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Ways to Preserve Biological Diversity of Bog Ecosystems within Natural Parks System.

Yulia V Yudina*.

Belgorod State National Research University, Russia, 308015, Belgorod, Pobedy str., 85.

ABSTRACT

Results of field research, GIS-mapping and simulation of ecosystems including relict bogs within the conservation area of a new regional Natural park are represented in the article. Functional zoning of the park area with the argumentation of different use provisions have been developed on the basis of author's landscape plan.

Keywords: relict ecosystems, swamps, biodiversity, nature management, Belgorod region, River Vorskla.

Corresponding author

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INTRODUCTION

Unfortunately both in Russia and in the rest of the world bog conservation has been secondary comparing to wetlands, towards which national and international programs are directed. The implement of international projects in Russia has started since 1967, when under this authority the UNESCO, the International Union for Conservation of Nature and the International Biological Program International meeting on the organization and implement of the project "Thelma". This project stated the goals of bog conservation, determined the factors influencing on their preservation, a list of conserved and recommended to conservation bogs was made. As a result of the Russian group members' work the list of bogs with a total area of 1.5 million ha was presented and published in the book [1], where the Mokhovoye transition bog No.8.10 (4 ha) in Belgorod region (near the town of Grayvoron in the river flood plain). It has been described 1903 V.N. Sukachev mentioning 8 types of mosses. As for herbarial material of forest-steppe bryophyte flora, the richest herbarium by Misguer on Kursk region flora was lost during the II World War: only some single collections 1859 and the Hotmigsk bog herbarium 1960 had been saved.

Belgorod region as an administrative unit may be represented as an integral ecosystem, if we do not apply basinal principles of territorial differentiation [3]. It helps to implement a new approach to representation of large natural reserves. We should also mention that most of relict bogs has been preserved in the west of Belgorod region within the river basin Vorskla (length – 130 km, area – 2001 km^2). This is the basin where the RNP "Hotmigskiy" is situated.

As we demonstrated earlier [4], bog ecosystems with their characteristic vegetation cover appearance started their formation in SB during the Holocene (4000-3700 years ago) age under the conditions of increasing climate humidity. Taking into account the uniqueness of forest-steppe bog spore-pollen complexes, A. Artyushenko [5] we came to a conclusion that Eoholocene bogs coincide with hollows in flood plains, Mesoholocene bogs take positions of second river terraces, and Neoholocene bogs are found in sandy terrace hollows and stream flood basins. The spots of upstream sphagnum bogs are unique for Belgorod region because they are relicts reflecting the characteristics of northern Boreal biota. And if sphagnum is found quite often they *Eriophorum vaginatum*, *Oxycoccus palustris*, *Scheichzeria palustris*, according to [6], can be found only as a part of completely formed sphagnum bogs with substantial peat deposits. All glacial elements in Belgorod region are under protection and listed in the Red Book. Some island ecosystems preserve their unique features biodiversity [7, 8], what gives us an opportunity to consider them not only as coenogenetic pools but also as a source of the species to implement ecological restoration measures. Self-regulation mechanisms of ecosystems that become balanced with the vegetation for hundreds of years [9], and with the soils for their first thousands of years [10], can be used to create bionics principles for the purpose of ecological restoration of derelict lands.

MATERIALS AND RESEARCH METHODS

As a result of the field research a new landscape plan of the regional natural park Hotmigskiy was created as a territorial basis for geoplanning and a landscape functional planning scheme development with the allocation of areas of different usage conditions. With the ArcGIS help of a terrain vector map and the second derivative method (plastic shading) we have completed the GIS-mapping of the research test site (a sandy terrace and river valley flood plain) and also 3D imaging of water collection has been performed by means of program ArcScene tools. We have applied remote estimation of land parameters by satellite data using the developed methods [11, 12] because it was difficult to access bogs for the research. We have also appealed to the results of the field research of sphagnum bogs in the Vorskla valley, which were conducted by the scientists Belgorod State National Research University [13] as a part of the complex research on the RNP "Hotmigskiy" ecological economic assessment with the participation of the author of this article.

THE MAIN PART

RNP "Hotmigskiy" was created 2002 under the resolution of the Head of Administration of Belgorod region and it is under full control of the forest administration. The RNP total area – 10662 ha, is situated within two districts – Borisovka (80.7%) and Grayvoron (19.3%). The territory was not covered with ice during the Quaternary period. The terrain was developing under the influence of denudation, as a result two

morphological elements were estranged: interfluvial masses and a valley-hollow chain. The total length of the regular watercourses is RNP 26.5 km, the channel density is 0.25 km/km^2.

At the moment human economic activities play a great role for the distribution of vegetation, because it results in the primeval vegetation cover is highly altered. Most parts of the territory, especially watershed areas, are tilled. Forests (oakeries and pineries) occupy 38.5 per cent of the total area RNP. The simulation of the vegetation cover conducted according to the soils and forests spread maps in the 18 s. demonstrated that forests were growing everywhere during the Holocene. The destruction of forests has started a few centuries ago.

In the valley Vorskla we can find small forestlands on hydromorphic and semihydromorphic soils. These forests existed in 18 s. but they are secondary.

Oakeries are the most characteristic, especially interfluvial ones. The main wood species of the first storey are oak, lime, ash and maple. The floristic composition of the River valley oakeries distinguishes itself by a large variety: the number of wood species reaches 70. There are a lot of northern elements including bog species.

Valley-river landscapes in the Vorskla stream reach from the Hotmigsk of Borisovka district to the Grayvoron district border have some distinctive features. Man-made pine forests and oakeries vegetate in the first terrace above the flood plain. The age of most matured pine woodlands is 70 years old.

The bogs can be found in RNP “Hotmigskiy” at the bottoms of ravines in the spring boil areas [14], but most often they can be seen in inundable valleys and first terraces above the flood plain of the Vorskla area. The floodplain bogs of RNP are mainly belt-type ones they are common at the river feeders and ravine bottoms.

The use of the RNP functional zoning is determined by the necessity of drawing the boundaries between natural and natural economic geosystems. Taking into account the landscape map as a territorial basis for geoplaning and effective environmental legislation, we have developed the landscape functional planning scheme with the allocation of areas of different usage conditions (see Table).

Table: Land distribution in functional areas of the RNP “Hotmigskiy”

Functional areas	Square	
	ha	% of RNP square
1. The protected Area	230.0	2.16
2. Specially Protected Area	3530.0	33.11
3. Cultural tourism zone	93.0	0.87
4. Recreational Area	2580.0	24.20
5. Zone of protection of historical and cultural sites	30.0	0.28
6. Area Visitor Services	180.0	1.69
7. The purpose of the economic zone	4019.0	37.69
In total	10662	100.00
8. The buffer zone RNP	5400.0	

The functional zone can be determined as a restricted area, where space and time administrative orders are effective. The RNP zoning was conducted by means of the areas united by the common purpose of use, on the basis of natural geosystems inventory, taking into account the priority, usability and stability estimation that gave the author an opportunity to provide rationalization for the boundaries of the zones recommended for natural environments conservation, and unique landscape systems, as well as the zones for the purposes of prospective social and economic development of RNP “Hotmigskiy”.

Conservation area: RNP “Hotmigskiy” as a main structure element of a single chain of natural reserve should play a great role in the conservation of natural, landscape and biological diversity. There is a necessity to expand existing protected areas by creation of conservation and special protection areas on the basis of

inventory, geobotanical, zoological, soil-geographical and landscape research. Bearing in mind that an optimally organized landscape diversity master system solves 90 per cent of the biological diversity conservation problem, it is prospectively to pay attention to the biological corridor, the reserve area "The Vorskla Forest" – the flood plain Vorskla. These are the areas were proved as protection areas for the purpose of conservation core formation RNP "Hotmigskiy".

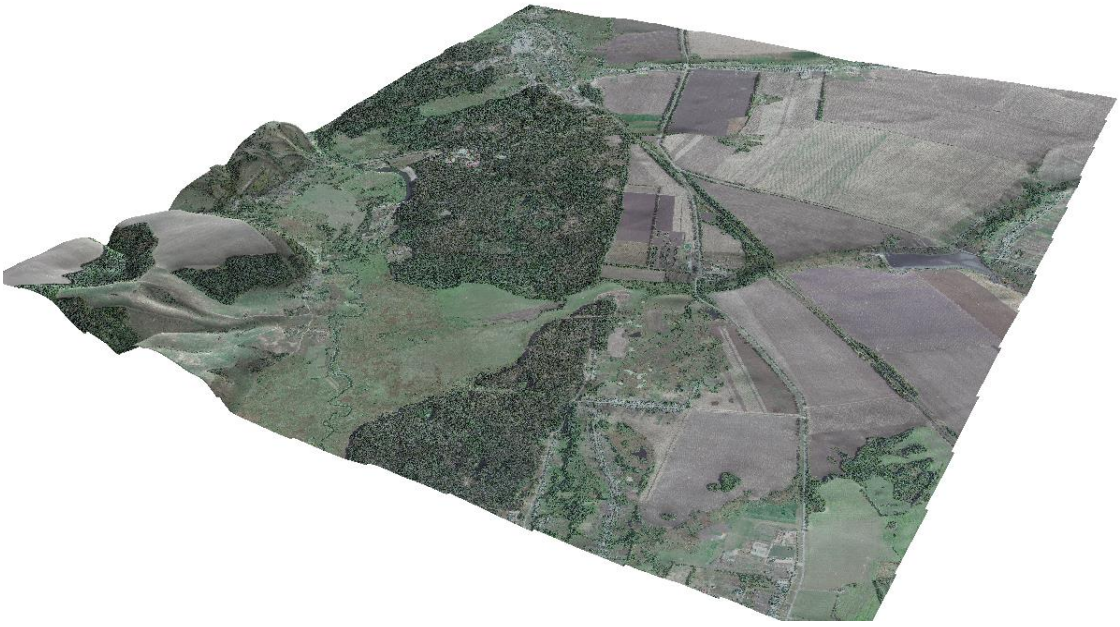
Belonging of the oakeries to the forest-steppe landscape can be considered from the perspective of their "typicality": they are the geosystems of average sensitivity being in relative equilibrium.

The conservation area of Dubino stow around the bog: the oakery with the trees age of years old on the first terrace above the Vorskla flood plain: in the first storey – *Quercus robur*, *Fraxinus excelsior*; in the second storey – *Ulmus glabra*, *U. laevis*, *Tilia cordata*; in the underwood – *Corylus avellana*, *Acer campestre*; in the grass cover – *Pteridium aquilinum*, *Dryopterisfilix-mas*, *Carex pilosa*, *Pyrola chlorantha*, *Corydalis cava*, *C. marschalliana*, *Asarum europaeum*, *Stellaria holostea*, *Pulmonaria obscura*, *Polygonatum odoratum*, *Epipactis helleborine*, *Convallaria majalis*, *Viola mirabilis*, *Lathyrus vernus*, *Poa nemoralis*.

The Dubino sphagnum bog in the Vorskla flood plain is characterized by the presence of rare vegetation: *Sphagnum obtusum*, *S. fallax*, *S. subsecundum*, *Tortulla subulata, Calla palustris*, *Eriophorum vaginatum*, *Carex humilis*, *Drosera rotundifolia*, *D. anglica*, *Saxifraga hirculus*, *Pyrola rotundifolia* and rare fauna – *Erpobdella testacea* [13].

Highly sensitive geosystems belonging to the "unique" category are hydrological nature reserves are the bogs Bubnovoye (5.2 ha), Noviy Most (4.2 ha), Sphagnovoye (2.0 ha) and unnamed reed-low-level bog (4.9 ha) near the Hotmigsk, which became a part of the RNP conservation area, their function is to conserve their unique vegetation including the representatives of northern relics.

While studying migration paths of water bodies the combination of new hydrological process simulation methods with the water collection [15, 16] condition GIS-analysis. The 3D block diagram of the Krasivo stow area (Figure) and mapping of this site performed with the use of the second derivative method (plastic shading) allowed the author to find a twisted landscape pattern as a reflection of abandoned channels Vorskla in the sandy terrace. Within one of such channels the Bubnovoye bog is located, in 1787 one channel Vorskla created water-bog body in the area of 325 ha. Thus, the Bubnovoye bog hydrological natural reserve is the last large fragment of the water-bog body that has been degrading for the last 150-100 years.



a)

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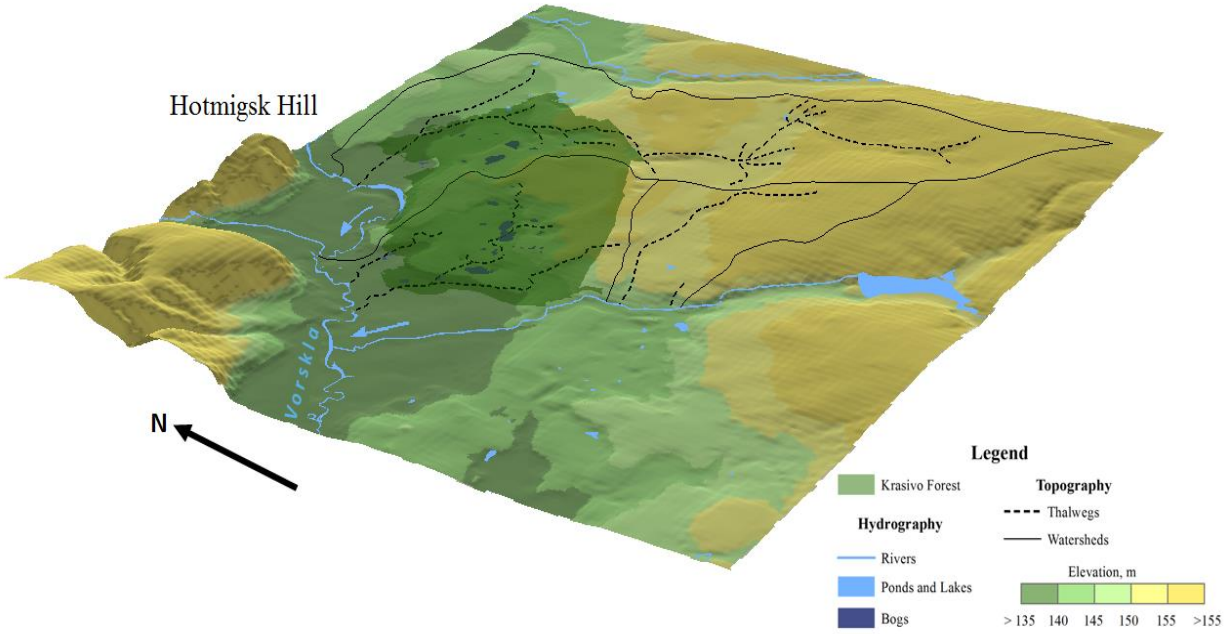

b)

Figure: Visualization of three-dimensional models of key land, Natural park "Hotmigskiy": a) a fragment of the satellite image of the study area; b) three-dimensional model of the study area

We should also mention the functional connection of the bogs with surrounding low-lying hollow areas. Previously, according to the land map 1955, the Bubnovoye bog occupied smaller area of 3.52 ha. The area progress is the evidence of close hydrological and hydrogeological connection with the river channel. Human influence, for example the construction of utility systems to expand RNP "Hotmigskiy" recreation potential may lead to the isolation of relict geosystems and their complete degradation. The fate of fragile ecosystems depends on modern directed climatic changes. With human co-creation with the nature it is important to achieve a resonance effect, i.e. mutual "penetration" of rhythms of society and natural environment [17]. In this connection natural conservation activities should be adaptive both in time and space aspects.

In the bogs periphery semihydromorphic landscapes are common and there plant and animal species from the Belgorod Region Red Book are found – *Sphagnum obtusum*, *S. fallax*, *S. subsecundum*, *Scheuchzeria palustris*, *Dentaria bulbifera*, *Dentaria quinquefolia*, *Parnassia palustris*, *Viscum album, Epipactis palustris*, *Icmadophila ericetorum*, *Hirudo medicinalis*, *Bufo bufo*, *Emys orbicularis*. The presence of strong peat depth (up to 7 m) allows us to consider this bog as a valueable but insufficiently explored natural repository of the Vorskla area Pleistocene history.

The Noviy Most bog (4.2 ha) is situated to the south of the Hotmigsk and keeps the representatives of the northern pine forest vegetation: *Sphagnum obtusum*, *S. fallax*, *S. subsecundum*, *Scheuchzeria palustris*, *Dentaria quinquefolia*, *Parnassia palustris*, *Calla palustris*, *Carex humilis, C. limosa*, *Hammarbia paludosa*, *Rubus saxatilis*.

Reed-sedge sphagnum bog (4.2 ha) 20 per cent willow filled with rare and protected plant species: *Sphagnum obtusum*, *S. fallax*, *Eiophorum gracile*, *Urticularia minor*, *Crepis paludosa*, *Orchis palustris*, *Platanthera bifolia*, *Hymnodenia conopsea, Icmadophila ericetorum*, *Cladonia deformis*, *Cypripedium calceolus.*

Other relict bogs have the following Red Book listing: *Sphagnum obtusum, Sphagnum fallax, Sphagnum subsecundum, Scheuchzeria palustris, Dentaria bulbifera, Epipactis palustris, Icmadophila ericetorum, Hirudo medicinalis, Bufo bufo, Emys orbicularis.*

According to sphagnum bogs research results [13] the species for the first time noticed in Belgorod region are found, some of them are even new for the science. For example *Erpobdella testacea* – the species characteristic for sphagnum bogs dwells only within Krasivo stow; spiders: *Agroecina striata* – the new species for the region, *Asagena meridionalis* – has not been found in Russia before, *Panamomops fagei* – new species for Russia, new species for the science – *Savignya sp*.; lacewings: *Psectra dipteral* – the rare species associated with bogs; beetles: *Bembidion biguttatum* – the new species for the region, *Chaetocena aerosa* – rare species associated with bogs; ants – *Formica picea и Formica uralensis* – the rare species associated with bogs of forest vegetation, new for the region [13]. It gives an opportunity to turn to the resume of the work in Belgorod region on finding potential areas with inclusion status Areas of Special Conservation interest the Emerald Network [19].

Special protection area: This is the area where the conditions for conservation of natural complexes and objects are provided and where only strictly controlled visits are allowed. Relict bogs buffer zones of Krasivo stow are also related to the special protection area. The functional features of bogs and, first of all, their hypsometric position within the first terrace above the Vorskla flood plain found its reflection in the phytodiversity of their surroundings. The Noviy Most bog is surrounded by the subor with scotch pines (age up to 95 years old, height up to 27 m) and oaks in the second storey. Near the Bubnovoye bog and adjoining smaller bogs in the special protection area the subor with pines and mountain oaks in the first storey and maples and limes in the second storey.

The habitats of insects listed in the Red Book of Russia that became a part of the special protection area: hymeoptera: in the flood plain Vorskla – *Sapyga quinquepunctata*, *Bombus armeniacus scythes*, *B. argillaceus, Megachile rotundata*, *Xylocopa valga*, *Dasylabris maura*, *Parnopes grandior*; butterflies – *Papilio machaon*, *Eudia pavonia*, *Hemaris fusciformis*, *Proserpinus Proserpina*, *Ammobiota hebe*; *Saturnia pyri*, *Endromis versicolora*), *Callimorpha quadripunctaria*, *Callimorpha dominula*.

CONCLUSION

Ecosystems which are highly sensitive not only to human activities but also to directed climatic changes the same as studied in this work relict bogs in low river flood plains, it is reasonable to protect them in a specially designed functional natural reserves zone, where all landscape-cascade paragenetically connected geosystems.

SUMMARY

Landscape plans created by natural component thematic layer overlay are objective territorial basis for a landscape functional planning scheme development with the allocation of areas of different usage conditions. In order to conserve the natural environment, natural landscapes, natural ecosystems and biodiversity it was suggested on the regional level to develop Natural parks system. It (taking into account the concept of landscape-hydrological geosystems contingency) enables to determine the boundaries and area of the conservation area for highly sensitive ecosystems more reasonably, under the conditions of forest-steppes they are (in the terraces and low river valley flood plains) relict bogs with unique biodiversity. It is important to emphasize that the published valuable bog systems and bodies lists on the project “Thelma”, they are less than 1.5 per cent of the total country bogs area in Russia, do not possess a legal status and only serve as guidelines. The exclusions are the bogs from the List of swamplands of Russia determined by the Russian Federation Government Decree (№1050 from 13.09.1994). That is why the geoplanning of the conservation area as a part of the park, as the author has performed it for the sphagnum bogs of the Vorskla area, with the use of GIS-mapping and simulation, palaeoecologic reconstruction will allow to conserve unique ecosystems with high sensitivity to human activities and directed climatic changes.

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