The anthropogenic impact on coniferous-deciduous forests of Moscow region

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Abstract. The paper analyzes the state of the green zone in Novoseltsevo village, Mytishchi urban district, Moscow region. Unorganized development of the territory has suppressed the stand and grass-dwarf shrub layer, which can lead to irreversible consequences and large economic losses. The authors suggest implementing measures for improving the green zone and rehabilitating tree species, building roads and creating a path network for vacationers, preserving green spaces and creating a comfortable environment for the population. The research contributes to the improvement of active recreation of the population in order to improve citizens’ health.

1. Introduction

By the beginning of the twentieth century, the main factor holding back the industrial development of Moscow was the lack of food and industrial water. This issue became especially acute after the transfer of the capital from Petrograd to Moscow and subsequent industrialization in the country. In the thirties of the last century, this issue became especially acute, since the Moscow water supply system was not able to provide residents with drinking and industrial water. To solve this issue, it was decided to use resources of the Volga River, which eliminated transport problems.

In the Soviet era, the Moscow canal performed a recreational function. In specially designated places along the banks, recreation centers and sanatoriums, hotels and fishing bases were built. In total, more than a hundred objects were built for the recreation of workers. During the construction, all environmental requirements were met, and mass recreation was prohibited in places not intended for recreation.

The situation changed radically in the 1990s. With a new economic formation, most of the objects were privatized, buildings were demolished and cottage settlements were constructed in violation of sanitary rules.

Over the past 25 years, the population of Moscow has almost doubled, and according to some data already exceeds fifteen million people. This population density creates an uncomfortable environment, reduces the efficiency of human activity and causes to stressful situations.

Therefore, the issue of mass recreation of the population is acute. Green zones near water bodies, which simultaneously perform health-improving and recreational functions, are required. Thus, spontaneous places of mass out-of-town recreation of the population began to appear.
However, an analysis of the state of new recreation areas showed that they require comprehensive measures aimed at the rational use of forest lands. [1]

2. Materials and methods

Forest studies in the water protection zones of the Moscow Canal were carried out using the landscape-ecological method; in the subzone of coniferous-deciduous forests with sod-podzolic soils, the studies were carried out by choosing sites with a field description of landscape components.

3. Results and Discussion

Peculiarities of the natural and cultural complexes of the northern, eastern, southern and western parts of the protective forest-park belt of Moscow are associated with the physical and geographical zoning of the territory. In Moscow, the boundaries of three physical-geographical (landscape) provinces converge. The western and northern parts of the forest-park protective belt are included in the Smolensk-Moscow landscape province, the eastern one - in the Meshcherskaya province and the southern one - in the Moskovsko-Oka province. The landscapes differ in relief, vegetation cover, natural resources, direction and intensity of economic use.

When characterizing the value of natural complexes for recreation, properties of landscapes are assessed to meet recreational needs. Therefore, specific characteristics of the recreational system are capacity, stability, and reliability. [2, 3]

The following requirements are imposed on the technical subsystem:

1. Meeting specific recreational needs;
2. Ensuring the livelihoods of vacationers and service personnel. There are technical systems used by vacationers directly (housing, vehicles, cafes, etc.) and indirectly (water supply warehouses, gas pipelines, treatment facilities, etc.). When describing technical means, construction standards are used.

The functions of the service group are as follows:
1. to produce, collect, preserve and deliver consumer products to vacationers;
2. to remove waste. The subsystems are managed by foresters.

The unity of all subsystems of the recreational system is reflected in the functional zoning of the territory of forest parks and design and planning solutions. Recreational systems can be complex and industry-specific: medical, tourist, sports, etc.

For recreation in forests near Novoseltsevo along the bank of the Moscow canal, a recreation area was created.

Forests located along the banks of the Moscow Canal perform sanitary and water protection functions; they are not intended to perform recreational functions. However, in recent years they have enjoyed great popularity, which has created an excessive anthropogenic load. The forest belt with a width of 150 - 250 meters is located on a hill that was formed as a result of excavation during the construction of the canal. The soils are sandy loam and underlain by sand at a depth of 80-100 cm. Accordingly, the excavated soil is sand. Pine forests were planted to strengthen the canal banks. The average age of the plantings is 70-80 years.

On the one hand, the forest borders on the canal; on the other hand, on power lines separate it from the also artificially planted forest composed of small-leaved trees (birch, linden). In the center of the forest there is a road connecting two villages.

The landscape is a half-open space of the thinned stand with an even distribution of trees. [3] The trees were originally grown in light conditions and formed wide crowns.

The first class of aesthetic assessment was represented by coniferous plantations on dry soils, with wide and dense crowns, good permeability and developed undergrowth. The herb-shrub layer was represented by herbaceous plants. The compositional center is the edge of the forest, overlooking the Moscow Canal.

Until 1991, this territory belonged to restricted facilities and was not subjected to large anthropogenic impacts.
In 1991, this territory was assigned to the forest-park part, which is used for mass recreation of the population.

The proximity to Moscow, the high aesthetic and sanitary-hygienic value of the site, reservoirs, high cross-country ability could not but become an attractive vacation spot for people.

Due to its location on a hill and sandy sediments, there are no puddles and mud, people can enjoy pure pine air; beauty of the landscapes attract mushroom pickers. On weekends and holidays, there are from seven to fifteen visitors per hectare of forest.

Types of recreation activities that are currently popular are as follows: picnics, beach activities, berry and mushroom picking, fishing, skiing, paintball, riding quads, etc. In the recreation area, on the bank of the Moscow Canal, there are two cafes where various events are held - discos, weddings, etc.

At present, measures for improving the recreational area and reducing the negative impact of anthropogenic loads are not sufficient. Only tables and benches rented to vacationers have been installed. Garbage is collected. But the main measures aimed at improving the territory are not implemented (e.g., road and path network construction, parking facility construction, etc.). There are no ecological and educational trails.

With such an anthropogenic load, the road and path network should occupy up to 20% of the territory, and only then it will be possible to receive more people.

Visitors damage the forest biocenosis in the following way:
1. making fires on the ground, since there are no special places;
2. people driving close to the green zone, thereby compacting the soil and destroying the grassy cover.
3. ATV riding which destroys the grass-shrub layer.
4. due to the lack of sports and playgrounds, sports games are played almost anywhere.
5. due to the lack of health paths, ecological paths, people create an excessive load on the soil and vegetation cover.

For more than twenty-five years, the stability of plantings has significantly decreased. The undergrowth is absent, the living ground cover is trampled down to a sandy base, the soil has been strongly compacted. Many trees have been mechanically damaged; there are bare tree roots on walking paths and only 80% trees are healthy.

Such indicators correspond to the third class on the plantation sustainability scale, which reflects the general condition of the plantation and shows their ability to withstand adverse anthropogenic influences leading to the premature death of vegetation. [4–6].

The next indicator is the stage of recreational digression of forest soil which makes it possible to identify changes in the forest biocenosis under the recreational loads. Changes in the forest environment are of a medium degree. The undergrowth is absent. There are no ill trees, no more than 20% of trees are dying.

Thus, according to the trampled ground cover and absent undergrowth, the stage of digression can be attributed to the fourth class. And according to the state of the stand, it can be attributed to the second class of digression. Undergrowth, healthy ground cover can be observed only in hard-to-reach places where it is inconvenient to arrange a place for a picnic or walk. According to all norms, areas with a degree of recreational digression higher than the fourth class should be excluded from the recreational areas, since plantations and ground cover will not be able to recover on their own. [7–10]

An example of the rational use of forest and water resources is the Khlebnikov forest park, located on the diametrically opposite side of the Klyazma reservoir. Thanks to the landscape and architectural activities, there picturesque landscapes which, together with various types of recreation activities, including the water ones, attract many visitors, but there are no negative effects on the ecosystem.

4. Conclusion
Thus, an analysis of the state of the Novoselki recreation area shows that it needs comprehensive forestry and reforestation measures. It is also necessary to develop measures aimed at the improvement of the recreation area. The recreation area needs parking facilities, a road and a path
Moreover, there are all conditions required for this - a picturesque area, a water basin, a healthy microclimate, proximity to the city. Such measures can increase the number of visitors without damaging the recreational area.

An excessively high concentration of vacationers in the forest contributes to the degradation of forest communities and has a negative effect on the sanitary, hygienic and protective functions. According to the All-Russian Research Institute of Forest Mechanization, the average annual permissible loads for mixed forests are 1.5-2 people/ha, and for forests specially used for recreation purposes - 10-30 people / ha. On the recreational territory, it is necessary to create functional zones: an active recreation area, a walking area and a faunistic rest area. Fire prevention information stands, signs and notices should be installed. When creating biogroups, one should take into account the degree of gas resistance of rocks to anthropogenic loads (Table 1).

**Table 1. Gas resistance of trees and shrubs**

| Trees and shrubs   | Sanitary and hygienic properties | Gas resistance |
|--------------------|----------------------------------|----------------|
|                    | Dust collecting                  | Reducing direct solar radiation | Phytoncidal | Bactericidal | Sulfurous anhydride | Nitrogen oxides | Ammonia | Phenol |
| Hanging birch      | +                                | +                            | 2           | 2           | 1                 | 2              |
| English oak        |                                  |                              |             |             |                   |                |
| Norway spruce      |                                  |                              |             |             |                   |                |
| Small-leaved linden| +                                |                              |             |             |                   |                |
| Scots pine         |                                  | +                            |             |             |                   | 2              |
| Bird cherry        | +                                | +                            | +           | +           | 1                 | 1              | 1       |
| Mountain ash       |                                  |                              | 3           | 3           | 3                 | 3              |
| Small-leaved elm   |                                  |                              | 1           | 2           | 2                 | 2              |
| Norway maple       |                                  |                              | 3           | 1           | 1                 | 2              |
| Juniper            |                                  |                              | 3           | 3           |                   |                |
| Hawthorn           |                                  |                              |             |             |                   |                |
| Common honeysuckle |                                  |                              | 3           | 2           | 3                 |                |
| Common lilac       |                                  |                              | 3           | 2           | 1                 | 2              |
| Currant            |                                  |                              |             |             |                   |                |
| Rose hip           |                                  |                              | 1           | 1           | 2                 |                |

Note: Points: 1 - weak, 2 - medium, 3 - severely damaged species.

The impact of unregulated recreational activities on the environment is multifaceted and ecologically hazardous. In order to comply with the environmental standards in recreation areas, methods have been developed for assessing and observing standards and norms of anthropogenic recreational loads on nature. [11–13] When assessing the recreational impact on the environment, the following factors are taken into account: types of recreation, zonal-azonal features of natural complexes, size, scale, nature, duration of impacts. Taking into account the types of landscapes, the degree of recreational stability and the stage of recreational digression were assessed. The maximum recreational load depends on these indicators. Recreational load indicators are calculated in person / ha for a certain period. Assessment of the recreational load provides grounds for establishing the attendance regime for park areas, ecological paths and tourist routes. [14–16]
Among other things, with further degradation of forest stands, the water protection function of forests will be reduced, they will no longer protect the soil from water and wind erosions. Restoration of the water-protective functions of the forest will require significant financial resources. Consequently, complex measures are crucial for recreation zones.

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