



THE ROLE OF URBAN GREEN VEGETATION IN THE FORMATION OF CITY MICROCLIMATIC CONDITIONS

Sadullayeva Kh. A.

Salomova F.I.

Jiyemuratova J.

Tashkent State Medical University

Abstract

This article explores the ecological and biophysical role of green plants in shaping favorable microclimatic conditions. It analyzes how vegetation contributes to air purification, humidity regulation, temperature reduction, wind speed mitigation, and shading, thereby improving the human living environment. The importance of green areas in urban planning and landscape design, as well as their contribution to ecological sustainability and microenvironment enhancement under climate change, is also discussed. The research findings confirm that green plants play a key role in creating comfortable, healthy, and sustainable microclimates in both urban and rural areas.

Keywords: Microclimate, green plants, ecological sustainability, air purification, humidity regulation, temperature reduction, green areas, urban ecology, landscape design, climate change.

Introduction

Relevance

The rapid development of modern cities, rising population density, and the increasing number of vehicles and industrial facilities intensify air pollution, the urban heat-island effect, noise levels, and other environmental factors that negatively affect public health. Under these conditions, the degree of urban greening plays a decisive role in ensuring environmental stability and creating healthy living conditions for the population [1].

High levels of greening reduce harmful airborne pollutants, improve air circulation, and regulate the microclimate by mitigating elevated temperatures and infrasonic exposure. At the same time, green spaces are crucial for mental well-being, reducing stress, and encouraging physical activity. Consequently, the demand for scientifically grounded assessments of the distribution of green areas across functional urban zones and their hygienic status has been increasing in the fields of urban ecology and sanitation.





With rapid population growth, expanding construction, and rising ecological pressure, the reduction of urban green massifs is increasingly recognized by specialists as a serious concern. Failure to adhere to greening standards not only disrupts ecological balance but also increases the likelihood of respiratory diseases, allergic conditions, and cardiovascular disorders among the population [2,3].

From this standpoint, it is essential to carry out a comprehensive assessment of green space coverage in functional city zones, evaluate their impact on sanitary–hygienic safety, identify shortcomings, and develop scientifically based recommendations. The results of such assessments can improve urban planning policies, reduce environmental risks, protect public health, and support sustainable urban development.

Urban transport systems also exert a significant influence on the sanitary–hygienic condition of the atmosphere, water bodies, soil, biota, and living environments. This occurs through gas emissions, particulate pollution, noise, electromagnetic fields, and thermal pollution. Areas occupied by transport infrastructure are characterized by anthropogenic landscape transformation, structural fragmentation, and disruption of ecological continuity, all of which contribute to environmental degradation [4,5].

The high degree of landscape fragmentation caused by intensive land use prevents urban ecosystems from fulfilling their environmental and aesthetic functions. Rapidly urbanizing cities with high population density are losing their natural resources. In large and megacities, restoring natural landscapes and ensuring the required area of vegetation often requires repurposing unsuitable territories and rehabilitating degraded areas—processes that demand significantly greater investment compared to small and medium-sized cities with ample natural green zones.

Public green spaces play an essential social and cultural role, providing opportunities for recreation, outdoor activities, and aesthetic enjoyment. Therefore, ensuring the urban development and functional integration of healthy environments is crucial for improving the spatial organization of cities and enhancing residents' quality of life. The design and expansion of green infrastructure serve as key instruments in achieving these goals.

Vegetation complexes integrated into public spaces and transport corridors act as a “green filter,” meeting residents' daily needs for clean air, recreation, and interaction with nature, while also promoting physical activity. Urban green spaces are thus essential for eco-city planning and sustainable urban development [6,7,8].





Objective of the Study

The primary objective of this research is to conduct a comprehensive assessment of the ecological, biophysical, and sanitary–hygienic significance of urban vegetation in shaping the microclimate of cities. Additionally, the study aims to develop scientifically grounded recommendations regarding the optimal composition and spatial distribution of green areas to support urban environmental stability and promote public health.

Materials and Methods

The following materials were examined in the study: green areas located in various functional zones of the city (parks, squares, boulevards, street-side tree and shrub belts along transport corridors); microclimatic indicators such as air temperature, relative humidity, wind speed, noise levels, and concentrations of airborne particulate matter and gaseous pollutants (nitrogen oxides, sulfur oxides, carbon dioxide, etc.); landscape structure and fragmentation levels; transport flow density and its influence on the microclimate; as well as the sanitary–hygienic condition, species composition, density, and spatial configuration of green spaces.

The study employed the following methods:

Hygienic assessment methods: Microclimatic parameters (temperature, humidity, wind speed, and noise) were measured in accordance with State Standard and sanitary regulatory standards.

Atmospheric quality monitoring: Concentrations of airborne particulates, levels of gaseous pollutants, and variability in phytoncide activity were evaluated using portable analyzers.

Landscape–ecological analysis: The structure, area, fragmentation indices, and spatial relationships of green areas relative to transport corridors were evaluated through cartographic and spatial analysis.

Biological and biophysical analysis: The dust-retention capacity of vegetation, its impact on microclimate regulation, shading effects, and its role in shaping moisture regimes were investigated.

Literature review: International and national scientific sources (Scopus, Web of Science) related to urbanization, urban ecology, microclimate hygiene, and landscape design were analyzed.

Results and Discussion

Active recreational activities, including sports participation, reduce the incidence of cardiovascular diseases by nearly 50%, respiratory diseases by approximately 40%,





and musculoskeletal and nervous system disorders by around 30%. The use of recreational resources shortens temporary work incapacity by 3–4 days per person and increases labor productivity by 3%. The positive impact of green vegetation on urban residents is linked to its ability to absorb free carbon dioxide, chlorides, and fluorides; reduce dust, gaseous pollutants, and noise; and enrich the environment with oxygen and phytoncides [9].

Beyond fulfilling sanitary–hygienic functions, green vegetation also exerts significant emotional and therapeutic–psychological effects on humans. In an urban environment with limited natural diversity, the emotional state of residents is highly influenced by the color combinations of landscape elements. While modern city dwellers are predominantly surrounded by grey tones of concrete and asphalt, natural vegetation offers visually comfortable green hues alongside a rich palette of other colors. The green color of plants has been shown to exert a positive physiological effect on the human body [10].

Therefore, integrating vegetation into landscape elements helps form calming urban environments, reducing the intensity and contradictions of urbanized settings. In transport-dominated zones, where vehicle flows generate linear sources of noise and air pollution, the use of tree–shrub belts as protective green strips is a common design strategy. However, these solutions alone are often insufficient to significantly lower gas pollution levels or ensure adequate acoustic comfort in adjacent residential areas [11].

The environmental protection potential of tree–shrub vegetation in urbanized areas is fully realized when their structure and species composition are selected appropriately. Optimal placement—both relative to pollution sources such as transport flows and relative to sensitive facilities such as residential buildings, public institutions, preschools, schools, recreational areas, and healthcare facilities—plays a decisive role. Alongside effective planning solutions, urban landscape design must ensure high architectural–aesthetic quality and visual appeal. This involves combining plant materials (trees, shrubs, hedges, lawns, flowers) with a wide range of small architectural forms such as pergolas, trellises, pavilions, garden furniture, flower beds, fountains, decorative stones, and sculptural ensembles [12].

The structure, spatial arrangement, and selection of vegetation along major roads and streets must account for transport dynamics, planning considerations, and microclimatic factors. When properly designed, greenery can protect pedestrian areas and residential zones from traffic pollution, reduce summer air temperatures, and in some cases provide shelter from prevailing winds. At the same time, tree–shrub structures—whether single plantings, group arrangements, or hedges—must



align with the volumetric–spatial composition of transport infrastructure, not hinder its functions, and contribute to forming a comfortable living environment while meeting architectural landscape requirements [13].

The formation of comfortable urban environments through the application of “green” technologies is a pressing necessity. Human-induced environmental changes—including shifts in temperature–humidity regimes and declining biodiversity—require prioritizing the preservation and expansion of green assets as a foundational approach to environmental protection and microclimate maintenance in populated areas [15].

Creating interconnected “green zones” within a unified “green framework” of the city demands systematic, research-based solutions. In the urban ecological systems of “healthy cities,” protective green infrastructure is developed and maintained to safeguard the environment [16,17]. One progressive method of increasing urban greening involves establishing rooftop gardens on residential and public buildings. While such projects offer ecological and aesthetic benefits, they require careful planning and preparation. Key considerations include assessing the roof’s load-bearing capacity (soil, vegetation, and water weight), determining exposure to sunlight, wind, and water availability—all of which guide appropriate plant selection. If excessive shading from nearby buildings reduces sunlight, shade-tolerant plant species must be chosen [18].

Conclusion

1. Urban vegetation constitutes a fundamental biophysical component shaping the microclimate of cities. By lowering air temperature, regulating relative humidity, moderating wind flows, reducing noise, and absorbing harmful airborne pollutants, green spaces create healthier and more comfortable living conditions for urban populations.
2. The reduction of green areas during rapid urbanization leads to microclimatic disturbances, intensification of the urban heat-island effect, and increased risks of respiratory and cardiovascular diseases. The expansion of transport infrastructure and industrial facilities further elevates ecological pressure, exacerbating environmental and public-health challenges.
3. Scientifically grounded planning and landscape design—specifically, optimizing the quantity, spatial configuration, and species composition of urban green spaces—are essential for establishing a resilient urban ecosystem. Linear tree–shrub belts along transport corridors, expanded greening of public spaces, rooftop gardens, and the integration of “green technologies” significantly improve the urban microclimate.





4. Green areas also play a crucial role in supporting psycho-emotional well-being. They reduce stress, enhance physical activity, enrich the aesthetic quality of the urban environment, and function as a “green filter” that protects human health.
5. The findings of this study hold practical significance for shaping urban ecological safety standards, sanitary-hygienic requirements, and sustainable development strategies. Increasing the level of urban greening stands out as one of the most effective foundations for improving public health and ensuring the long-term stability of urban environments.

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