

# Plant typology in urban development as a natural barrier protecting citizens from external natural factors

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## ANNOTATION

Green spaces in urban areas not only create an aesthetic appearance, but also play a functional role in protecting people from noise, wind, dust and overheating. They can be called the lungs of cities. The article examines the typology of plants in urban areas from the point of view of their impact on the microclimatic conditions of the city's inhabitants.

*Key words: typology of plants in urban development, dust protection, noise protection, sun protection, wind protection.*

## 1. INTRODUCTION

Modern Ukrainian cities face a number of challenges related to climate change, increasing anthropogenic load and deterioration of the urban environment quality. The intensity of heat waves increase, noise levels, dust concentration in the air and other negative factors significantly affect comfort and health of the population. At the same time vegetation is one of the most effective natural regulators of microclimate, providing protection for humans from solar radiation, overheating, dust, noise and wind.

Kyiv is traditionally considered one of the greenest cities in Europe. According to the HUGSI (Husqvarna Urban Green Space Index) satellite index, about 44% of the capital's area is occupied by green spaces, and the average green space coverage is over 80 m<sup>2</sup> per inhabitant.

The article proposes to consider the typology of plants in urban development as a natural barrier to protect citizens from external natural factors.

## 2. UKRAINIAN AND FOREIGN EXPERIENCE

In Germany, a number of government programs are being implemented in which landscaping and preserving the natural environment are factors in sustainable development. In particular, the Energiewende strategy aims to reduce greenhouse gas emissions by switching to renewable energy sources and increasing energy efficiency, which indirectly affects the reduction of heat load in cities. The Ecopark, Green Urban Logistics and Energieeffiziente Gebäude initiatives emphasize the role of green spaces as elements of climate adaptation and quality of life in the urban environment.

Ukraine is also implementing national and regional initiatives in which greening is a tool of environmental policy. The President's Green Country Program [1] anticipates planting one billion trees over five years, which should reduce land degradation and absorb a significant share of CO<sub>2</sub>. The Greening of Ukraine project aims to restore green areas in cities destroyed by war. In cooperation with the EU and UNDP [2], initiatives are being implemented that create concepts of "green" communities and integrate nature-based solutions into urban planning.

In Germany, environmental programs are systemic in nature and supported by comprehensive legislative mechanisms, financing, and monitoring of results. In Ukraine, such initiatives

are mostly at the project or declarative level and depend on international technical assistance. At the same time, modern Ukrainian programs demonstrate a tendency to integrate European approaches - use of nature-based solutions, increasing biodiversity and forming green infrastructure as a part of urban renewal. In addition to state or city programs that initiate and implement research into the impact of green spaces on the microclimate of urban environment, university scientific developments provide a wide array of knowledge based on tests, measurements and calculations [3].

### 2.1. Wind protection

The issue of wind protection is actively researched in the field of urban planning and microclimatic modeling. The work [4] considers the influence of vegetation on the speed and structure of air flows, as well as the effectiveness of green spaces as natural screens in the urban environment.

### 2.2. Dust protection

Vegetation plays a key role in reducing the concentration of solid parts in the air. It has been proven in [5] that canopy density, leaf type, and tree height significantly affect the efficiency of dust filtration along highways and in residential areas.

### 2.3. Sun protection

Plants play a significant role in regulating thermal balance of urban areas, reducing overheating of coatings, facades and internal spaces of buildings. According to studies [6], shading created by trees reduces air temperature by 2–4 °C, and surface temperatures of asphalt by up to 20 °C. The mechanisms of evaporative cooling and photosynthetic activity contribute to the formation of a comfortable microclimate. Research [3] proves that the configuration and density of vegetation directly affect its effectiveness in sun protection. Green roofs and vertical gardening increase energy efficiency of buildings, which is confirmed by European experiments.

### 2.4. CO<sub>2</sub> reduction

Green spaces are a natural mechanism for reducing the concentration of carbon dioxide in the atmosphere. Studies [7] show that trees in the cities can absorb 10 to 40 kg of CO<sub>2</sub> per tree annually, reducing the overall carbon footprint of cities. Green infrastructure is an effective tool for climate neutralization of urban areas.

### 3. PLANT TYPOLOGY IN URBAN ENVIRONMENT

Typology of plants in the urban environment is formed on the basis of their functional impact on microclimate, ecological balance and human comfort. Vegetation performs not only an aesthetic or recreational function, but also acts as a natural barrier that mitigates the effects of external climatic factors. In the climatic zones of Ukraine - from moderately continental to prairie - the role of greenery in stabilizing the microclimate is especially significant.

#### 3.1. Plants in the structure of urban development

In parks, recreational areas, on the street and road network, green spaces create a comfortable environment by reducing noise, filtering dust, creating shade and maintaining air humidity. The compositional arrangement of trees and bushes provides natural screening of noise waves, especially near highways or traffic interchanges. The shade from the crowns reduces overheating of soils, paths and recreation areas, which is important during summer heat waves. Right next to buildings, plants perform sun-shielding and heat-regulating functions. Trees planted near facades reduce overheating of walls and windows, providing natural shading. Orientation of the building is taken into account. Greening roofs and facades - a modern form of integrated urban greening - creates an additional layer of thermal insulation, improves the energy efficiency of buildings and contributes to the absorption of CO<sub>2</sub>.

#### 3.2. Typology by plant size

Plants are classified by size, which determines their functions and spatial role in the urban environment:

Grass layer - lawns, mosses and ground cover plants that reduce evaporation from surfaces and retain dust.

Floral arrangements - provide aesthetic perception but also participate in heat exchange and biofiltration.

Bushes - the middle layer of greenery which forms noise-absorbing and dust-retaining strips especially effective along transport arteries.

Trees - the main vertical structure of green spaces which provides shading, wind protection, acoustic absorption and regulation of the carbon cycle.

#### 3.3. Typology by crown density and light transmission

According to the density and transparency of the crowns, three main types are distinguished:

Dense crowns (linden, ash, oak);

Translucent crowns (birch, maple, acacia);

Light crowns (poplar, mountain ash, larch).

#### 3.4. Typology by traditional purpose in an urban planning situation

Depending on the location and functions of green elements in the city structure, the following types are distinguished:

Park plantings - recreational spaces;

Street green rows along transport highways;

Protective plantings near residential and industrial zones - reduce wind speed and dust dispersion;

Vertical and roof greening - energy efficiency and biodiversity factors;

Neighborhood plantings - local green microspaces for social comfort and protection.

### 4. CONCLUSIONS

Thus, the typology of plants in urban development in Ukraine reflects the relationship between the natural properties of vegetation and the architectural and planning structure of the city. It is a tool for optimizing the microclimate, reducing environmental load, and forming a harmonious environment adapted to the climatic conditions of our country.

#### Reference list

- [1] Decree of the President of Ukraine No. 228/2021. On some measures for the preservation and restoration of forests.
- [2] Nature-based solutions for sustainable cities in Ukraine. UNDP Project. <https://www.undp.org/ukraine/projects/nature-based-solutions-sustainable-cities-ukraine>.
- [3] Sergeychuk O.V., Kozak Y.V. Determination of shading reduction factors when shading by rows of trees. *ICGG 2024 – Proceedings of the 21st International Conference on Geometry and Graphics*. V.2. 2024. pp. 13-21. Springer. DOI [https://doi.org/10.1007/978-3-031-71008-7\\_2](https://doi.org/10.1007/978-3-031-71008-7_2)
- [4] Zanotto F., Marchi L., Grigolato S. Wind-tree interaction: Technologies, measurement systems for tree motion studies and future trends. *Journal of Agricultural and Biosystem Engineering Research* 237(8). 2023. Vol.2, No 2. P.128–141. DOI:10.1016/j.biosystemseng.2023.12.005.
- [5] Barwise Y., Kumar P. Designing vegetation barriers for urban air pollution abatement: A practical review for appropriate plant species selection // *npj Climate and Atmospheric Science*. – 2020. – Vol. 3. – Art. No. 12. DOI: 10.1038/s41612-020-0115-3.
- [6] Chapman L., Bell C., Bradley A. The Effect of Urban Density and Vegetation Cover on the Urban Heat Island in Birmingham, UK // *Journal of Applied Meteorology and Climatology*. – 2018. – Vol. 57(11). – P. 2381–2398. DOI: 10.1175/JAMC-D-17-0316.1.
- [7] Nowak D. J., Crane D. E., Stevens J. C. Carbon storage and sequestration by urban trees in the USA // *Environmental Pollution*. – 2002. – Vol. 116(3). – P. 381–389. DOI: 10.1016/S0269-7491(01)00214-7