Monitoring and current state of geoecosystem of broadleaf forests of Podolsk region within the protected natural areas

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Abstract. The paper considers the present state of forests of Podolsk region within specially protected areas. Unfortunately, within the studied reserve the strict requirements of preservation and protection of broadleaf forests of the studied territory are not always fulfilled. The authors of the paper describe in sufficient detail the existing problems of the reserve. Measures for further monitoring of the geosystem are proposed.

1. Introduction

The published materials of academician Gerasimov I.P. and Israel Yu.A. report that at present the hydrometeorological service will have to significantly expand its functions to control the environmental pollution. Their work should be supplemented by some monitoring services for phenological observations in reserves, specially protected areas, agrometeorological monitoring and epidemiological surveillance at agriculture stations. The paper emphasizes the peculiarities of geosystem monitoring and defines its conceptual view.

It is “a system of targeted control observations and development of certain natural (reference) ecosystems, effective design and stable functioning of optimal geo-ecosystems of different economic importance” [1–5].

The monitoring objectives are as follows:

• for natural ecosystems – control over full reproduction with high yield power;
• for agrosystems – control over full use and extended reproduction of natural soil fertility;
• for recreational systems – control over optimum balneological condition of the environment.

The concepts of background indicators of biosphere monitoring corresponding to natural indicators were also introduced. Specially protected areas require continuous attention of scholars, and their monitoring is consistently maintained.

Such attention is caused by the fact that there are significant sources of negative anthropogenic influence on breeding grounds. Most often these territories are exposed to littering and dirt, careless handling of fire, burning of dried grass, forest cover, forest and meadow fires.

Cars and other vehicles enter the territory of the reserves; they move off-road across the reserves. On the one hand, they serve a factor of concern for animals, and on the other, they disrupt soil and plant cover. Reserves are influenced by human activity due to the harvesting of wild plants.
Often roads and other communications are laid on the territory of reserves, unauthorized construction, increasing recreational impact and extraction of mineral resources are becoming quite normal [6, 7].

2. Materials and methods

The state of the geosystem of the Broadleaf Forests of Podolsk Region reserve was assessed on the basis of long-term studies of protected species of plants and animals. The studies included data on key ornithological areas, forest genetic reserves and valuable soil sites. Data of the Ministry of Ecology and Nature Management of the Moscow Region, data of the Russian Birds Conservation Union and data of the Ministry of Forestry entered into the Red Book of the Russian Federation are also available [5–7].

3. Results and discussion

Considering natural ecosystems for specially protected natural areas as a reference, the geosystem of the Broadleaf Forests of Podolsk Region reserve of the Moscow Region is considered below taking into account the geographical peculiarities of the territory.

Crystalline basement created by metamorphic rocks that are formed under the influence of high temperatures and pressure can be found at its base at a more than a kilometer depth. It was formed in the Archean and Lower Proterozoic about 1.5–3 mln years ago.

The thickness of sedimentary rocks is located on it in the form of a sedimentary cover. The deposition of crystalline rocks was disturbed by slow lowering and elevation at different sites. The greatest correspondence is typical for parts of valleys that are located above the faults. Here the sections contact the basement depth sections. In the Late Proterozoic (more than 600 mln years ago), a sedimentary cover was formed under marine conditions (surface lowering). Sand and clay with a capacity of 350–500 m were accumulated.

At the beginning of the Paleozoic the territory was slowly raised and over the next 170 million years there was land. Thus, as a result of erosion processes, some of the ancient sediments disappeared. In the Early Devonian (400 mln years ago), due to the next descent, the region was transformed into the sea bottom. Various rocks were deposited in both Devonian and Carbonic periods forming sedimentary sea covers (carbonate rocks consisting of calcium carbonate and dolomites). They became the main rocks of these shallow sea periods. Debris have been accumulated over millions of years of the sea existence. Within the considered area, modern limestone is often exposed. Fossils and prints of invertebrate animals of the Carbonic period (sponges, corals) can also be found [5].

In the Permian period the sea withdrew to the Urals. The territory became land for more than 110 mln years. Erosion dissolved limestone thus forming karst, increasing elevation changes and creating deep river valleys. However, the new sea invasion again had an impact on the deposits already in the Jurassic and Cretaceous periods. Sands and clays with either grey or dark color are found in the sediments. The landslides appeared in the place of Jurassic clays. The studied area felt the new tectonic lifting about 80 mln years ago. Then the clays of the Jurassic began to prevail in the watershed. Cretaceous sand deposits also came to the surface.

Valleys were formed during that period with carbon limestone. Nevertheless, the Quaternary period of the Cenozoic era led to significant changes in the studied area. The sheet drifts that descended from the Scandinavian Mountains of the Fennoscandia entered and left the territory several times. The glaciers brought debris from Scandinavia in the form of pebbles and boulders. Ice drifted sand and clay of more ancient eras. The relief was smoothed because of the slow-flowing ice. There was a new uneven relief with the accumulation of debris. If the glacier stopped, then it accumulated hills and beds in the form of moraines at its edge. The meltwater stream from the glacier deepened the river valleys. If river valleys were closed with ice, the lakes were formed. There were three glacial periods with lower, middle and upper moraines [5].

During Oka glaciation (about 400–500 thousand years ago), the moraine covered the interstream area thus giving rise to a monticulate-morainic relief. The Lichvin interglacial period, which existed for about 150,000 years, replaced the Oka glaciation. The period was characterized by a warm climate,
which was more mild, wetter and warmer than the modern one. The glaciation led to a new lowering of the surface. The glacier fell into fields of the dead ice. A moraine with small thicknesses was formed. The Odintsov interglacial existed for about ten thousand years. The climate was mild and humid during that period. Although the Moscow glaciation (190–170 thousand years ago) was quite strong. It was it that destroyed the traces of previous rainfall, but was quite short.

The relief of Podolsk region was transformed under the influence of the aqueo-glacial flow. The soils of broadleaf forests were created already in Late Moscow period. The natural boundaries that predominate in the area under study today represent flat and wavy lake-aqueo-glacial plains.

The area of broadleaf forest reserve is now representing plains of clay loam mantle formed during the previous periods. The slopes are 1–2, less often 3–5. The heights above sea level range from 136 m (Petritsa River) to 173 m at elevations. Erosion forms – troughs, draws, ravines, floodplains – are well expressed. The width of troughs is not more than a few meters with a depth of up to 1 m. The middle parts of ravines are 35–45 m with a width of 2–3 m. The height of slopes is up to 6–9 m. The slopes are convex-concave with a gradient of 9–20 degrees. Rills with sods and tree vegetation are typical for ravines and draws. Temporary streams flow along the bottom.

The Petritsa River sometimes reaches a width of 140 m. On its left bank there are some segments of floodplains at an altitude of up to 1.5 meters from the river bed edge. On the concave parts of the river bank, the floodplain is not expressed. The drain within the area under study is directed into the Mocha River, which is a tributary of the Pahra River. The right tributary of the Petritsa River is the Zhestvenka River with a width of up to 80 m. Temporary streams flow through the bottoms and ravines. There is a small low-lying swamp measuring about 3 hectares between the hills on the northern part of the reserve. The largest pit in the reserve is adjacent to the swamp in the north-east [5, 7].

On elevated and slope territories there are sod-podzolic soils alternating with grey soils. The sod-podzolic-gley soils are located in depressions. In water-logged draws and ravines, on their bottom, there are humic gley soils. There are light humus soils on floodplains. Low level swamps have peat eutrophic soils. Broadleaf mature forests with oaks and limes, hazelnut, mixed herbs, with secondary aspen-birch forests in combination with oak and lime are typical for described reserve.

Besides, there are also small-leaved forests with grey alder, bird cherries, aspen, goat willow, pine and spruce. There are sections of spruce-oak forests with mixed herbs. Wet meadows are presented only within a single lowland swamp. There are areas with lime forests, sometimes – oak forests. There are single examples of maple trees in the area. The diameter of lime trunks is 40–45, oak – 45–50 cm. The age of these trees is about 100 years. Multistemmed shrubs of hazel, fly honeysuckle, wartbark euonymus are found in the undergrowth. There are bird cherries and coppice limes. Archangel and goutweed prevail in the grass layer, there is a lot of piliferous sedge, unclear lungwort, coughwort, Kashubian buttercup, windflower. In certain areas there are many wood horsetails, pileworts, throatworts and roof avens, wood sedges and great starworts. There are also some examples of male fern, bitter pea vine, nemoral bluegrass, herb Paris and viola, Eurasian Solomon’s seal, bird’s-nest orchid, wood geranium, flaccid melic, giant fescue. The oldest oaks are confined to slope edges. Piliferous sedge and Great Bellflower, baneberry and paradox viola are plentiful among the mixed herbs [6–9].

Golden saxifrage, swamp hawksbeard, female fern, gill-ale and spotted dead nettle grow on ravine bottoms. The lily of the valley is quite rare. In broadleaf forests, spruce is rare in the second tier. Ash, elm and lime are found on small sections of temporary streams. Whitebeam occurs in the northern part of the reserve. Grey alders, aspens, bird cherry trees also grow in the valleys of the Petritsa River on the lower parts of its banks. Old spruce also grows here. On small floodplains it is possible to see black alder, Dutch-rush, buttons, wormwood, motherwort, wild angelica, ippecac, beakcervil, awwless brome, cocksfoot, and on especially wet areas – lime grass, wood clubroot, ipecac. There is goutweed, mercury, archangel, wild ginger, buttercup, pilewort, meadowsweet, nettle in the grass layer.

There are 68 species of vertebrate animals on the territory. Amur sleepers and crucian carps are found in water bodies. Grass frog, cuckoo, false spiraea, blackbird, robin, blackcap, chiffchaff, oriole, tit, field mouse, Alpine hare, and squirrel live in forests. Besides the above species, corncrake, yellowhammer, tree pipit, whinchat, grey stiff-tailed duck, starling, common magpie, nuthatch, and
bullfinch live in forest edges. Throughout the reserve there are foxes, stoats, weasels. Sometimes there are elks and boars.

The reserve of Podolsk region with protected ecosystems was identified due to long-term monitoring. These ecosystems include lime-oak and oak-lime Corylaceae forests of mixed herbs. It also includes pure lime wood, oak-lime with maple hazelnut slope forests with mixed herbs, spruce-oak hazelnut forests with mixed herbs, reedgrass-cane-sedge swamp. The following rare and vulnerable species of animals, plants and mushrooms listed in the Red Book of the Moscow region: ordinary honey buzzard, green snake, black and blue slug are particularly protected. The species of living organisms representing rare and vulnerable taxa are not included into the Red Book of the Moscow region, but require continuous control and observation: badger, small Apatura, white admiral, dusky meadow brown [6, 7, 9].

The following rare and vulnerable species of plants require continuous control and observation: hautbois strawberry, Great Bellflower, common spotted orchid, bird’s-nest orchid, throatwort, peach-leaved bellflower. There is a need for continuous protection of mushroom species included into the Red Book of the Moscow region – coralloidal barnyard grass [5–8, 10].

The above description of the Broadleaf Forests of Podolsk Region reserve indicates the following regime of special protection of the territory taking into account its continuous monitoring. Hiking, skiing, cycling and equestrian walks are allowed without the use of motor facilities and the construction of sports facilities; competitions and health activities only within existing paths. The following is allowed: conservation, protection and reproduction of forests according to their purpose (protective forests), selective sanitation cutting, cleaning of quarter, boundary glades, glades of existing communication routes; any forestry and landscape activities for cultivation of forest cultures in the territory of forest nursery, mushroom foraging and berrying, mowing; operation, repair and reconstruction of existing communications (except for spontaneous dirt roads), engineering facilities without right-of-way expansion; laying of tourist trails and routes within existing trails, arrangement of artificial nests, log houses, bird boxes, self-feeding stations. Photographing and video, scientific research corresponding to the tasks of the reserve are also allowed.

However, currently there are prohibited activities in the territory of the reserve [8, 10]:

**The following is excluded:**
- improvement, construction of health and fitness, sports and technical facilities (any construction, laying of roads and other communications);
- erection of non-capital buildings (bandstands, inventory storage facilities); installation of temporary buildings;
- any cuttings other than selective sanitation cuttings, any cuttings and removal of wood between 1 March and 30 November; any cutting of broadleaf breeds, any destruction and damage to trees and shrubs;
- operation, repair and reconstruction of existing communications and engineering facilities within their right-of-ways; arrangement of tourist stations, laying of tourist trails and routes beyond the scope of sports festivals and training camps by way of sports outside the existing road and trail networks.

**The following is prohibited:**
- activities that can lead to pollution of the reserve, including aerial distribution of chemicals, use of chemical agents for pest control (except pheromone traps);
- chemical activities to control plant diseases, weeds and low-value tree and shrub species;
- storage of toxic chemicals, mineral fertilizers, fuel and lubricants, manure and garbage, littering and pollution of the reserve;
- driving into and through the territory using motor vehicles.

It is prohibited to make fires, listen to audio devices without headphones, perform drainage amelioration, carry out exploration activities, explosive works.

It is prohibited to enter and travel across the territory by motor transport. It is not allowed to collect wild plants, dig and transplant them, remove protected animals and mushrooms, plant exotic plants in the territory of the reserve.
In order to ensure the efficiency of the reserve, it is necessary to carry out a number of measures to inform all interested organizations and persons about the regime and boundaries of the reserve, to establish information barriers, collect and remove garbage from the territories, monitor the compliance with the protection regime of the territory of the Broadleaf Forests of Podolsk Region [6–8, 10].

4. Conclusion
The above description of the Broadleaf Forests of Podolsk Region reserve indicates a certain regime of special protection of the territory taking into account its continuous monitoring.

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