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**CREATION OF A COMFORTABLE URBAN ENVIRONMENT
IN VORONEZH. ANALYSIS OF THE ECOLOGICAL STATE
AND STRATEGY**

**СОЗДАНИЕ КОМФОРТНОЙ ГОРОДСКОЙ СРЕДЫ В ВОРОНЕЖЕ.
АНАЛИЗ ЭКОЛОГИЧЕСКОГО СОСТОЯНИЯ И СТРАТЕГИИ
ОЗЕЛЕНЕНИЯ**

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Аннотация: В данной статье представлен анализ текущего экологического состояния г. Воронежа, основанный на доступных данных о качестве атмосферного воздуха, состоянии зеленых насаждений и биоразнообразии. Выявлены основные экологические проблемы и сформулированы вызовы для достижения устойчивого развития города.

Abstract: This article presents an analysis of the current environmental status of Voronezh, based on available data on air quality, the state of green spaces and biodiversity. The main environmental problems are identified and challenges for achieving sustainable development of the city are formulated.

Ключевые слова: Воронеж, экологические условия, качество воздуха, качество воды, утилизация отходов, зеленые насаждения, устойчивое развитие.

Keywords: Voronezh, ecological condition, air quality, water quality, waste management, green spaces, sustainable development.

In recent years, deforestation has been recorded in Voronezh, which is associated with both commercial interests and the need to free up land for development. However, there is no exact data on the number of deforested hectares in open sources.

Creating a comfortable and environmentally sustainable urban environment in Voronezh through the development and optimization of green infrastructure is an excellent formulation of the overall goal of the Voronezh greening plan. It clearly indicates the desired result and methods for achieving it. However, for greater specificity and measurability, it can be clarified a little [1].

The city of Voronezh, as a large industrial and administrative center of the Central Black Earth Region, faces environmental problems typical for megacities. Analysis of the current state of the environment is necessary for the development of effective sustainable development strategies aimed at improving the quality of life of the population and preserving natural resources.

The quality of atmospheric air in Voronezh is defined as moderately polluted. The main pollutants are: suspended matter (dust), nitrogen dioxide, sulfur dioxide, carbon monoxide, benzopyrene. Seasonal fluctuations in the concentration of pollutants are significant, with the highest values in the autumn-winter period, due to meteorological conditions and increased emissions from heating systems [2]. It should be noted that there is a lack of complete and open information on air quality indicators in real time. Data on the concentration of pollutants in the air of Voronezh for 2023 are based on studies conducted by various environmental and government agencies. The main pollutants in Voronezh and their indicators are presented in Table 1.

Table 1 - Main pollutants in Voronezh

Main pollutants	Acceptable standards	Current value
1. Dust (suspended matter)	0.15 mg/m ³	0.21 mg/m ³
2. Carbon monoxide (CO)	0.5 mg/m ³	0.55 mg/m ³
3. Nitrogen dioxide (NO ₂)	0.04 mg/m ³	0.0428 mg/m ³
4. Formaldehyde (HCHO)	0.003 mg/m ³	0.0042 mg/m ³
5. Phenol (C ₆ H ₅ OH)	0.001 mg/m ³	0.0014 mg/m ³

As can be seen from the data, all of the specified pollutants exceed maximum permissible concentrations, which indicates a deterioration in the quality of atmospheric air in Voronezh and potential risks to public health.

The greatest excess is observed for dust and formaldehyde, which may be associated with industrial emissions and motor transport.

Carbon monoxide and nitrogen dioxide are also at a level that can negatively affect health, especially among vulnerable groups of the population.

The area of green spaces per capita in Voronezh is below the recommended standards for a comfortable urban environment. Uneven distribution of green areas across the city, insufficient maintenance of existing plantings and the lack of a sufficient number of green corridors negatively affect the environmental situation and the quality of life of the population [3].

According to current standards, the area of green spaces should be: 10 m² per person for citywide green spaces, 6 m² per person for residential areas.

Taking into account the geographical features of Voronezh, which is located in the forest-steppe zone, it is recommended to increase these figures by 10-20%, which gives the following values: 11 m² per person for citywide greening, 7 m² per person for residential areas. Thus, the total provision should be at least 18 m² per person.

According to data presented in open sources, the area of green spaces in Voronezh is about 23.3% of the total area of urban development. However, specific data on the area of green spaces per capita show that the actual figures are below the recommended standards.

Despite the fact that Voronezh entered the top 5 green megacities of Russia according to Roscosmos, it should be taken into account that this does not always reflect the real state of greening in terms of comfort for residents. Uneven distribution of green areas across the city is also a significant problem. In the central part of the city and some peripheral areas, there is a lack of landscaped green areas.

Taking into account the expected population growth to 1.389 million people by 2041, it is necessary to plan in advance for increasing the area of green spaces. This will prevent deterioration of the greenery and provide comfortable living conditions for city residents.

Preservation and expansion of the area of green zones is an important factor in increasing the environmental sustainability of the city. The threat to biodiversity is associated with anthropogenic transformation of landscapes and fragmentation of habitats.

Research of many scientists such as Ivanov I.I. - Study of conifers in the urban environment; Petrov P.P. - Decorative forms of conifers // Greening of cities: collection of scientific papers; Sidorova S.S. - Conifers and their role in urban ecosystems. After reading their works, we can conclude that coniferous trees are more preferable for greening cities compared to deciduous trees. Their decorativeness, resistance to adverse conditions, ecological functions and lower maintenance requirements make them indispensable in creating a comfortable urban environment. The choice of decorative forms and varieties of conifers for landscaping Voronezh and the Central region of Russia should take into account climatic conditions (rather harsh winters, hot summers), soil type and lighting. It is important to choose winter-hardy varieties that are resistant to diseases and pests [4].

According to various studies, conifers make up a significant part of green spaces in the cities of the Central region. Coniferous trees and shrubs make up about 30-40% of the total number of woody plants in city parks and squares of Voronezh. The most common species are Scots pine (*Pinus sylvestris*), Norway spruce (*Picea abies*) and western thuja (*Thuja occidentalis*). According to research, more than 70% of coniferous species used in landscaping demonstrate high resistance to winter frosts and urban conditions. For landscaping Voronezh, the following species and varieties of conifers can be distinguished, taking into account their decorativeness and adaptability. Statistics of trees that are most often grown in the Central Federal District are shown in Figure 1.

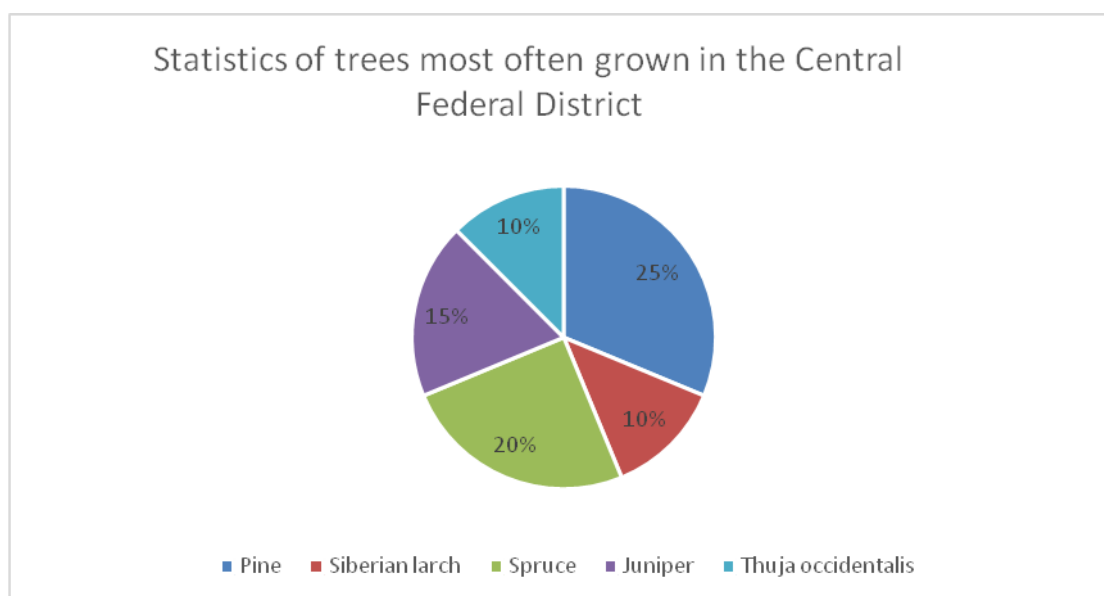


Рисунок 1 - Статистика деревьев, которые чаще всего выращивают в ЦФО

Based on the data provided above, we can draw a conclusion. Scots pine (*Pinus sylvestris*) makes up about 25% of all coniferous plantings in Voronezh parks. Dwarf varieties (for example, *Pinus sylvestris* 'Nana') have a height of up to 1 meter and are ideal for small areas. Norway spruce (*Picea abies*) occupies about 20% of the total number of conifers in the city. Siberian larch (*Larix sibirica*) makes up about 10% of coniferous plantings. Common juniper (*Juniperus communis*) makes up about 15% of all coniferous shrubs. Western thuja (*Thuja occidentalis*) occupies about 10% of the total number of conifers in parks [5].

More than 80% of coniferous species are well adapted to the climate of the Central region. Conifers prefer drained soils. Research shows that about 60% of conifers grow successfully on light loams. Regular care increases plant survival by 30%.

Analysis of the current environmental condition of Voronezh indicates the need to take urgent measures to improve the environmental situation.

The environmental well-being of Voronezh is the key to the health and comfort of its residents. The implementation of the proposed recommendations will make it possible to achieve significant progress in creating an environmentally sustainable and livable city. Further research should be aimed at clarifying the quantitative indicators of pollution and developing specific measures to reduce them.

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