Ecosystem Approach to Assessing the State of the Urbanized Environment

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Abstract. The intensive process of urbanization has led to a number of environmental problems associated with a sharp deterioration in the quality of the urban environment. All this necessitates an objective assessment of its current state and knowledge of the mechanisms of functioning of systems in the interests of human ecological safety under the conditions of anthropogenic stress. Coniferous plants are used in urban landscaping. Under urban conditions, conifers perform the role of biological indicators, while the assimilation apparatus is a marker feature, which allows assessing the environmental conditions of urban areas. Pine (Pinus sylvestris L.) is used in gardening of city streets and recreation areas. At the same time, pine ordinary responds to the effects of the urbanized environment. The results of the assessment of the state of the air environment by the dendroindication method based on the morphological features of conifers showed that of the 22 surveyed objects, only 3 of the air condition are estimated to be clean in the area village, the main building of the Siberian Federal University and on Botanical Boulevard. At two sites, the state of the air environment is estimated as clean, three - relatively clean. These objects are located on the periphery of the city, one of them in the valley of the river. On the remaining objects, the state of the air environment is estimated from polluted (5 objects), dirty (6 objects) to very dirty (2 objects).

1. Introduction
In complex environmental conditions of cities, green spaces perform a number of important functions: medium-forming, sanitary-hygienic, recreational, largely determining the degree of comfort of the urban environment and, consequently, the health of residents [1, 2, 3]. One of the main problems of cities is pollution of the environment, and especially of atmospheric air [4]. In recent years, Russia is actively forming guidelines in the direction of humanizing the urban environment. The priorities are comfort, safety, attractiveness and continuous improvement of pedestrian spaces, which are tools for improving the quality of life in cities and a means of addressing the social, economic and environmental aspects of their sustainable development. Coniferous plants are used in urban landscaping, among which common pine (Pinus sylvestris L.) has become widespread. Trees growing in the urbanized environment, take on gas and dust emissions from traffic flows and adverse changes in soil regimes (soil compaction and salinization, lack of oxygen, increased oxide content), which leads to a slowdown or cessation of their normal growth and development. Pine is a valuable tree for creating large urban and suburban parks, as well as forest parks, provided that there are no industrial
enterprises near them emitting harmful gases. It is used both in pure and mixed stands, arrays (in forest
parks), in groups and in the form of tapeworms. Despite its large size, it fits into the landscape design
of small objects (squares, gardens). It is effective both as a tapeworm and in group plantings with
deciduous and coniferous trees. However, it should be remembered that pine with age not only
changes, but also significantly increases in size. If this factor is not foreseen immediately when a tree
is planted in a group, trees can restrict one another’s living space, as a result of which the aesthetic
appearance of the group composition changes. It is undesirable to plant several pines in a small area.
With the growth of the plant, the lower branches die off; the trees are strongly drawn out and lose their
decorative effect. Of course, group plantings of pine ordinary look great, but they should be placed on
fairly large areas. In green building it has not only decorative, but also sanitary and hygienic values
due to the antiseptic effect of resinous volatile substances.

At the same time, it has been established that pine ordinary responds to the effects of an urbanized
environment. In trees in urban plantings, the height, the length of the crown decreases, the diameter
of the trunk, the width of the crown, density of spread, and the cross-sectional area of the needles
decrease. The fact of high sensitivity of coniferous trees was noted in many studies of foreign and
Russian scientists. Indicator plants can be used both to identify individual air pollution and to assess
the general state of the air environment [5, 6]. Thus, the state of an element of a biological system
reflects the impact on it of natural or anthropogenic factors and environmental conditions and can be
used to assess its condition. The ecosystem approach to the assessment of the environment makes it
possible to diagnose its changes.

2. Scientific significance

A promising approach to studying the quality of the urban environment, in general, and its individual
components, in particular woody vegetation, is the concept of environmental monitoring, which is
based on the organization of a system of continuous observations, analysis and forecast of its
condition. Periodic fixation of the state of landscaping objects and a comparative analysis of modern
materials with the preceding ones allow us to estimate the dynamics of the state of the studied objects,
changes in the quality and quantity of woody plants, and also to establish the causes of the processes
taking place [7]. Bioindicators are developmental organisms that serve as indicators of anthropogenic
changes in the habitat. They indicate the presence of a pollutant in the air or soil by early
morphological reactions - a change in the color of the leaves, various forms of necrosis, premature
fading and falling leaves. In perennial plants, pollutants cause a change in the size, shape, number of
organs, the direction of growth of the shoots, or a change in fertility. They accumulate in their tissues a
pollutant or harmful products of metabolism, formed under the action of pollutants, without visible
changes. When the toxicity threshold of a toxic substance for a given species is exceeded, various
responses manifest themselves, resulting in a change in the growth rate, biometric indicators and,
ultimately, a decrease in productivity.

3. Objects and methods of research

Based on this, we selected greening objects located in the city of Krasnoyarsk in various landscape
zones in areas with different levels of anthropogenic load, as close as possible to the environmental
monitoring posts [8]. Based on the tasks selected, twenty-two objects of landscaping were selected. An
environmental passport was compiled for each object of landscaping, which reflects the following
characteristics: the location of the object; wind conditions; anthropogenic load; the number of pine
trees, their sanitary and aesthetic condition; the distance from the planting of Scots pine to the
highway; the number of vehicles passing along the adjacent road per day. Surveys of the state of the
environment were carried out on the basis of the analysis of technogenic, recreational, author-transport
and urban planning loads.

Analysis of the results showed that motor transport makes the greatest contribution to the
environmental burden on the surveyed objects. The second most negative impact factor is man-made
loads from stationary sources of pollution (industrial enterprises), recreational, city-planning and
landscape conditions make a smaller contribution. At the same time, pine ordinary is very sensitive to high recreational loads and soil compaction. Thus, at 9 sites out of 22 plants grow in critical conditions of growth, 5 - in conflict, 6 - in tense and only 3 - in satisfactory. To assess the state of the urban environment, we used a method based on identifying the dependence of the degree of needle damage (necrosis and desiccation) on air pollution in the area of pines.

4. Results of research

In the course of studying the features of growth, morphological characteristics, life expectancy of pine needles, it was established that on the studied objects the difference in needle length is 73.83 mm (the maximum value is 101.63 mm, the minimum is 27.8 mm). At the study sites, the maximum age of the needles was 4 years and at the minimum - 1 year. Basically the age of the needles of plants is 2 and 3 years. The obtained data showed that the pine trees, which grow in the conditions of the environment, are assessed as satisfactory and stressful, have needles, which age is 3 - 4 years, while the needles have little or no damage. The trees growing in conditions of the phytomedium, the quality of which is estimated as conflicting and critical, the age of the needles is 1 - 2 years, with a significant part of the needles damaged.

The results of assessing the state of the air environment by the dendroindication method based on the morphological features of conifers - the extent and nature of damage to the pine needles of Scots pine - showed that of the 22 objects surveyed only 3 showed the condition of the air environment as perfectly clean in the area of the village of Udachny, the main building of the Siberian Federal University and Botanical Boulevard. These objects are located at a considerable distance from the central part of the city, they are located on its windward side relative to the prevailing south-westerly wind, next to large tracts of natural vegetation. At two sites, the state of the air environment is estimated as clean, three - relatively clean. These objects are also located on the periphery of the city, one of them in the valley of the river. On the remaining objects, the state of the air environment is estimated from polluted (5 objects), dirty (6 objects) to very dirty (2 objects). At the same time, one of the studied objects is located in the zone with low background environmental pollution (Botanic Boulevard), but on the dividing strip of the road. The reaction of pine needles has shown that the state of the air in the roadside on both sides of which the traffic flow is estimated to be dirty. It should be noted that the assessment of the state of the environment, performed by various methods, is consistent enough with the correctness, while the assessment by the method of biotesting gives a clear gradation.

5. Conclusion

The dynamics of responses of biometric parameters of Scots pine makes it possible to assess the ecological condition and level of degradation of the urban environment, as well as the limits of plant resistance to man-made pollution. The correspondence of the main parameters to the invariants of stability serves as a characteristic of their individual growth and reflects the degree of ecological risk of the territories. This provision is recommended to use in monitoring green spaces, as well as to assess the risk of environmental pollution of large industrial city of Siberia. The scientifically based information about the conditions of the phytomedium will allow the use of plant species that meet the landscape conditions and man-made loads, which will increase the level of sustainability, durability and decorativeness of green plantings in the urban environment.

References

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