Perspective steppe protected areas of the Central Chernozem region of Russia (a case study of Voronezh oblast)

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Abstract. The article gives a short description of the present state of Voronezh oblast steppe natural territorial complexes and discovers the reasons of preserved steppe landscapes identification and protection. The authors provide landscape and floristic descriptions of 9 perspective steppe protected areas which are located in 7 administrative-territorial units. Within descriptions particular emphasis is laid on the plant species of Russia and Voronezh oblast Red Data Books. A map of perspective steppe protected areas location is presented in accordance with a scheme of regional physical and geographical zoning.

1. Introduction

A steppe is an endangered biome of Earth. It severely impaired in old-cultivated regions of European Russia, in particular, in Voronezh oblast which was chosen as a study area.

The area of Voronezh oblast is 52.4 thousand km². Its length from north to south is from 52°06’ to 49°34’ and from west to east is from 52°06’ to 49°34’. According to a physical and geographical zoning the region mostly locates within a forest steppe natural zone. Only south and southeast of it lies within a steppe natural zone. From north to south, an area of forests on watersheds decreases and open spaces take their places. Voronezh oblast northern watersheds before an agriculture period were covered with broad-leaved forests and meadow steppes. South of the Ostrogozhsk-Novokhopersk line they changed to bunchgrass steppes. Currently, there are almost no natural steppe landscapes in the region. Vast interfluvial areas are occupied by agricultural fields. Rarely narrow strips of virgin steppes on slopes of gullies, ravines and river valleys can be found. People use them as hay fields and pasturelands.

It is necessary to conduct a comprehensive study of preserved steppe territories in the region for the following reasons:

1) changes in organizational and legal management forms and ownership of the means of production in the 1990s. It led to a decrease of agricultural lands, including arable lands. There is a multiple excess of croplands loss over a total area of agricultural and arable lands withdrawn from circulation. At that time on many abandoned arable lands formed fallows occupied by steppe plant communities. However since the 2010s agricultural productivity has been increasing very fast and it goes hand-in-hand with fallows destruction;

2) regional climate change of the last decades and aridification growing. These changes are confirming by maximum positive temperature trends and negative precipitation trends during the...
growing season. The only exception is the northwestern part of the region where there is a positive trend in precipitation;

3) enhancing of natural flora transformation due to alien species invasion, including their invasion of steppes. Naturalization of alien species and their quick dispersal often lead to negative ecological consequences. E.g. in Voronezh oblast there are about 40 alien and 16 invasive plant species from a steppe phytocenotic group (without archeophytes).

These reasons confirm the need to search for steppe landscapes remains with weakly disturbed vegetation cover. They should be seen as etalon landscapes which are defining the basis of environmental sustainability and conserving landscape diversity of steppes and forest steppes in the Central Chernozem region. Accommodation of landscape diversity in Voronezh oblast is possible mainly through a creation of small-area protected objects like a kind of local island landscapes that can significantly diversify and enhance sustainability of developed territories [1]. In this case we consider a natural monument of a regional level with a complex profile to be the optimal form of protection. This is due to steppe communities with rare plants are occupied small territories where other objects of protection are usually absent. Advantages of a natural monument include not only an establishment of environmental regime without withdrawal of lands from a land user, but also an absence of administrative management in a certain category of natural protected areas. All this significantly simplifies the process of new protected areas creation and minimizes costs of organizational activities.

2. Methods and Materials
The research materials are the Herbarium collection of the Department of Geography, Geo-Ecology and Tourism, Voronezh State University (VORG), and field research of the authors. In the process of collecting, processing, analyzing and interpreting data on the phytodiversity of Voronezh oblast the following methods were used: rout observations, herborization, complex landscape and floristic characteristics (analysis of landscapes structural and morphological constitution, descriptions of soil, lithogenic basis and compiling floristic lists), identification of plant species systematic positions, development of a database “Digital Herbarium VORG”, GIS methods.

An allocation of the perspective steppe protected areas in the region is based on an integrated physical and geographical approach with the main principle of landscape representativeness. It consists in taking into account zonal and provincial conditions of a territory. This is why the perspective protected areas in the article although locate within the same landscape-typological complexes (slope type of locality) but vary widely in genesis, age, structure, morphology and dynamics, because they locate within different zonal and provincial conditions.

3. Results and Discussion
According to “The list of Voronezh oblast natural protected areas of regional and local levels” approved by order of the Department of Natural Resources and Ecology of Voronezh oblast No. 13 of 18.01.2021, there are 247 protected areas in the region. The long-term work of the Department Geography, Geo-Ecology and Tourism (Voronezh State University) researchers let to identify new perspective protected areas with rare plants. It is proposed to supplement this list with 9 new objects located in Buturlinovsky, Semiluksky, Nizhnedevitsky, Novokhopersky, Kantemirovsky, Petropavlovsky municipal districts and Borisoglebsky urban district. The authors believe that it is advisable to include them in “The list of Voronezh oblast natural protected areas of regional and local levels” as natural monuments of a regional level with a complex profile in 2022.

Taking into account regional landscape features of Voronezh oblast the perspective protected areas locate in two natural zones (forest steppe and steppe), three landscape provinces (forest steppe province of the Central Russian Upland, forest steppe province of The Oka–Don Lowlands and steppe province of the Central Russian Upland) and five physical-geographical regions (figure1).
Figure 1. Distribution of the perspective protected areas in Voronezh oblast according to a scheme of physical and geographical zoning (V.B. Mikhno, K.A. Drozdov, V.N. Dvurechenski, A.V. Berezhnoi, V.N. Bevz [1]).

Legend:
Forest steppe zone: A – forest steppe province of The Central Russian Upland: Districts: I – The Don chalk typical forest steppe, II – The Kalita billowy-ravine south forest steppe, III – The Kalach gully-ravine south forest steppe; B - forest steppe province of The Oka–Don Lowlands: IV – The left bank near-valley terraced district of typical forest steppe, V – The Central levelled district of typical forest steppe, VI – The Southern Bityug and Khoper district of typical forest steppe, VII – The Middle-Khoper near-valley south forest steppe; steppe zone: B – steppe province of The Central Russian Upland: VIII – The Boguchar right bank billowy-ravine steppe district, IX – The South Kalach left bank gully-ravine steppe district.

Boundaries of physical and geographical unites: 1 – zone; 2 – province; 3 – district.

Perspective protected areas: ① - tract "Peshnyanskaya Ravine" (Buturlinovsky dist.); ② - tract “Krasni Yar” (Novokhopersky dist.); ③ - ravine 2 km away from Melovatla vil. (Semiluksky dist.); ④ - tract “Golovin” (Nizhnevolsky dist.); ⑤ - tract “Makolovskaya Ravine” (Borisoglebsk urb. dist.); ⑥ - tract “Gorelka Ravine” (Borisoglebsk urb. dist.); ⑦ - tract “Vyazovaya Ravine” (Petropavlovsky dist.); ⑧ - tract “Krutoi Yar” (Petropavlovsky dist.); ⑨ - chalk downs of the southern exposure at Novobelaya vil. (Kantemirovsky dist.).

The tract “Peshnyanskaya Ravine” lies between Elizavetino vil. and Kucheryaevka vil. Its coordinates are 50.799770° N, 40.87262° E. The ravine is located on the right bank of the Tolucheevka river and in part of the Kalach gully-ravine south forest steppe district of The Central Russian Upland in the border area with Vorobyevsky municipal district. A specific feature of the territory is a presence of the Upper Cretaceous chalk and marl rocks close to the earth’s surface. They have a significant impact on landscapes structure and morphology. The ravine is deep-incised (60 m deep) with a total length of about 14 km and a width in the middle part of up to 700-800 m. Its slopes are completely matted and covered mainly with steppe plant communities. Ordinary chernozems of varying degrees of washout dominate in soil cover. Anthropogenic impacts in the tract are quite noticeable, e.g. hay-making, limited pasturing of cattle and a small apiary. Once every few years the ravine partially burns out due to landscape fires. So, in spring 2020 a fire completely destroyed one of the largest cenopopulations of Astragalus pubiflorus in a region. Of the animals in the tract Lepus europaeus, Marmota bobak and Vulpes vulpes identified.
Among cereals dominate *Bromus inermis* and *B. riparius*, *Festuca valesiaca*, species of *Poa* and *Agropyron*. A specific phonological aspect for a steppe gives species of *Stipa*. A colorful aspect steppe has during *Filipendula hexapetala*, *Salvia nutans*, *S. tesquicola*, *Coronilla varia*, species of *Trifolium*, *Tanacetum vulgare* blooming. Indicators of soil salinity like *Peucedanum ruthenicum* and *Galatella villosa* are common.

The species of The Red Data Book of Russia [2] (hereinafter these species marked with ° symbol), The Red Data Book of Voronezh oblast [3, 4] (hereinafter these species marked with * symbol) and from the list “Populations of species that need monitoring in Voronezh oblast” (hereinafter these species marked with ** symbol) are *Stipa pennata*°*, *Iris aphylla*°*, *Bulbocodium versicolor*°*, *Iris pumila*°*, *Astragalus pubiflorus*°*, *A. macropus*°*, *Ornithogalum kochii*°*, *Clematis integrifolia*°*, *Adonis volgensis*°*, *Ferula tatarica*°*, *Stipa tirsu*°*, *Campanula rapunculus***. 

Plant species composition needs further study. Presumably, there can be up to 400 species in total. Rich flora of the ravine including endangered species is a reason for organizing a natural monument of a regional level with a complex profile in an area of about 700 ha.

The tract “Krasni Yar” with the coordinates 50.891328° N, 41.344248° E locates on the left bank of the Tatarka river within the Kalach gully-ravine south forest steppe district of The Central Russian Upland. The ravine is lightly-incised (15 m deep) with a total length of about 8 km and a width in the middle part of up to 300-400 m. Gentle slopes of the ravine compose of deluvial loam soils of varying thickness [5]. The main relief-forming rocks are of the Upper Cretaceous age. A landscape specific of a territory is a presence of a moraine of the Don glacier snout. The vegetation cover of the ravine mouth has severely degraded due to overgrazing; the density of field roads is low.

In the tract the following endangered species identified: *Iris aphylla*°*, *I. pumila*°*, *Bulbocodium versicolor*°*, *Stipa pennata*°*, *Astragalus sareptanus*°*, *A. tescultatus*°*, *A. macropus*°*, *Stipa lessingiana*°*, *St. tirsu*°*, *Amygdalus nana*°*, *Clematis integrifolia*°*, *Adonis volgensis*°*, *Artemisia armeniaca*°*, *Ephedra distichya*°*, *Astragalus ucrainicus***, *Valeriana tuberosa***, *Hyacinhella leucophaea*** etc.

Organization of a natural monument of a regional level with a complex profile in an area of about 430 ha is recommended.

The ravine 2 km away from Melovatla village with the coordinates 51.88238° N, 38.66354° E. lies on the left bank of the Veduga river. The perspective protected area is located within the Don chalk typical forest steppe district of The Central Russian Upland on a strongly rugged billowy valley-ravine plain. The main landscape forming role here play carbonate chalk and marl rocks. Total length of the ravine is about 14 km and a width in the middle part of up to 500 m. On the left slope (north-western, western and south-western exposures) of the ravine and partially on a plakor there is a steppificated and strongly sparse ravine oak-wood. In its first floor *Quercus robur* dominates. Accompanying tree species are *Fraxinus excelsior* and *Acer campestre*. In the oak-wood undergrowth there are *Acer platanoides*, *Malus domestica*, *Pyrus communis*, *Sorbus aucuparia*, *Rhamnus cathartica*, *Euonymous verrucosus*, *Loniceroc xylestom*, *Loniceroc tatarica*, *Corylus avellana*. Forest fringes occupy with *Populus tremula* and *Prunus spinosa*. In the oak-wood traces of cutting trees of different years are noticeable. In the steppificated wood the following endangered species identified: *Iris aphylla*°*, *Potentilla alba*°*, *Aconitum nemorosum*°*, *Adenophora liliifolia*°*, *Lilium martagon*°*, *Platanthera bifolia*°*, *Artemisia armeniaca*°*, *Centaurea phrygia***. Plant species composition is about 200 species in total.

In the ravine’s slope edge the oak-wood replaces by a meadow steppe. Its vegetation cover is visibly anthropogenically transformed due to overgrazing. This is evidenced by the presence of weed plants, including *Conyza canadensis*, *Lactuca serriola*, *Setaria viridis*, etc.

In the meadow steppe the following endangered species identified: *Iris aphylla*°*, *Artemisia sericea*°*, *A. armeniaca*°*, *Galatella tatarica*°*, *Rhaponticoides ruthenica*°*, *Gentiana cruciata*°*, *Echium russicum*°*, *Polygala cretacea*°*, *Potentilla alba*°*, *Aconitum nemorosum*°*, *Adonis vernalis*°*, *Anemone
The tract “Golovin” with the coordinates 51.31258° N, 38.4807° E lies on the ravine’s slope of north-eastern exposure on the right bank of the Skupaya Potudan river. It locates within the Don chalk typical forest steppe district of The Central Russian Upland on the border of Kurskaya and Belgorodskaya oblast. The tract is situated within the tree-structured form erosion ravine. Its total length is about 9 km, a width in the upper part of up to 300 m, in the middle part of up to 700 m. Lithogenic basis of the ravine formed with loams, chalk and marl rocks. Soil is leached chernozem. The ravine’s floor occupies by agricultural crops and cattle occasionally graze on its slopes. The following endangered species observed here: *Iris aphyllophyta*, *Stipa pennata*, *Delphinium cuneatum*, *Clematis integrifolia*, *Linum flavum*, *Astragalus albicaulis*.

The tract “Makashevka ravine” lies 1.5 km away from Makashevka village and 100 m away from the anteriosion wall, its coordinates are 51.491248° N, 42.611594° E. The ravine locates within the lightly rugged fluvio-glacial and morainic lowlands. It is situated on the left bank of the Khoper river within the Middle-Khoper near-valley south forest steppe of the Oka–Don Lowlands. The ravine is lightly-incised (8 m deep) with a total length of about 10 km and a width in the middle and the upper parts of up to 200-300 m. Chernozems of light and medium degrees of washout dominate in land cover. Off-white strip of volcanic ash is visible at the edge of slopes.

On the slopes of western exposures of the ravine mouth observed species of *Stipa*, including *Stipa pennata*, *St. tirsa* and *St. lessingiana*. Furthermore the following endangered species identified: *Tulipa biebersteiniana*, *Scabiosa ucranica*, *Astragalus macropus*, *A. pallescens*, *Hyacinthella leucophaeae*, *Astragalus pseudotataricus* etc. Plant species composition is about 320 species in total. Organization of a natural monument of a regional level with a complex profile in an area of about 300 ha is recommended.

The tract “Gorelka ravine” near Gorelka village has the coordinates 51.38638° N, 42.69871° E. The ravine is U-shaped, shallow (10 m deep), with length of about 6-7 km and a width in of up to 600 m. It locates on the left bank of the Khoper river several km south of Makashevka ravine and formed with thick layers of the Neogene and the Quaternary sedimentary rocks. Near Gorelka village Lower Cretaceous sands protrude from under the Quaternary sediments. In that territory the role of the Oka glacial period moraine is especially visible [6]. In the tract the following endangered species identified: *Stipa zalesskii*, *St. pennata*, *Iris pumila*, *Stipa lessingiana*, *Echium russicum*, *Astragalus macroopus*, *A. pallescens*, *A. sareptanus*, *Gontiolimon tataricum*, *Allium pascoskianum*, *Jurinea multiflora*, *Ferula tatarica*, *Adonis volgensis*, *Tulipa biebersteiniana*, *Iris halophila*, *Campanula altaica*, *Hyacinthella leucophaeae*, *Astragalus ucranicus* etc.

Finds of two regional indigenous species have a significant botanical and geographical interest. They are *Astragalus albicaulis* and *Allium lineare*. For *Allium lineare* it is the third habitat in Voronezh oblast and it locates 130 km northeast away of the nearest previously known habitat. *Astragalus albicaulis* is a calcicole plant and a dominant of chalk downs in the south of the oblast. In the tract it grows on washed-out chernozems of the ravine slopes. Organization of a natural monument of a regional level with a complex profile in an area of about 620 ha is recommended.

The tract “Vyazovaya ravine” near Ogoryov khutor, 6 km east of Krasnoflotskoye village has the coordinates 50.07326° N, 41.30601° E. The ravine locates on the right bank of the Matyushina river. It is situated on the border of the maximum of the Quaternary Ice Age within the South Kalach left bank gully-ravine steppe district of The Central Russian Upland. Its deep-incised (20-25 m deep), a width is...
up to 200-300 m, slopes are relatively gentle and slopes are completely matted. The main relief-forming rocks are chalk, marl of Turon and Senon covered with a low-power layer of the Paleogene boulder clay sediments. In land cover lightly washed-out chernozems dominate. Vegetation is bunchgrass steppes. The following endangered species identified here: *Stipa pennata*\(^*\), *St. zalesskii*\(^*\), *St. pulcherrima*\(^*\), *St. dasyphylla*\(^*\), *Paeonia tenuifolia*\(^*\), *Bulbocodium versicolor*\(^*\), *Iris aphylla*\(^*\), *Genista tanaitica*\(^*\), *Tulipa biebersteiniana*\(^*\), *Adonis vernalis*\(^*\), *A. volgensis*\(^*\). On the ravines slopes sporadically occurs *Astragalus hemingii*. It is the third habitat of a species in the region with the largest cenopopulation. Floor of the ravine occupies with a rare in the region species *Tulipa patens*. Organization of a natural monument of a regional level with a complex profile in an area of about 40 ha is recommended.

The tract “Krutoi Yar” lies south-east of Makasheva Krasnolutskoye village and have the coordinates 50.07313° N, 41.30677° E. It locates not far from Vyazovaya ravine on the left bank of the Matyushina river and occupies southwestern slope of a short (4 km length) and narrow ravine. Seven species of *Stipa* observed here. They are *St. pennata*\(^*\), *St. capillata*, *St. tirsa*\(^*\), *St. dasyphylla*\(^*\), *St. zalesskii*\(^*\), *St. pulcherrima*\(^*\) and *St. ucrainica*. Some more endangered species identified here: *Bulbocodium versicolor*\(^*\), *Ornithogalum kochii*\(^*\), *Astragalus macropus*\(^*\). Plant species composition is about 350 species in total. Organization of a natural monument of a regional level with a complex profile in an area of about 60 ha is recommended.

The Chalk downs of the southern exposure at Novobelaya village have coordinates 49.83628° N, 39.29405° E. The chalk downs occupy the right bank of the Belaya river and lie within the Boguchar right bank billowy-ravine steppe district of The Central Russian Upland. During the Dnepr glacial period the territory was in the periglacial zone and was strongly influenced by fluvio-glacial powers [6]. A landscape specific of a territory determines by its location in a steppe zone. In that tract a landscape forming role of chalk rocks is well expressed. That’s associated with a development of carbonate landscapes with rare and relict plants. Ordinary chernozems dominate in a land cover but lithological and geomorphological features of the territory have led to mosaic and wide dissemination of washed-out typically stony soils.

On the chalk downs of south and south-west exposures near Novobelaya village occurs *Scabiosa isetensis*. The habitat of that species found in 1996 and its identification confirmed a corresponding member of the USSR Academy of Sciences, Dr. Sci. Biol. V.N. Tikhomirov. It is the one not only for Voronezh region, but also for the Central Chernozem region [7]. According to the observation dated 17.07.2020 cenopopulation of *Scabiosa isetensis* near Novobelaya village is in good condition. The sampling area 10x10 m had 127 flower beds measuring 30, 40, 50 cm in diameter, 20-40 cm high and projective cover about 55%. The other endangered species observed here. They are *Stipa pennata*\(^*\), *Silene cretacea*\(^*\), *Matthiola fragrans*\(^*\), *Hedysarum grandiflorum*\(^*\), *Hyssopus cretaceus*\(^*\), *Artemisia hololeuca*\(^*\), *A. salsooides*\(^*\), *Scrophularia cretacea*\(^*\), *Erucastrum cretaceum*\(^*\). Plant species composition is about 300 species in total. Organization of a natural monument of a regional level with a complex profile in an area of about 50 ha is recommended.

4. Conclusions

Relict steppe landscapes of Voronezh oblast usually cover small territories and sporadically found among farmlands. Many of them do not have a protected status and local people do not know about the value of these territories. Therefore, every year their number and area reduce due to plowing, construction works etc. Meanwhile, steppe landscapes with well-preserved vegetation cover remain storehouses of valuable medicinal, food, decorative and a number of other plants categories useful to humans. Moreover, it is possible to use them as objects of ecological tourism. This is especially important due to implementation of the federal project “Conservation of biological diversity and development of ecological tourism” of the national project “Ecology” in 2018-2024.

The perspective protected areas are distinguished by high floristic diversity, a presence of a large number of plant species of the Red Data Books of Russia and Voronezh oblast and low anthropogenic transformation of the territory. Furthermore, in their floras there are rear species with the main part of
natural ranges lies far away from the region, e.g. *Scabiosa isetensis* near Novobelaya village. If these territories will receive the conservation status than individual plans of their development can be prepared. To conserve relict steppe landscape on local and regional levels the following actions are recommended: 1) improvement of legislation base in the nature conservation sphere; 2) promote the observance of regulated mode on the protected areas; 3) interactive process between the scientific community and the interested public with the local authorities; 4) introduction of a rational vegetative reclamation methods on anthropogenically transformed territories; 5) trend analysis and assessment of the impact of climate change; 6) use of scientific approaches in new technologies for the biodiversity of landscapes development.

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