URBAN TREES FOR PEOPLE AND CLIMATE: BALANCING ECOSYSTEM SERVICES AND LONG-TERM VITALITY IN PUBLIC SPACES

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Abstract
Urbanization and climate change significantly intensify the Urban Heat Island (UHI) effect, directly impacting the quality of public recreation. Green spaces, particularly tree vegetation, represent one of the most effective nature-based solutions, bridging the gap between environmental protection and human thermal comfort. Studies indicate that well-designed green spaces can reduce urban air temperatures by 2-4 °C (locally up to 8-10 °C compared to impervious surface) and significantly mitigate temperature extremes during heatwaves.
However, for recreation and protection to go “hand in hand”, a strategic approach is required. A key factor is the proper selection of tree species – prioritizing those with a high Leaf Area Index (LAI) and resilience to urban stressors (e.g., *Tilia, Acer platanoides, Carpinus betulus, Quercus, Ulmus, Alnus glutinosa*, or *Zelkova*).
Furthermore, the long-term sustainability of these benefits depends on an integrated maintenance system (regular irrigation, crown pruning, and root protection). This paper analyses functional green spaces in European cities to demonstrate how systematic management enhances tree vitality while providing high-quality recreational environments. The proposed principles aim to optimize green infrastructure as a resilient framework for climate adaptation.

Key words: urban heat island, nature-based solutions, recreational comfort, greenery maintenance, climate change adaptation

Introduction

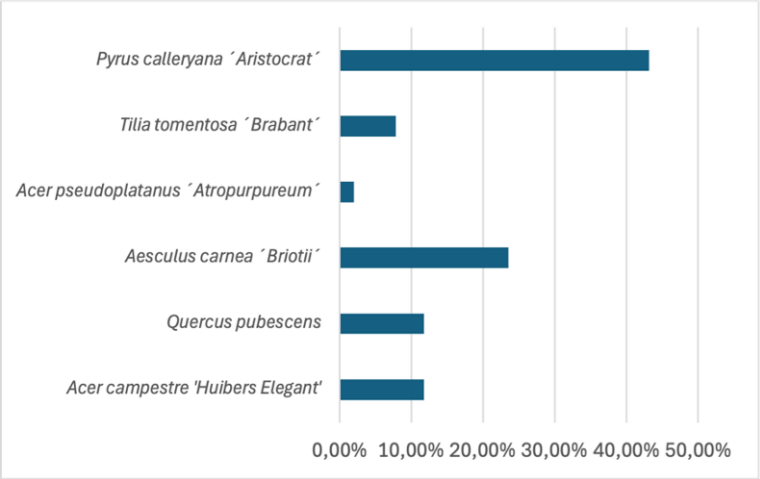
Climate change and urbanization are changing the shape of cities, exposing them to increasing risks and worsening thermal impacts. Although many cities have the resources to adapt, designing resilient urban environments remains a challenge due to accelerating climate change, increasing biotic hazards, and rapid urbanization. Tree plantings are widely used in urban areas as a natural solution to mitigate the effects of climate change and, at the same time, contribute to the sustainable development of cities and the improvement of human health and well-being. In addition to the correct selection of trees, the technological basis of planting and the maintenance itself, the latest studies show that community involvement is also a significant element. The participation of the lay public significantly improves the lay public's understanding of how long trees last for future generations (Esperon-Rodrigues, 2025). Trees are among our best allies in the fight against climate change and biodiversity loss. Although we often think of trees in connection with forests, most of our interactions with trees take place in urban environments, where they provide us with shade, moderate heat, mitigate floods, act as a sound barrier, eliminate pollution, enhance the attractiveness of the environment, and much more. However, to preserve and enhance these diverse benefits, we urgently need to rethink the selection of trees for the urban environment to include those species and origins that are best suited to environmental conditions and able to withstand the stress of a rapidly changing and unpredictable climate, spreading pests, and emerging tree diseases. At the same time, it is necessary to emphasize the choice of assortment, which is diverse (Kuczman et al., 2022). By choosing a richer composition of woody plants, the overall resistance of the vegetation to pests and climatic extremes can be significantly increased (Kowalski et al., 2024; Bechera et al., 2022). As reported by Cimburová et al. (2021), trees in urban spaces offer people several benefits, including regulatory, cultural, supply and support services, which are a great benefit for the sustainable development of cities and an attractive attribute for a better quality of life for residents. Improving the benefit level of a better life for users is also the ability of woody plants to capture fine dust particles $PM_{2.5}$, which has a direct impact on air quality. Studies have shown that, for example, Platanus, Acer and Tilia species are among the effective species in this regard (Xiao et al., 2015). As stated in the study by Livesley et al. (2016) the resistance of young trees to urban stressors is the subject of intensive research. Modern approaches include the use of special substrates, innovative planting systems (eg structural soils) and intelligent irrigation technologies. Integrated green planning that takes climate change and extreme weather events into account is key to ensuring the long-term vitality of urban trees.

Materials and methods

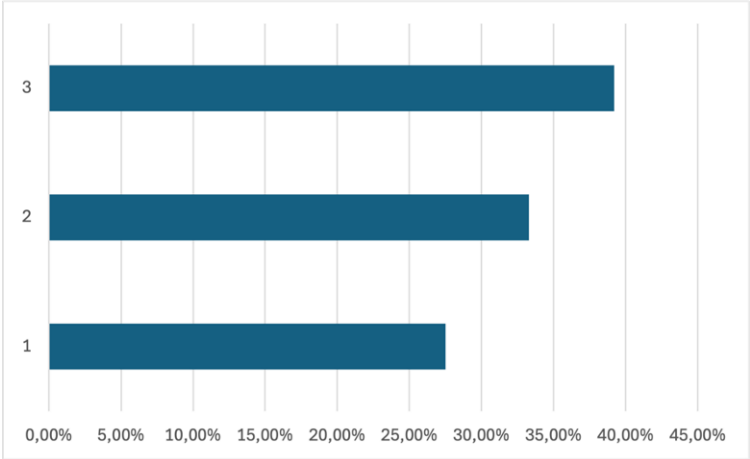
New plantings in cities increase biodiversity and improve the quality of the environment in urbanized areas. The sustainability of biodiversity brings irreplaceable economic and ecological values to humanity. Biodiversity is a prerequisite for the preservation of life on Earth. Trees also have an irreplaceable place in nature, as do many other organisms, and fulfil many functions. Many other organisms also exist directly or indirectly thanks to woody plants, because no animal, human, or plant can survive in isolation from its surroundings. The work is focused on the collection and evaluation of dendrometric data, data on the health status of trees, and on biotechnological procedures during planting and maintenance based on the methodology we have established. Partial results will be published continuously. The findings will lead to an evaluation of the survival rate of new tree plantings and identify the most common damage to them. The contribution of the work will be the evaluation of the correctness of the selection of tree species for the urban environment, the evaluation of individual inventory indicators, together with the proposal of the application of biotechnical measures that will lead to the elimination of adverse environmental effects and contribute to increasing the survival rate and quality of newly planted trees. It is important in the future to identify the determining factors that affect the survival rate of new plantings. These criteria include lack/excess of available water in the soil space, compaction, soil type, lack of soil air, soil contamination, heat island effect, reduced growth space, range and quality of planting material on green areas in urbanized areas.

Results

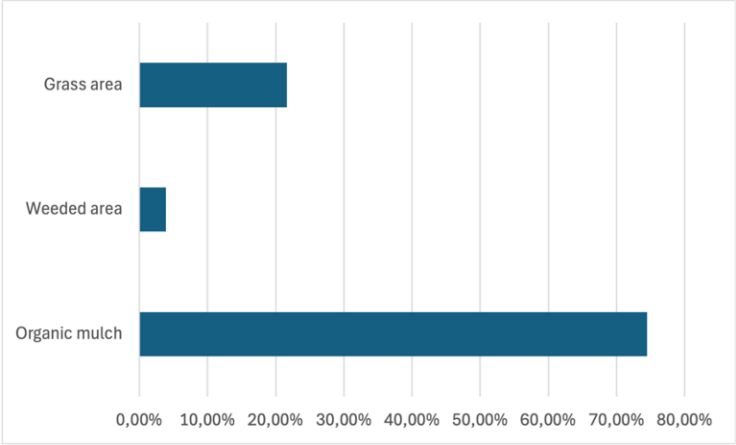
The research problem is defined by the high mortality of trees in public greenery, i.e. the factors that influence it. Increased death of newly planted trees in the first years after planting has been observed for a long time in the public gardens of settlements. This high mortality of trees significantly reduces the efficiency and return on investment in planting, negatively affects the aesthetic, ecological and air-conditioning function of greenery. The causes of the failure and death of plantings are diverse - from inappropriate species composition, through technological mistakes in planting, insufficient watering, and incorrect follow-up care. As a model area, an area of greenery in an urbanized environment in the village of Neunkirchen (Lower Austria) was selected. A total of 51 young trees were evaluated in the model area, which were planted between 2018 and 2020. The percentage representation of trees is shown in graph 1. The planting of the area was carried out by a local private company, and the emphasis was also on the continuity and continuity of the positive relationship to greenery and trees on the part of the users and residents of the new housing complexes. However, the subsequent care of the trees after their planting was not completely consistent, and a total of 11 trees fell in the area, which were not included in our study due to their death. Other trees have minor damage, which we observe mainly in the case of damage to the trunk by a support round in the case of trees with one or two perpendiculars. Most woody plants have a system of three mooring poles, as shown in graph 2. In the model area, most of the trees are mulched with wood chips. We also see areas that are weedy or have grass, as shown in graph 3. The largest increases were observed in trees from weedy areas, which did not even have an irrigation bag installed. Water management is therefore efficient, and the green soil cover can be effectively used by trees in the dry stage.



Graph 1: Share of woody plants in the evaluated area



Graph 2: Percentage representation of the number of mooring poles



Graph 3: The tree root bowl cover

Discussion

In cities, trees are exposed to many stress factors, such as air pollution, limited space for the root system, increased temperatures (urban heat island effect) or soil salinization during the winter season (Gillner et al., 2015). New plantings in cities increase biodiversity and improve the quality of the environment in urbanized areas. The sustainability of biodiversity brings irreplaceable economic and ecological values to humanity. Biodiversity is a prerequisite for the preservation of life on Earth. Trees also have an irreplaceable place in nature, as do many other organisms, and fulfil many functions. Many other organisms also exist directly or indirectly thanks to woody plants, because no animal, human or plant can survive in isolation from its surroundings.

Conclusion

Trees and green spaces in the urban environment represent the primary pillar for the sustainable development of metropolises and the well-being of their inhabitants. They provide a wide range of ecosystem services, including air quality improvement, microclimate regulation, and the essential support of physical and psychological health of recreational users. This study highlights that for recreation and nature protection to truly go „hand in hand," there must be a profound respect for the biological needs and long-term vitality of trees within the demanding conditions of public spaces.

The high mortality of young plantings observed in our research underscores the consequences of neglecting this balance. Effective planning, the selection of resilient taxa (such as *Tilia*, *Quercus*, or *Zelkova*), and proper technological maintenance are not just technical requirements, but acts of respect toward nature that ensure these living organisms can fulfil their recreational role for decades. Furthermore, involving the lay public and fostering their awareness of the significance of urban greenery is crucial for creating a shade responsibility for our environment.

Ultimately, only an integrated approach that prioritizes tree vitality can transform urban green infrastructure into a resilient framework for climate adaptation. By protecting the health of our urban forests, we directly protect the quality of human reaction, ensuring that both can coexist in a sustainable and mutually beneficial harmony.

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Souhrn
Stromy a zelené plochy v městském prostředí představují základní pilíř udržitelného rozvoje metropolí a kvality života jejich obyvatel. Poskytují širokou škálu ekosystémových služeb, mezi které patří zlepšování kvality ovzduší, regulace mikroklimatu a v neposlední řadě zásadní podpora fyzického i psychického zdraví uživatelů při rekreaci. Tato práce a následné hlubší studium ukazují na naléhavou potřebu nastolit rovnováhu mezi významem těchto benefitů a zajištěním vitality stromů v náročných podmínkách veřejných prostranství.
Aby rekreace a ochrana přírody v městském prostředí kráčely skutečně „ruku v ruce", je nezbytný hluboký respekt k biologickým potřebám dřevin. Vysoká mortalita mladých výsadeb, kterou jsme v rámci výzkumu zaznamenali, podtrhuje důsledky opomíjení této rovnováhy. Efektivní plánování, výběr odolných taxonů a správná technologická péče nejsou pouze technickými požadavky, ale projevem respektu k přírodě, který zaručuje, že tyto živé organismy budou moci plnit svou rekreační roli po celá desetiletí.
Považujeme za velmi důležité zapojit do tohoto procesu i laickou veřejnost a podporovat její povědomí o významu městské zeleně. Pouze dlouhodobý a komplexní přístup, který prioritizuje vitalitu stromů, může zajistit, že městská zelená infrastruktura bude fungovat jako odolný rámec pro adaptaci na změnu klimatu. Ochranou zdraví našich městských stromů přímo chráníme kvalitu rekreace pro člověka a zajišťujeme, aby obě tyto složky mohly existovat v udržitelném a vzájemně prospěšném souladu.
Jedním z mých oblíbených citátů je myšlenka profesora Machovce (1982): *„Porosty stromů v urbánním prostoru jsou tím nejhodnotnějším bohatstvím, které v zahradně-architektonické praxi máme, proto je důležité porosty dřevin chránit."*

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