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THE CONTRIBUTION OF ORNAMENTAL TREES TO URBAN ECOSYSTEM SERVICES: A REVIEW

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ABSTRACT

The significance of ornamental trees in urban landscapes has expanded beyond their traditional decorative role to encompass critical environmental and social functions. Increasingly, these species are being recognized as integral elements of green infrastructure and Nature-based Solutions (NBS). This review adopts a trait-service framework to examine how specific botanical characteristics, including canopy architecture, leaf morphology, and flowering phenology, influence ecosystem service delivery. Research indicates that ornamental trees contribute substantially to urban climate regulation through shading and evapotranspiration, while also enhancing air quality by capturing atmospheric pollutants. Furthermore, these species provide valuable cultural ecosystem services by supporting psychological restoration, promoting social interaction, and strengthening place identity. Although certain management challenges, such as allergenic pollen production and infrastructure conflicts, may arise, appropriate species selection and maintenance can mitigate these issues. Overall, ornamental trees represent multifunctional assets capable of improving environmental quality and human well-being in urban ecosystems.

Key words : Ornamental Trees, Urban Forestry, Ecosystem Services, Nature-based Solutions, Urban Heat Island, Green Infrastructure.

Introduction

The perception of ornamental trees within urban environments has undergone a notable transformation over recent decades. Previously valued primarily for their visual attractiveness, including flowering displays, distinctive foliage, and architectural form, ornamental trees are now increasingly regarded as essential components of urban green infrastructure. Contemporary studies emphasize that aesthetic appeal and ecological functionality are not mutually exclusive; rather, ornamental species can simultaneously provide visual enhancement and environmental benefits (Francini *et al.*, 2022).

Within the framework of Nature-based Solutions (NBS), ornamental trees contribute to several ecological functions, including phytoremediation, soil stabilization, biodiversity enhancement, and climate regulation (Francini *et al.*, 2022). Consequently, urban forests are no longer viewed merely as decorative features but as dynamic

systems that support environmental sustainability and improve the quality of urban life.

Rapid urbanization has intensified environmental challenges such as elevated temperatures, declining air quality, increased surface runoff, and reduced human interaction with natural environments. Among these challenges, the Urban Heat Island (UHI) effect remains one of the most pressing concerns. The cooling capacity of urban vegetation is highly dependent on species-specific traits and spatial arrangement, indicating that not all trees contribute equally to temperature moderation (Knight *et al.*, 2024). In addition to regulating environmental conditions, ornamental trees support human health through visual and psychological benefits. Seasonal colour variation, flowering displays, and complex canopy structures have been associated with stress reduction, attention restoration, and improved emotional well-being (Wolf *et al.*, 2020).

The ecosystem services framework provides a comprehensive approach for evaluating the multifunctional contributions of ornamental trees. Traits traditionally considered ornamental, such as leaf pubescence and wax coatings, are now recognized for their ability to intercept particulate matter and improve urban air quality (Francini *et al.*, 2022). This integration of ecological function and visual appeal aligns closely with the principles of biophilic design, which emphasize the importance of human connections with nature in urban settings.

Climate Regulation and Urban Cooling

Urban vegetation plays a crucial role in mitigating the adverse effects of rising temperatures. Ornamental trees contribute to urban cooling through two primary mechanisms: shading and evapotranspiration. Canopy architecture influences both the amount of solar radiation intercepted and the reflectance characteristics of vegetation. Species possessing dense and multilayered canopies are particularly effective at reducing ambient temperatures and improving microclimatic conditions.

Studies have demonstrated that ornamental trees with extensive canopy coverage can lower surrounding air temperatures by as much as 2°C, thereby reducing thermal stress in urban environments (Sanusi *et al.*, 2016). Although, native species are often valued for their ecological compatibility, certain ornamental species exhibit superior localized cooling capacities due to higher transpiration rates and greater leaf reflectivity (Armson *et al.*, 2012). These characteristics make ornamental vegetation a valuable strategy for mitigating the Urban Heat Island effect and enhancing thermal comfort in cities.

Air Quality improvement

Ornamental trees contribute significantly to air quality enhancement by removing both particulate and gaseous pollutants from the atmosphere. The efficiency of particulate matter capture depends largely on leaf surface characteristics. Species possessing hairy, rough, or structurally complex leaves generally exhibit greater retention of airborne particles than species with smooth leaf surfaces (Sæbø *et al.*, 2012).

In addition to particulate filtration, ornamental trees absorb gaseous pollutants, including carbon dioxide (CO₂), sulfur dioxide (SO₂), and nitrogen dioxide (NO₂), through stomatal uptake. This continuous process improves ambient air quality, particularly in heavily trafficked urban corridors where pollutant concentrations are elevated (Grote *et al.*, 2016).

Stormwater Management

Urbanization often results in extensive impervious surfaces that increase runoff and place pressure on drainage systems. Ornamental trees assist in stormwater regulation by intercepting rainfall and enhancing soil infiltration. Tree canopies reduce the velocity and volume of rainfall reaching the ground, thereby minimizing surface runoff.

Research indicates that urban tree canopies may intercept between 15% and 40% of annual precipitation, significantly reducing stormwater loads (Xiao *et al.*, 2002). Furthermore, ornamental species incorporated into rain gardens and bioretention systems improve water infiltration and pollutant removal. Such systems have been reported to remove up to 90% of suspended solids and heavy metals from urban runoff (Davis *et al.*, 2009).

Noise Reduction

Vegetation serves as a natural barrier against urban noise pollution. Dense ornamental plantings reduce sound transmission by absorbing, scattering, and deflecting sound waves. Species characterized by thick foliage and multi-layered vegetation structures are particularly effective in mitigating traffic-related noise (Van Renterghem *et al.*, 2012).

Beyond measurable reductions in noise levels, ornamental vegetation also contributes to psychological comfort. The visual presence of greenery has been shown to reduce perceived noise annoyance and enhance feelings of environmental restoration (Margaritis *et al.*, 2017).

Aesthetics and Sense of place

Ornamental trees play a significant role in defining the visual character and identity of urban environments. Their diverse growth habits, seasonal flowering patterns, foliage colours and architectural forms contribute to aesthetically appealing landscapes that enhance the overall quality of urban life. Beyond their visual contribution, ornamental plantings influence economic and social outcomes by increasing property desirability and strengthening community identity.

Property Value and Economic Benefits: Numerous studies have demonstrated a positive relationship between high-quality ornamental landscapes and residential property values. Attractive streetscapes, tree-lined avenues, and well-maintained public green spaces enhance neighbourhood appeal, often resulting in measurable increases in real estate values. The presence of ornamental vegetation has been reported to increase residential property values by approximately 5–20%,

depending on location and landscape quality (Wolf, 2023).

Urban Identity and City Branding: Distinctive ornamental tree species contribute to place-making by creating memorable landscapes that reflect local culture and environmental character. Seasonal floral displays and unique foliage patterns can become symbolic features of cities, attracting tourists and enhancing resident satisfaction. Such landscape elements strengthen urban identity and contribute to successful city branding initiatives (Lindemann-Matthies *et al.*, 2010).

Psychological and Mental Health Benefits

Urban green spaces containing ornamental trees provide substantial psychological and emotional benefits. Theories such as Biophilia and Attention Restoration Theory suggest that humans possess an inherent affinity for natural environments and derive restorative benefits from interactions with vegetation (Kaplan, 1995).

Stress Reduction and Physiological Recovery: Exposure to aesthetically pleasing ornamental vegetation has been associated with reductions in stress-related physiological indicators, including cortisol levels and heart rate. Landscapes characterized by colourful flowers, balanced forms, and diverse vegetation structures create calming environments that support emotional well-being and reduce psychological stress (Kaplan, 1995).

Cognitive Restoration: Natural patterns commonly observed in ornamental foliage and branching structures facilitate cognitive recovery by directing attention toward effortless forms of engagement. Such environments allow individuals to recover from mental fatigue, improve concentration, and reduce irritability. Research indicates that visual exposure to complex natural forms enhances cognitive functioning and contributes to improved psychological health (Lee *et al.*, 2015).

Social Cohesion and Community Development

Ornamental vegetation contributes to stronger social relationships and improved community interactions within urban environments. Attractive public spaces encourage outdoor activities and increase opportunities for social engagement among residents.

Enhancement of Walkability: Street trees and ornamental plantings improve pedestrian experiences by providing shade, visual interest, and environmental comfort. These factors encourage walking and outdoor recreation, thereby increasing opportunities for casual social interactions and community engagement (Coley *et al.*, 1997).

Perceptions of Safety: Well-maintained landscapes featuring ornamental trees and shrubs are often

associated with increased feelings of safety among residents. Green environments promote greater use of public spaces, resulting in increased social surveillance and stronger community presence. Studies have linked attractive urban landscapes with reduced crime rates and enhanced neighbourhood security (Kuo and Sullivan, 2001).

Heritage preservation and Environmental education

Many ornamental tree species possess cultural, historical, and educational significance that extends beyond their ecological functions. These species often serve as living symbols of local heritage while simultaneously supporting environmental awareness and education.

Cultural Heritage and Living Monuments: Historically significant ornamental species, including long-lived trees and culturally valued flowering plants, function as living monuments that connect contemporary communities with their cultural traditions and historical landscapes. Species such as Ginkgo biloba and ornamental cherry trees are frequently recognized as important cultural assets within urban environments (Jim and Chen, 2006).

Educational Opportunities: Botanical gardens, arboreta, and ornamental landscapes provide valuable educational opportunities for urban populations. These environments serve as outdoor classrooms where individuals can learn about biodiversity, ecological processes, seasonal changes and environmental stewardship. Such educational experiences contribute to greater public understanding of sustainability and conservation (Mayer-Smith *et al.*, 2007).

Functional Contributions of Ornamental Vegetation to Urban Ecosystems

Habitat Connectivity and Pollinator Mobility : Urban development often fragments natural habitats, restricting wildlife movement and reducing ecological connectivity. Ornamental trees can mitigate these effects by serving as biological corridors that connect isolated green spaces. Flowering ornamental species provide essential food resources for pollinators such as bees, butterflies, and other beneficial insects, facilitating movement and genetic exchange among populations across urban landscapes (Baldock *et al.*, 2015).

Ecological Trade-offs between Native and Exotic species : The selection of ornamental species involves balancing ecological value with horticultural performance. Native species generally provide superior habitat resources for local wildlife because of long-term co-evolutionary relationships with indigenous organisms. In contrast, exotic ornamental species often offer

attractive visual characteristics and enhanced tolerance to urban stresses but may support fewer specialist insects and wildlife species. Consequently, landscapes dominated by exotic ornamentals may appear visually diverse while contributing less effectively to ecosystem functioning and biodiversity conservation (Narango *et al.*, 2018).

Urban Provisioning through Edible Landscaping : The incorporation of fruit-bearing ornamental species into urban landscapes represents an emerging strategy for enhancing urban food security. These multifunctional trees combine ornamental appeal with food production, transforming passive landscapes into productive green infrastructure. Such approaches can strengthen

community engagement with local food systems while increasing the functional value of urban green spaces (Clark *et al.*, 2013).

Resource Recovery and Renewable Energy Potential : The ecological benefits of ornamental vegetation continue throughout the plant life cycle. Pruning residues, fallen branches, and removed trees can be processed into mulch, compost, or bioenergy resources. Redirecting this biomass from waste streams into productive uses contributes to resource efficiency and supports circular economy principles within urban ecosystems (MacFarlane *et al.*, 2009).

Table 1 : Comparative Ecological performance of Native and Exotic Ornamental species.

Criterion	Native Ornamental species	Exotic (Non-Invasive) Ornamental species	Citation
Biodiversity Support	Native ornamentals provide valuable habitat and food resources for specialist herbivores and other native wildlife, thereby supporting local ecological networks.	Exotic ornamentals generally attract a narrower range of organisms and are more likely to support generalist species than specialist fauna.	Tallamy <i>et al.</i> (2009)
Tolerance to Urban Heat Stress	Although well-adapted to local environmental conditions, some native species may exhibit moderate sensitivity to the elevated temperatures associated with urban heat islands.	Many non-invasive exotic species demonstrate greater tolerance to harsh urban environments because they are often pre-adapted to stressful site conditions.	Sjöman <i>et al.</i> (2016)
Ecological Risk	Native species usually pose minimal ecological risk since they are naturally integrated into local ecosystems and ecological processes.	Ecological risks vary among exotic species; while many remain non-invasive, some possess the potential to spread beyond intended planting areas.	Richardson <i>et al.</i> (2000)
Functional Adaptability	Their performance is generally optimized within specific climatic and ecological conditions.	Exotic ornamentals often display greater adaptability and can perform successfully across a wide range of urban environments.	Kendal <i>et al.</i> (2014)

Table 2 : Management Challenges associated with Ornamental Trees and recommended Mitigation measures.

Management Challenge	Impact on Urban Environment	Recommended Management Strategy	Citation
Allergenic Pollen Production	Pollen released from certain ornamental species may contribute to respiratory allergies and other public health concerns among urban residents.	Prioritize low-allergen cultivars and select dioecious species where appropriate to reduce pollen exposure.	Cariñanos <i>et al.</i> (2014)
Leaf Litter and Plant Debris	Excessive accumulation of leaves and organic debris can obstruct drainage systems and increase maintenance requirements.	Implement routine maintenance schedules and ensure appropriate spacing between trees to facilitate effective management.	Escobedo <i>et al.</i> (2011)
Infrastructure Damage	Aggressive root growth may cause pavement lifting, sidewalk deformation, and damage to underground utility networks.	Employ root barriers, provide adequate rooting space, and utilize permeable pavement technologies to minimize conflicts.	Randrup <i>et al.</i> (2001)

Management Challenges and Ecosystem Disservices

Although, ornamental vegetation provides numerous environmental, social, and economic benefits, it may also generate certain ecosystem disservices that require careful management. Common concerns include allergenic pollen production, accumulation of plant debris and conflicts between tree root systems and urban infrastructure. Rather than discouraging urban greening efforts, these challenges highlight the importance of informed species selection, proper landscape design and proactive maintenance practices.

Conclusion

The contemporary role of ornamental trees extends far beyond their traditional function as decorative landscape elements. As demonstrated throughout this review, ornamental vegetation represents a multifunctional component of urban green infrastructure capable of delivering a wide range of ecosystem services. Through mechanisms such as temperature regulation, air purification, stormwater management, biodiversity enhancement and noise attenuation, ornamental trees contribute significantly to environmental resilience and urban sustainability.

Furthermore, the cultural ecosystem services provided by ornamental species including psychological restoration, social cohesion, aesthetic enhancement, and heritage preservation highlight their importance in promoting human health and well-being. The trait service framework illustrates how specific plant characteristics directly influence ecosystem service delivery, enabling more informed species selection and landscape planning decisions.

Although, challenges such as allergenic pollen production, leaf litter accumulation, and infrastructure conflicts require careful management, these concerns can be effectively addressed through strategic species selection and appropriate maintenance practices. Future urban forestry initiatives should therefore prioritize the integration of horticultural aesthetics with ecological functionality to create resilient, sustainable, and livable urban environments. By adopting such an approach, cities can maximize both environmental performance and societal benefits while fostering long-term urban sustainability.

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