Assessment of the dynamics of biodiversity of green spaces of Krasnoyarsk city

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Abstract. In large Russian cities there is a significant decrease in urban plantations, which negatively affects the environmental situation. In recent years, there has been a growing scientific interest in assessing biodiversity of green spaces. As a result, the analysis of the dynamics of the number of trees and shrubs in urban areas is a very relevant and practical issue. The work is based on research results for 28 years. The object of research was the green space of the city of Krasnoyarsk. An analysis of the assortment of intra-quarter plantations and a survey of the territory of the quarters showed that mainly the decrease in the number of trees and shrubs was caused not by negative environmental factors, but by the point development of the territory. As a result, it can be stated that the dynamics of green plant biodiversity in the urban environment is caused by a number of processes that can be either negative (reducing plant resistance, decreasing area) or positive (increasing the assortment of plants, improving the quality of care for green spaces).

1. Introduction

Urban plantations have a direct impact on humans. They perform aesthetic, psycho-emotional and sanitary-hygienic functions. Especially important is their role in large industrial cities. Urbanistic territories make it possible to fully determine the influence of anthropogenic factors on the development and growth of plants. The time period (dynamics) creates the conditions for the identification of resistant species that can successfully perform various functions in the urban environment.

The state of plantings of cities and suburban areas has been studied by a lot of scientists. The main researches in this area include assessment of urban green spaces in large industrial cities [1,2,10]. However, since the 90s in large Russian cities there has been a significant decrease in urban plantations, which negatively affects the environmental situation. A number of authors propose monitoring urban plantations to assess their landscape-architectural and environmental properties [3, 9, 10]. But specific data on the negative dynamics of the number of urban green spaces that occurred in the new socio-economic conditions since 1990 are not given in the literature.

In recent years, there has been growing scientific interest in assessing the biodiversity of green spaces [4-8]. As a result, the analysis of the dynamics of the number of trees and shrubs in urban areas...
is a very relevant and practical issue. These changes in the number of urban plantations will make it possible to plan green economy and predict the quality of the urban environment.

2. Materials and methods

The work is based on research results for 28 years. The object of the research was the urban greenery of the city of Krasnoyarsk on an area of 28.33 ha.

Inventories of 1990 and 2018 were carried out by a continuous count of trees and shrubs. A detailed description of the stands and research methods had been published earlier [2].

3. Results and discussion

On the basis of inventory data, passports of plantings of neighborhoods were compiled, which allowed us to study the dynamics of woody-shrubbery over 28 years.

Figure 1 shows the structure of plantings, including the area of lawns, flower beds and freestanding trees.

![Figure 1. The quarterly structure of green areas of Krasnoyarsk.](image)

The maximum percentage of the total area of the object (quarter) is occupied by two categories: green spaces (1.2-21.8%) and lawns (1.2-90.9%). Flower beds (0.0-0.2%) and detached trees (0.0-0.4%) do not significantly affect the structure of green spaces in the city of Krasnoyarsk. The average quarter area was 2.833 ha.

To assess the dynamics of trees and shrubs, data on the number of trees and shrubs in 1990 and 2018 were used. The difference in the number of trees and shrubs was estimated both in absolute units and in percent. Information on the dynamics of woody-shrubby vegetation is given in table 1.

Of the 10 surveyed quarters, only in the 8th quarter did the number of trees increase, which is 10% of the total. In three quarters (No. 6, 8, 9), the number of shrubs increased. In general, the number of trees decreased by 1012 pcs., and the number of shrubs decreased by 571 pcs. The data presented indicate the negative dynamics of the number of trees and shrubs (table 1).

| Quarter number | Number of trees, pcs. | Difference in the number of trees | Number of shrubs, pcs. | Difference in the number of shrubs |
|----------------|-----------------------|----------------------------------|------------------------|----------------------------------|
| 1              | 214                   | -22                              | 308                    | -215                             |
|                | 192                   | -10.3                            | 93                     | -69.8                            |
| 2              | 367                   | -259                             | 27                     | -19                              |
|                | 108                   | -70.6                            | 8                      | -70.4                            |
| 3              | 236                   | -163                             | 35                     | -20                              |
|                | 73                    | -69.1                            | 15                     | -57.1                            |

Table 1. The dynamics of woody-shrubby vegetation within the quarter.
In order to identify changes in the species composition of tree-shrubbery vegetation, a quantitative dynamic of trees and shrubs by species for 18 years has been revealed. An analysis of the above data showed that the most abundant species among trees were *Malus baccata* (-70.3%), *Betula pendula* (-69.9%), *Populus balsamifera* (-62.5%) and *Ulmus parvifolia* (-59.2%). A breed like *Sálix álba* has completely disappeared.

At the same time, over the past 18 years, such breeds as *Pícea púngens*, *Pópulus álba* and *Prunus maackii* have been planted in intra-quarter stands. These are highly decorative breeds and their planting increases the aesthetics of intra-quarter stands. The number of breeds increased from 10 to 12 species. In general, the number of trees decreased by 51.2%.

Of the species composition of shrubs, species such as *Syringa josikaea* (-61.7%), *Prunus tomentosa* (-60.7%) decreased most of all. Such breeds as *Berberis thunbergii*, *Ribes aureum*, *Rúbus idáeus*, *Ribes úva-críspa* and *Hippophae “Schuyskaya”* have completely disappeared. The number of *Rosa spinosissima* (by 29 pcs.), *Sambucus racemosa* (by 1 pcs.) increased (table 2). Species such as *Cotoneáster lucídus*, *Sorbaria sorbifolia*, *Rosa rugosa* appeared. In general, the number of shrubs decreased significantly (by 65.5%). The number of shrubs over 28 years decreased from 11 to 9. Their decorativeness has not changed, since, despite the planting of highly decorative shrubs for the period under review, there has been a significant decrease in the number of other, also highly decorative shrubs.

In general, the decline in tree-shrubbery over 28 years amounted to 1628 pcs., i.e. 58 pcs. per 1 ha. The annual decrease in the number of trees and shrubs was 2 ha per 1 ha.

An analysis of the range of intra-quarter plantations and an examination of the territory of the quarters showed that the decrease in the number of trees and shrubs was caused not by negative environmental factors, but by a decrease in the area of green spaces caused by point building, arrangement of parking lots, and installation of pavilions.

In addition, it should be noted that the number and assortment of trees and shrubs was influenced by the level of green economy of enterprises engaged in servicing the surveyed area. So, unlike the rest of the quarters in quarter 8, the number of trees and shrubs increased by 132 compared to 1990.

**Table 2. Assortment and dynamics of the number of trees and shrubs.**

| Assortment of trees and shrubs | Amount, pcs. | Dynamics |
|-------------------------------|--------------|----------|
|                               | 1990         | 2018     |
| **Trees**                     |              |          |
| *Acer negundo*                | 622          | 454      | -        |
| *Malus baccata*               | 603          | 179      | -        |
| *Populus balsamifera*         | 435          | 163      | -        |
| *Ulmus parvifolia*            | 120          | 49       | -        |
| *Betula pendula*              | 83           | 25       | -        |
| *Pícea obováta*               | 60           | 24       | -        |
| *Sálix álba*                  | 51           | 0        | -        |
| *Larix sibirica*              | 7            | 28       | +        |
4. Conclusion

In the new socio-economic conditions, there has been a sharp reduction in the number of urban green spaces. Urban ecosystems are affected by many negative factors of biological and anthropogenic origin. Urban plantings are prone to diseases and pests, due to the general weakening of plantings due to gas contamination and dustiness of the air, disturbed temperature conditions of the soil and air. But most often, the reduction in the number of trees and shrubs is due to construction with an unacceptable building density.

To assess the dynamics of intra-quarter stands based on inventory data from 1990 and 2018 for 10 quarters of the Central District of Krasnoyarsk on an area of 28.33 hectares, the change in the number of trees and shrubs was estimated by quarters, by species and as a whole.

The studies revealed a sharply negative dynamic in the number of trees and shrubs. Out of 10 surveyed quarters, only in one quarter (quarter No. 8) the number of trees increased, which is 10% of their total number. In three quarters (quarter No. 6, 8, 9), the number of shrubs increased. In general, the number of trees decreased by 1012 units, shrubs by 571 units.

The decrease in the number of trees and shrubs over 28 years amounted to 1628 units, which is 58 units per 1 ha. The annual decrease in the number of trees and shrubs was 2 ha per 1 ha.

The dynamics of the species diversity of trees during the study period is positive, the number of species increased from 10 to 12. According to the bushes, the dynamics of species diversity is negative, the number of species of shrubs over the 28 years decreased from 11 to 9.

An analysis of the range of intra-quarter plantations and a survey of the territory of the quarters showed that mainly the decrease in the number of trees and shrubs was caused not by negative environmental factors, but by a decrease in the area of green spaces, due to point building, the arrangement of parking lots, and the installation of pavilions.

As a result, it can be stated that the dynamics of green plant biodiversity in the urban environment is due to a number of processes that can be negative in nature (decrease in plant resistance, decrease in area) and have positive trends (increase in the assortment of plants, improve the quality of care for green spaces).
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