



Urban Forests, Forest Urbanisms, and Global Warming

By Cecil C. Konijnendijk, Kelly Shannon, and Chiara Cavalieri

During the current climate emergency, there has been an increasing focus on the role of forests, trees, and associated vegetation in urban areas—places where most of us live, work, learn, and play. As past studies have shown, urban forests play a role in the mitigation of global warming by, for example, sequestering carbon and reducing energy costs. However, their key contributions relate to the adaptation of urban areas. Urban tree canopies cool down urban heat islands, also during more frequent heat waves, and offer pockets of shade for residents. Urban forests also help regulate stormwater, jointly with a series of other ecosystem services. They also restore disturbed biodiversity and make place for non-human species in cities (Ferrini et al. 2017; Endreny 2018; Konijnendijk 2023). In recognition of these and other urban forest benefits, large-scale tree planting in urban areas has been recommended internationally, nationally, and locally (Sousa-Silva et al. 2023). Nevertheless, urban forests are themselves increasingly affected by global warming, extended periods of droughts, more frequent occurrences of pests and diseases, and extreme weather events (Esperon-Rodriguez et al. 2022).

The necessity to develop urban forestry goes hand-in-hand with the continual need to transform urban building morphologies and typologies—to reduce carbon emissions, adapt to the climate crisis, and respond to new ways of inhabiting cities. The overarching challenge of how to accommodate more urban populations with the simultaneous development of more urban nature demands radical rethinking of paradigms (Waldheim 2004; De Meulder et al. 2019; Gandy 2022; Rinaldi 2023; Wambecq 2023). Settling with and within forests occurred for millennia and

still does in different parts of the world (Tavares 2016). The contemporary challenge is to envision a robust forest urbanism that redefines ways of living and stewardship of the environment, taking into account the ecological as well as the social side of this challenge, hence the dual term forest urbanism and urban forestry.

Planning, designing, establishing, and managing resilient urban forests and forest urbanisms that contribute to global warming mitigation and adaptation requires interdisciplinary collaboration. To discuss and enhance this type of collaboration, an international conference was held in Leuven in June 2022 under the title of “*Urban Forests, Forest Urbanisms, and Global Warming—Developing Greener, Cooler, and More Resilient Cities.*” The conference addressed central questions such as: What do we know about the mitigation and adaptation benefits of urban forestry? How can the climate benefits of urban forests be optimised through governance, planning, design, and management? What integrative and innovative approaches can be developed, for example, in collaboration between (urban) forestry, urbanism, (landscape) architecture, ecology, sociology, and other fields? What do the green and climate-resilient cities of the future look like, and how are they actually made? How can large-scale tree planting and afforestation be embedded in sustainable and socially inclusive urban forestry programs? Which new forms of forest urbanisms can be developed?

The event was structured along the three pillars of Science, Policy, and Design, with a mix of panel debates, invited talks, and voluntary contributions. This special issue of *Arboriculture & Urban Forestry* includes

some of the papers presented at the event, mostly during the Science sessions (although one of the papers, by Smachylo, was part of the Policy pillar). These sessions concentrated on insights from earth, environmental, and related sciences—particularly ecology, forestry, soil science, geology, and environmental psychology. They focused on empirical and evidence-based approaches that support policies, programmes, and projects. Research from across the world highlighted the state-of-the art in the interdisciplinary field of urban forestry, particularly with regards to climate change mitigation and adaptation to global warming.

The selection of papers compiled in this special issue reflects the diversity of research presented at the conference. Three contributions directly focused on urban tree diversity and the need to recognise and promote desirable tree species and characteristics. **Maribel Carol-Aristizabal et al.** use a Delphi and expert-based approach to study which tree species are perceived as best able to withstand urban stressors in the northeastern part of North America, with *Ginkgo biloba*, *Gleditsia triacanthos*, *Quercus* spp., and *Ulmus* spp. being ranked highest. Also for North America, **Annick St-Denis et al.** introduce a new decision-support and open-source software available on a web platform, designed to consolidate information related to the urban forest in one place and facilitate decision-making at different scales. Using artificial intelligence, the tool identifies the types of trees (species and functional groups) that are absent or underrepresented at different scales to make recommendations that increase species and functional diversity to improve resilience to global change. **Saskia de Wit et al.** look at tree species in relation to visual-spatial perception, addressing the spatial and multi-scalar relationship between city and trees, an aspect which has received little attention to date. The authors argue that analysing the urban forest from a visual-spatial perception is needed to understand relationships between different components as well as site-specific qualities. Using the Dutch city of Delft as study area, the study identified 35 generic tree configuration types. With this “vocabulary,” the authors studied specific tree configurations and their relations, describing the urban forest from an eye-level perspective as an essential level on which the spatiality of the urban forest can be understood.

Maidier Llaguno-Munitxa et al. also focus on visual aspects, starting from the premise that visual accessibility to nature has a positive relation to human health. As the authors argue, however, visual accessibility is seldom considered in planning and policy-making, also because of the challenges associated with the measurability of green views. The authors look at the potential value of two methods that can help compute street-level tree views.

Modelling, and more specifically agent-based approaches, scenario simulation, and machine learning were used by **Bulent Ozel and Marko Petrovic** to develop a framework for designing and monitoring green infrastructure. Digital representation of trees was created using a combination of datasets such as earth observations from space, street-view images, field surveys, and qualitative descriptions of typologies within existing and future projects. Scenarios were also used by **Agatha Czekajlo et al.** in their work in a Vancouver, Canada, neighbourhood. The researchers spatially modelled 4 planting scenarios for increasing tree canopy cover by 2050 in a densifying neighbourhood. Their systematic framework for generating and spatially modelling trees in a simulated future neighbourhood provides an opportunity for iteratively assessing multiple potential tree-planting configurations and achieving municipal canopy targets.

Ultimately urban forestry decision making comes down to governance processes and the interests and perspectives of the actors involved. In her contribution to this special issue, **Julia Smachylo** looks at the wider context of private forest ownership, in the case of the urbanising landscape of Ontario, Canada. She illustrates a shift in stewardship on private lands through a rescaling of management responsibility that embraces different perspectives and builds place-based practical knowledge of forest systems. The role and importance of forest management plans as key elements of landscape stewardship and achieving policy objectives is highlighted.

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