classes, of which 2 species are listed in the Red Book of the Ulyanovsk region, which confirms the expediency of organizing a specially protected natural area.

The landscapes of the Novocheremshansky State sanctuary, due to their remoteness from large settlements, are not of serious interest to recreationists. Local residents use the resources of the sanctuary to a limited extent, and not to a greater (and even to a lesser) extent than the resources of other territories adjacent to the villages, which is why traditional types of nature management – picking mushrooms, berries, nuts – practically has no effect on the state of the landscapes of the sanctuary.

The expediency of using a landscape approach in this area is confirmed by a complex of natural and anthropogenic indicators. So, for example, within the forest landscape of the moist second over-floodplain terrace, complicated by beams, under the restoration of linden in the culture of pine on gray forest soils, the most anthropogenic activity was recorded - a dense network of dirt roads, traces of long-standing logging, on the site of which pine crops now grow. Even the outbreak of the number of caterpillars of *Lymantria dispar* (Linnaeus, 1758) is confined to the borders of this landscape. The complex of the listed factors clearly indicates the need to use landscape boundaries in territorial planning and design of economic activity.

Acknowledgments

The research was carried out with the support of the Research Center "Povolzh'e".

References

6. I. Eliasson, S. Fredholm, I. Knez, E. Gustavsson The Need to Articulate Historic and Cultural Dimensions of Landscapes in Sustainable Environmental Planning A Swedish Case Study, Land **11** (11), 1915 (2022)
7. K.N. Dyakonov, N.S. Kasimov, A.V. Khoroshev, A.V. Kushlin Landscape Analysis for Sustainable Development: Theory and Applications of Landscape Research in Russia (Alex Publishers, Moscow, Russia, 2007)


15. A.P. Dedkov Natural conditions of the Ulyanovsk region (Publishing house of Kazan University, Kazan, USSR, 1978)