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From Smart Urban Forests to Edible Cities: New Approaches in Urban Planning and Design

Editors

Alessio Russo and Francisco J. Escobedo

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Academic Editors
Alessio Russo (University of Gloucestershire)
Francisco J. Escobedo (USDA Forest Service)

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Editorial

From Smart Urban Forests to Edible Cities: New Approaches in Urban Planning and Design

Alessio Russo [1,*] and Francisco J. Escobedo [2]

[1] School of Arts, University of Gloucestershire, UK
[2] USDA Forest Service, Pacific Southwest Research Station, USA

* Corresponding author (arusso@glos.ac.uk)

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Abstract
In recent years, the pressing environmental, social, and economic problems affecting cities have resulted in the integration of the disciplines of landscape architecture and urban forestry via a transdisciplinary approach to urban planning and design. Now, new urban forestry approaches and concepts have emerged for more sustainable city planning. The discipline is using different methods and approaches to address many pressing issues such as human well-being and also food security. But, research on these topics is still limited and not available for many cities in the world. To fill this gap, we present this thematic issue "From Smart Urban Forests to Edible Cities: New Approaches in Urban Planning and Design." The findings from this thematic issue offer new insight to policymakers and practitioners, as well as contribute to the emerging literature on edible and forest cities. Furthermore, the findings spanning different cities from different geographies can be used towards achieving the 2030 Agenda and Sustainable Development Goals of making cities and human settlements more resilient, inclusive, safe, and sustainable, as well as ending hunger, achieving food security, and improving nutrition. However, further studies are still needed, especially in developing countries and the Global South.

Keywords
ecosystem services; environmental justice; green infrastructure; urban agriculture; urban food forests; urban forests; urban green space

Issue
This editorial is part of the issue "From Smart Urban Forests to Edible Cities: New Approaches in Urban Planning and Design" edited by Alessio Russo (University of Gloucestershire) and Francisco J. Escobedo (USDA Forest Service).

1. Introduction

According to the latest United Nations (UN) estimates, the world's population will increase to 8.5 billion in the next 10 years, rising to 10.9 billion in 2100. Furthermore, by 2030, cities will house 70% of the world's population (UN, 2019). The 21st century is being marked by several challenges affecting more sustainable urban development as the urban population continues to grow. In the 21st century, urbanists have paid little attention to a city's food security, but recent events such as the Covid-19 pandemic, armed conflicts, and climate change have brought this problem to the forefront. Therefore, more research is now required to aid the food revolution in cities and to be capable of feeding 10 billion people (Russo & Cirella, 2019). According to Sustainable Development Goal 11, by 2030, we should "make cities inclusive, safe, resilient, and sustainable" (UN, 2022). Urban planning has a long tradition in addressing design and livability issues in cities (Ruth & Franklin, 2014). Similarly, nature-based solutions, forest cities, smart cities, biophilic cities, eco-urbanism, blue-green cities, garden cities, and other approaches that use green spaces, urban agriculture, and vegetation have also been proposed to address complex societal challenges in metropolitan areas (Escobedo et al., 2019; Russo &

Cirella, 2018; Sardeshpande et al., 2021). To address the recent problems associated with issues such as rapid urbanization, the Covid-19 pandemic, in-situ densification in cities, poverty and environmental justice, progressive environmental degradation, and climate change effects; new solutions and approaches are required (Escobedo et al., 2019). Thus, to address such complex problems more transdisciplinary approaches must be taken. One first step is an urgent need to better understand cities as social-ecological systems.

2. Thematic Issue: From Smart Urban Forests to Edible Cities

Accordingly, this thematic issue contains five peer-reviewed articles and two commentaries spanning different cities and many of these problems from across the world. Three main themes were addressed in this suite of works: 1) urban agriculture and urban food forests; 2) environmental justice aspects of urban green space; and 3) urban forest planning and citizen participation. Figure 1 shows the most frequent words found in these articles and commentaries. With urban as the central theme of these publications, we see that issues related to planning, green spaces, forests, environment, and food were the central pieces of this thematic issue.

In the opening piece, Cariñanos et al. (2022) provided a reflective commentary on the importance of urban food forests (UFFs) in cities of the 21st century. According to the authors, urban planning should provide frameworks for effectively, and transparently, implementing land-use regulations to encourage a wider use of UFFs. They should, in particular, ensure that green spaces, including those designated for urban UFFs, are given equal weight in the urban planning process as are other built-environment elements. As such, green space planning should be viewed as an opportunity to create multifunctional spaces that benefit a wide diversity of city dwellers (Cariñanos et al., 2022).

Rockwell et al. (2022) study the role of tree species richness, stem density, and canopy cover and its role in food forest gardens in subtropical landscapes in Miami-Dade County's Public Schools. The food forest canopy was comparable to urban tree cover in adjacent neighborhood, according to the authors. They also found that food forests had higher arborescent species richness (including an increase in edible taxa) and stem density than nearby neighborhood plots. Instead of focusing on large individual street trees, planting edible species in small spaces (e.g., empty lots or residential yards) could improve local food production. They also argue that rather than focusing on ornamental taxa, local food production could be improved by planting a diversity of edible species as well. Their research emphasizes the importance of using mixed edible tree species plantings to meet urban forestry and agricultural goals proposed by city planners and managers (especially in terms of several ecosystem services; Rockwell et al., 2022).

France (2022) contributes a more nuanced perspective that is different from many of the other quantitative, analysis-based articles in the thematic issue. In their piece, the author points out that indeed, the urban

Figure 1. The 100 most frequently used words in this thematic issue, using NVivo 12 Pro.

agriculture literature has primarily focused on landscapes as biophysical spaces in which to grow food, rather than as humanized spaces in which to grow experience, making the case for different dimensions of what is well-being and consideration for achieving outcomes, such as the UN's Sustainable Development Goal 11. Specifically, in order to invigorate case study descriptions through the reflexive tool of narrative scholarship, it is necessary to leave the desk behind and enter the field (France, 2022).

Das (2022), in their contribution from India, found that in organized green spaces, environmental justice must be developed and managed. In Das' study, the factors that contributed to environmentally unjust development and management of organized green spaces were examined, and various strategies that would lead to reversing environmental justice were evaluated, using the context of three Indian cities. The findings suggested that factors related to organized green space, such as community features and infrastructure, the economics of development and management of organized green space, linking green space to environment and health, spatial development, land use and accessibility, and land availability and governance of the supply of green space, all contributed to environmental injustice (Das, 2022).

Birks et al. (2022) investigated the role of a key process in transdisciplinary and governance processes in cities: citizen participation and the public's role in urban forests, in the Metropolitan Area of Rouen, France. Here, the authors' use of different survey instruments and quantitative analyses shed new light on these frequently used instruments processes that are key to effectively managing and planning urban forests and cities. Given the high degree of ambivalence and contrast in how population groups relate to urban forests and to representative/participatory systems, the findings highlight the challenges, difficulties, and limitations of a participatory approach (Birks et al., 2022).

Lewis et al. (2022) used a structured content analysis to look into the evolution of urban green space planning in Europe and the US by using two case study cities: Buffalo, New York, and Porto, Portugal. Although located in two different continents, both cities experienced suburbanization and shrinkage, but their green space planning histories were very different. The goal of their study was to see how objectives and priorities for planning green spaces change during a period of urban shrinkage, and specifically what functions these cities have assigned to green space. They found that over time, green spaces were expected to produce more ecological functions in both cities, as well as contribute to the city's economic and demographic outcomes, particularly in Buffalo. Finally, the authors suggested that general green space planning studies should take demographic change into account as a relevant context factor (Lewis et al., 2022).

Finally, Muñoz Sanz et al. (2022), using a mixed-methods approach, compared how three cities (Almere, Madrid, and Boston) approach urban forest project planning and their alignment with different organizational and typological interpretations of an urban forest. Through the analysis of project documents and expert interviews, their study provides an approach that can be used to learn about a project's main goals, its organizational structure, and the planning process that was used. Their findings suggest that environmental issues are being effectively mainstreamed among actors, but they also point to a lack of objective criteria that can be used to evaluate urban forest success. Interestingly, the authors found that municipal planners were able to circumvent existing internal rigidities and barriers by relying on intermediaries and local academia as sources of external knowledge or by facilitating experiments. Studies such as these indicate the socio-ecological complexities of cities and suggest that there may not be a single type of urban forest that can achieve the desired environmental and social goals while also overcoming implementation challenges (Muñoz Sanz et al., 2022).

3. Conclusions

This thematic issue addresses an important and timely topic for the design of future cities. But, as several authors point out, there is a need for a more nuanced and global perspective that provides insights into alternative approaches to urban greening. Similarly, although several studies in this thematic issue were based on methods from the biophysical and ecological science or urban planning, other perspectives and methods can equally contribute to more effective, efficient, and equitable urban planning and UFF. Accordingly, the studies we presented demonstrated the importance of doing this in regions where soon most of the urban residents will be residing in the near future, and highlight the need for more experiences and studies from the Global South. And although most of our studies were from high income countries, we feel the results and lessons do have implications for other cities who strive for more effective governance. Indeed, the thematic issue's articles and commentaries provided different insights on how cities change as societies and economies transition from industrial to service-based sectors. In conclusion, as transdisciplinary approaches are being touted as being key in cities, rarely are they studied using an applied research and planning lens. Here, we hope this thematic issue contributes towards this, by providing experiences and research from cities in France, the US, India, Portugal, the Netherlands, and Spain.

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Conflict of Interests

The authors declare no conflict of interests.

References

Birks, C., Féménias, D., & Machemehl, C. (2022). Citizen participation in urban forests: Analysis of a consultation process in the metropolitan area of Rouen Normandy. *Urban Planning*, *7*(2), 174–185. https://doi.org/10.17645/up.v7i2.4997

Cariñanos, P., Borelli, S., Conigliaro, M., & Fini, A. (2022). The place of urban food forests in cities of the 21st century. *Urban Planning*, *7*(2), 135–138. https://doi.org/10.17645/up.v7i2.5567

Das, D. K. (2022). Factors and strategies for environmental justice in organized urban green space development. *Urban Planning*, *7*(2), 160–173. https://doi.org/10.17645/up.v7i2.5010

Escobedo, F. J., Giannico, V., Jim, C. Y., Sanesi, G., & Lafortezza, R. (2019). Urban forests, ecosystem services, green infrastructure and nature-based solutions: Nexus or evolving metaphors? *Urban Forestry & Urban Greening*, *37*, 3–12. https://doi.org/10.1016/j.ufug.2018.02.011

France, R. (2022). From desk to field: Countering agrourbanism's "paper landscapes" through phenomenology, thick description, and immersive walking. *Urban Planning*, *7*(2), 155–159. https://doi.org/10.17645/up.v7i2.5591

Lewis, O., Sousa, S., & Pinho, P. (2022). Multifunctional green infrastructure in shrinking cities: How does urban shrinkage affect green space planning? *Urban Planning*, *7*(2), 186–201. https://doi.org/10.17645/up.v7i2.5008

Muñoz Sanz, V., Romero Muñoz, S., Sánchez Chaparro, T., Bello Gómez, L., & Herdt, T. (2022). Making green work: Implementation strategies in a new generation of urban forests. *Urban Planning*, *7*(2), 202–213. https://doi.org/10.17645/up.v7i2.5039

Rockwell, C. A., Crow, A., Guimarães, É. R., Recinos, E., & La Belle, D. (2022). Species richness, stem density, and canopy in food forests: Contributions to ecosystem services in an urban environment. *Urban Planning*, *7*(2), 139–154. https://doi.org/10.17645/up.v7i2.5135

Russo, A., & Cirella, G. (2018). Modern compact cities: How much greenery do we need? *International Journal of Environmental Research and Public Health*, *15*(10), Article 2180. https://doi.org/10.3390/ijerph15102180

Russo, A., & Cirella, G. T. (2019). Edible urbanism 5.0. *Palgrave Communications*, *5*(1), Article 163. https://doi.org/10.1057/s41599-019-0377-8

Ruth, M., & Franklin, R. S. (2014). Livability for all? Conceptual limits and practical implications. *Applied Geography*, *49*, 18–23. https://doi.org/10.1016/j.apgeog.2013.09.018

Sardeshpande, M., Rupprecht, C., & Russo, A. (2021). Edible urban commons for resilient neighbourhoods in light of the pandemic. *Cities*, *109*, Article 103031. https://doi.org/10.1016/j.cities.2020.103031

United Nations. (2019). *World population prospects 2019: Highlights*. https://www.un.org/development/desa/publications/world-population-prospects-2019-highlights.html

United Nations. (2022). *#Envision2030 Goal 11: Sustainable cities and communities*. https://www.un.org/development/desa/disabilities/envision2030-goal11.html

About the Authors

Alessio Russo is a senior lecturer and academic course leader for the Master of landscape architecture at the University of Gloucestershire, Cheltenham, UK. Before joining the University of Gloucestershire, he worked in Russia as an associate professor at RUDN University in Moscow and professor and head of Laboratory of Urban and Landscape Design at Far Eastern Federal University in Vladivostok. His current research interests are manifold, ranging from ecosystem services to health and wellbeing in urban green spaces.

Francisco J. Escobedo is a research scientist with the US Forest Service-Pacific Southwest Research Station and the Los Angeles Center for Urban Natural Resources Sustainability. His research focuses on the environmental sustainability and resilience of communities and ecosystems in urban and peri-urban areas as well as measuring and understanding the benefits and costs of urban forests and how socioeconomic factors and policies drive changes to these ecosystems. Most recently he was a professor of socio-ecological systems at the Universidad del Rosario in Bogota, Colombia (2016–2020) and an associate professor of urban and community forestry at the University of Florida, US (2006–2015).

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Commentary

The Place of Urban Food Forests in Cities of the 21st Century

Paloma Cariñanos [1,*], Simone Borelli [2], Michela Conigliaro [2], and Alessio Fini [3]

[1] Department of Botany, University of Granada, Spain
[2] Forestry Division, Food and Agriculture Organization of the United Nations (FAO), Italy
[3] Department of Agricultural and Environmental Sciences, University of Milan, Italy

* Corresponding author (palomacg@ugr.es)

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Abstract
The history of urban food forests (UFFs) dates back to ancient times, when civilizations incorporated edible species into wild forests to create an ecosystem as natural as and self-sufficient as possible. Since the second half of the 20th century, the practices of integrating edible plants into ornamental landscapes have spread throughout the world. Currently, UFFs must face a number of challenges similar to those encountered by urban forests: land tenure, governance, technical capacities, and pollution and global change issues, and must be addressed in order to identify the most suitable combination of productive, environmental, and socio-economic functions of UFF. The events on a global scale that occurred in the first decades of the 21st century are forcing those who live and work in urban environments to react quickly to address the upcoming challenges.

Keywords
ecosystem services; edible cities; food forests; food security; urban challenges; urban forests

Issue
This commentary is part of the issue "From Smart Urban Forests to Edible Cities: New Approaches in Urban Planning and Design" edited by Alessio Russo (University of Gloucestershire) and Francisco J. Escobedo (USDA Forest Service).

1. Introduction

Food production in urban public spaces is not a new concept. In most civilizations, fruit trees in combination with other plants and crops were commonly found in cities. For instance, fig trees, palm trees, jujube, olive, peaches and pomegranates were common in Egyptian gardens, which are considered "pioneers" in the creation of edible landscapes. The desire for natural features aimed at stimulating the senses filled Islamic gardens with cherries, peaches, almonds, as well as exotic plants as status symbols for royals, such as pears, bananas and apples. The discovery of America made it possible to transfer to Europe the American indigenous peoples ecosystemic approach of edible forests, which incorporated a number of edible species in natural forests taking advantage of the natural ecological processes. The concept of edible gardening was already a reality in the Renaissance, where a typical plot could contain figs, pears, and apples, as well as a selection of vegetables and medicinal plants. This was also the time in which the open air orangeries, dedicated to the plantation of citrus fruits, originated in Italy.

In the 20th century, the practices of integrating edible plants into ornamental landscape spread throughout the world under different names: edible landscaping, edible green infrastructure, foodscaping, urban food commons. More recently, Clark and Nicholas (2013, p. 1652) defined urban food forests (UFFs) as "multiple perennial and annual food-producing species in multistoried arrangements, providing canopy cover while at the same time addressing resident needs such as food security and health." In other words, UFFs are high-yield, low-impact, and low-maintenance cultivation practices inspired by natural forest systems which they attempt to mimic.

2. The Benefits of UFFs

UFFs promote the multifunctional use of green public spaces, as they combine food production with biodiversity conservation, maintenance of ecosystem services, and public services provision. If properly designed, an hectare of mature food forest can provide food for 5–6 people, but species whose edible portion is rich in protein, such as *Phaseolus* spp., *Castanea* spp., *Juglans* spp. are needed to make a UFF-based diet balanced (Nytofte & Henriksen, 2019).

In addition to this, UFFs provide a wide range of direct and indirect benefits to human health: They improve eating habits with the introduction of healthier products, increase the availability and accessibility of healthy food in cities, and improve mental health through the provision of spaces where to practice gardening activities to relax and restore.

UFFs may provide important social benefits by promoting citizen engagement and social cohesion (Borelli et al., 2021) as they have proven to be engines of collective action promoting community revitalization and enabling spaces for education, research, and outdoor leisure (Bukowski & Munsell, 2018). The contribution of UFFs to sustainable urban development is also remarkable in aspects such as promoting sustainable farming methods, recovering forgotten fruit and vegetable varieties, giving added value to public spaces, reducing the cost of maintaining green spaces, and providing a habitat for wildlife.

UFFs also provide the ecosystem services associated with urban forests such as prevention of erosion and generation of soil, support and conservation of biodiversity, regulation of the local water regime, mitigation of the urban heat island effect, and provision of quality public spaces.

3. Supporting the Establishment of UFFs

The establishment of UFFs is still not very widespread. To encourage a wider use of this land use system, urban plans should provide frameworks for implementing land-use regulations in an effective and transparent manner. In particular, they should ensure that green spaces, including areas that are designated for urban UFFs, receive equal attention in the urban planning process as the elements of the built environment. Indeed, green space planning should not be seen as a space for conflict between urban forestry, urban agriculture, and urban recreation but rather as an opportunity to create multifunctional spaces maximizing benefits to urban dwellers.

Quality governance of green spaces also requires that the city administration has a solid vision of how natural resources should be managed and that technical municipal services have the necessary skills and knowledge on the establishment and management of UFFs. It is also essential that the community is empowered to actively participate in the governance process. Depending on the local conditions, governance can follow different models ranging from full self-governance of land users to a more comprehensive governmental regulatory framework.

Urban pollution is also a concern. The chronic exposure of UFF to high soil- and air-borne pollution load has raised concerns about the safety of food produced in urban areas (Gori et al., 2019). However, although uptake and translocation of heavy metals from the soil to above-ground organs has been reported for several plant species (Samsøe-Petersen et al., 2002), most heavy metal accumulation by woody plants occurs in other organs than the fruit (Gori et al., 2019), which makes them generally safer for urban consumption than food produced by non-woody crops (von Hoffen & Säumel, 2014). Also, chronic exposure to air-borne particulate matter can lead to fruit contamination because of atmospheric deposition of pollutants. However, as most of available knowledge is based on studies focused on individual species, future research should focus on the understanding of heavy metal uptake by complex, multi-layered systems, such as UFFs.

4. Conclusions

The events on a global scale that occurred in the first decades of the 21st century such as pandemics, wars, and exacerbation of extreme weather events are testing the capacity of cities to respond to both natural and anthropogenic impacts. In addition to these challenges, already complex in themselves, urban environments must address a rapid transformation to accommodate the significant migratory flow of people who move to the city in search of better living conditions. One of the priority actions is to guarantee food security to the entire population, allowing equal access to healthy food and promoting healthy lifestyles (Castro et al., 2018).

In this context, UFF stands out as an effective option to address upcoming challenges. Many cities around the world have begun to redesign their food provision model towards more resilient and equitable ones, which minimize the global trade of food and look inside for solutions (Russo & Cirella, 2019). Several initiatives implemented in the Mediterranean region have highlighted the potential that numerous native species of urban trees could have to be part of UFF (Cariñanos et al., 2019). In addition, the role model that UFF has in reconnecting adults and children to healthy eating habits, food growing, and the special experience of foraging and harvesting food directly from the plant in a nature-like setting has been pointed out (Riolo, 2019). The "incredible-edible-Todmorden" initiative in the UK, or that of the French city of Rennes, which has declared its commitment to become an edible city, are just a few examples of strategies ready to be applied. But it is in the United States that UFFss are capturing the most attention from people and neighborhoods. From the Beacon Hill Food Forest in Seattle, to the Brown Hill in Atlanta,

there are more than 70 UFF across the country, in which the connection of people with a forested space where food grows is reinforcing their social sense of place, values, identity, and community.

These initiatives show that urban food forestry is an increasingly widespread practice. However, more effort is needed in identifying the most suitable combination of productive, environmental, and socio-economic functions and in designing the most effective mosaic of "green" land uses suited to the different conditions of individual cities. It is therefore time to take action and rethink and redesign urban green spaces, using UFFs as a strategy towards a safer, more inclusive, resilient, economically and environmentally sustainable city model.

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Conflict of Interests

The authors declare no conflict of interests.

References

Borelli, S., Conigliaro, M., & Salbitano, F. (2021). The social impacts of NBS: Access to and accessibility of green spaces as a measure of social inclusiveness and environmental justice. In E. Croci & B. Lucchitta (Eds.), *Nature-based solutions for more sustainable cities–A framework approach for planning and evaluation* (pp. 211–224). Emerald Publishing.

Bukowski, C., & Munsell, J. (2018). *The community food forest handbook: How to plan, organize, and nurture edible gathering places*. Chelsea Green Publishing.

Cariñanos, P., Delgado-Capel, M., Maradiaga-Marín, M. F., & Benítez, G. (2019). Considerations on the allergy-risks related to the consumption of fruits from urban trees in Mediterranean cities. *Urban Forestry and Urban Greening*, *45*, Article 126303.

Castro, J., Ostoic, S. K., Cariñanos, P., Fini, A., & Sitzia, T. (2018). "Edible" urban forests as part of inclusive, sustainable cities. *Unasylva*, *69*(250), 59–65.

Clark, K. H., & Nicholas, K. A. (2013). Introducing urban food forestry: A multifunctional approach to increase food security and provide ecosystem services. *Landscape Ecology*, *28*(9), 1649–1669.

Gori, A., Ferrini, F., & Fini, A. (2019). Growing healthy food under heavy metal pollution load: Overview and major challenges of tree based edible landscapes. *Urban Forestry and Urban Greening*, *38*, 403–406.

Nytofte, J. L. S., & Henriksen, C. B. (2019). Sustainable food production in a temperate climate—A case study analysis of the nutritional yield in a peri-urban food forest. *Urban Forestry and Urban Greening*, *45*, Article 126326.

Riolo, F. (2019). The social and environmental value of public urban food forests: The case study of the Picasso Food Forest in Parma, Italy. *Urban Forestry and Urban Greening*, *45*, Article 126225.

Russo, A., & Cirella, G. T. (2019). Edible urbanism 5.0. *Palgrave Communications*, *5*(1), 1–9.

Samsøe-Petersen, L., Larsen, E. H., Larsen, P. B., & Bruun, P. (2002). Uptake of trace elements and PAHs by fruit and vegetables from contaminated soils. *Environmental Science and Technology*, *36*(14), 3057–3063.

von Hoffen, L. P., & Säumel, I. (2014). Orchards for edible cities: Cadmium and lead content in nuts, berries, pome and stone fruits harvested within the inner-city neighbourhoods in Berlin, Germany. *Ecotoxicology and Environmental Safety*, *101*, 233–239.

About the Authors

Paloma Cariñanos is a professor of botany at University of Granada, Spain. Her research is focused on the evaluation of services and disservices provided by urban forests, with special emphasis on those that have an impact on health, green infrastructure, and management of biodiversity in urban envoronemnts. She is coordinator of FAO's Silva Mediterranea WG on urban and periurban forestry since 2020.

Simone Borelli holds a degree in forestry, an MSc in watershed management, and a PgDip in public management. He has worked for the Food and Agriculture Organization of the UN (FAO) for 25 years and is currently responsible for urban forestry, providing technical support and policy advice to member countries. He is one of the creators of the World Forum on Urban Forestry and of the Tree Cities of the World programme. He has also worked for WWF and Bioversity.

Michela Conigliaro holds a Master's degree in biodiversity conservation and ecosystem management from the University of Rome, Italy. She has been working for FAO since 2012, when she joined the Forestry Department to support the implementation of the Urban and Peri-urban Forestry Programme. Prior to working for FAO, Michela collaborated to the development of regional activities with the IUCN Centre for Mediterranean Cooperation in Malaga, and with the Italian Committee of IUCN in Rome.

Alessio Fini is associate professor of arboriculture and urban arboriculture at the Department of Agricultural and Environmental Sciences—Production, Landscape, Bioenergy at the University of Milan. His research interests are mainly focused on sustainable cultivation techniques for nursery production and urban forestry, on stress tolerance of urban trees, and on ecosystem services provisioning by urban vegetation. He is associate editor of *Urban Forestry and Urban Greening* journal and coordinator of FAO´s Silva Mediterranea WG on urban and periurban forestry since 2020.

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Article

Species Richness, Stem Density, and Canopy in Food Forests: Contributions to Ecosystem Services in an Urban Environment

Cara A. Rockwell [1,*], Alex Crow [2], Érika R. Guimarães [2], Eduardo Recinos [3], and Deborah La Belle [3]

[1] Institute of Environment, Florida International University, USA
[2] Department of Earth and Environment, Florida International University, USA
[3] The Education Fund, USA

* Corresponding author (crockwel@fiu.edu)

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Abstract
Food forests expand the traditional concepts of urban forestry and agriculture, providing a broad diversity of tree-related ecosystem services and goods. Even though food forest systems bridge an obvious gap between agriculture and forestry, their potential value in the urban landscape is often undervalued. The inclusion of edible species in urban forest stands can enhance nutrition and well-being in the urban landscape, where food deserts are common. The potential for ecosystem services is especially pronounced in subtropical and tropical regions, where there is a heightened need for shade due to climate change-related heat waves. For this study, we investigated the tree species richness, stem density, and canopy cover provided by food forest gardens in 10 Miami-Dade County, Florida public schools located in the urban landscape. We compared results with neighboring properties around the schools and discovered that the food forest canopy was comparable with neighborhood urban tree cover. Additionally, we established that arborescent species richness (including an increase in edible taxa) and stem density was higher in food forests than in adjacent neighborhood plots. We posit that local food production could be enhanced by planting edible species in small spaces (e.g., empty lots or residential yards), as opposed to focusing on just ornamental taxa or recommended street trees. Our study highlights the importance of using mixed edible tree species plantings (especially with consideration to provisioning, regulating, and supporting services), potentially meeting urban forestry and agricultural goals proposed by urban planners and managers.

Keywords
agroforestry; environmental services; green infrastructure; urban ecology; urban forestry; urban planning; urban sustainability

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1. Introduction

Urbanization has accelerated over the last few decades, with an estimated 55% of the global population now living in cities (Gao & O'Neill, 2020). Multiple socioeconomic benefits are associated with the urbanization process, yet questions remain about the feasibility of creating sustainable urban spaces where population density is high. As an example, urban forestry has gained considerable traction as an essential component of urban planning in the last decade (Escobedo et al., 2019; Miller et al., 2015). Increased forest canopy (or other types of green infrastructure; see Meléndez-Ackerman et al., 2018) in an otherwise artificial environment ensures the maintenance of several important ecosystem services, including mitigation of urban heat islands (Bowler et al., 2010; Moll, 1989) and carbon storage (Escobedo et al., 2010; Nowak & Crane, 2002). Indeed, in the last decade, there has been an intensified global effort to increase forest cover in the urban landscape, and

with good reason. For instance, a recent study looking at 37 metropolitan areas in the US determined that tree canopy coverage in minority neighborhoods averaged only 23%, compared to 43% in predominately US-born white neighborhoods (Locke et al., 2021). Other researchers corroborate this inequity of tree cover distribution across lower income neighborhoods (e.g., Flocks et al., 2011; Landry & Chakraborty, 2009), including the strong correlation between urban biodiversity and neighborhood wealth (the so-called "luxury effect"; see Hope et al., 2003; Leong et al., 2018; Schell et al., 2020). This type of socioecological disparity has led to the development of environmental justice movements (see Campbell, 2014), conceptual models (e.g., Johnson et al., 2020), as well as citizen science tools (e.g., Tree Equity Score; Vibrant Cities Lab: Resources for Urban Forestry, Trees, and Green Infrastructure).

Such discussions have important implications for sustainability and resilience in the urban landscape, not a minor consideration in this era of global climate change (see Ahern, 2013). Community resilience has been defined by other authors as the ability of community members to manage and use communal resources (including food) in order to thrive in an unpredictable and dynamic environment (see Food and Agriculture Organization of the United Nations, 2013; Magis, 2010; Tendall et al., 2015). Resilience is typically viewed as a key factor in determining sustainability (or the ability to meet our needs without compromising the needs of future generations; Berkes et al., 2008; Brundtland & Khalid, 1987; Wu, 2010). Accordingly, one way to reduce a community's ecological and economic vulnerability is to encourage a diversification of natural resources, including economically and culturally important plants (Brown & Jameton, 2000; Buchmann, 2009; Clark & Nicholas, 2013). Other studies have highlighted the important role that locally produced food plays in social networking, health, and community autonomy, particularly during times of economic and environmental strife (e.g., Buchmann, 2009; Meléndez-Ackerman et al., 2018; Shimpo et al., 2019). An increasingly popular trend in urban landscapes includes the cultivation of edible species in multi-storied home gardens, or "food forests" (FFs; Jacke & Toensmeier, 2005). FFs (in the permaculture lexicon, an edible agroforest with an emphasis on perennial plant taxa; see Park & Higgs, 2018; Park et al., 2018) expand the traditional concepts of urban forestry. Despite its ties to the relatively recent permaculture community, these types of multi-storied home gardens are some of the oldest agroforestry systems in existence, particularly in the pantropical regions of the world (Michon et al., 1986; Miller & Nair, 2006; Soemarwoto, 1987). The inclusion of high value edible tree species in gardens has the potential to enhance nutrition and well-being in urban areas, where "food deserts" are common (see Jensen & Orfila, 2021), perhaps explaining their increasing popularity in temperate areas (Lovell et al., 2017).

The ecological design of a FF mimics the structure and biodiversity of a natural forest system (Clark & Nicholas, 2013), including the high species richness, nutrient cycling, and multiple canopy layers typically found under natural conditions (McCoy et al., 2021). Even though FF systems are thought to deliver a broader perspective on the concepts of urban forestry and agriculture (McLain et al., 2012; Park et al., 2018), and contribute to urban food security (Albrecht & Wiek, 2021), their long-term impact in the urban landscape is still uncertain. While the expansive body of scientific studies on tropical rural agroforestry systems dates back several decades, empirical evidence on ecosystem services provided by FFs in the Northern Hemisphere is still in the early stages of development. Ecosystem services are typically defined as falling under distinct categories, including provisioning, regulating, supporting, and cultural services (see Escobedo et al., 2011; Zhang et al., 2018). In the case of FFs, these systems have the potential to provide a broad diversity of tree-related services under all four classifications: provisioning (food security, medicinal resources), regulating (carbon storage, nutrient cycling, shade, erosion mitigation, etc.), supporting (habitat, biodiversity), and cultural (environmental education, sense of place, aesthetic appeal; Eiden, 2021; Thiesen et al., 2022).

Certainly, an added benefit of the FF design (especially in tropical climates) is the patchy shade conditions provided by the multiple canopy layers. The upper and mid-canopy layers, as well as the high stem density, inevitably provide protection for plant species in the lower strata that might be more vulnerable to drought and heat. Additionally, well-designed mixed-species gardens that are considered "closed systems" (i.e., few to no external inputs; see Hart, 1996) are likely to improve soil health, with added benefits to the overall ecological sustainability of home gardening. Nitrogen loss in particular is reduced, due to the enhanced nutrient uptake by tree and crop roots from varying soil depths, a feature much more prominent in mixed-species communities (Nair & Graetz, 2004). The relatively small size of FFs also lends well to encouraging the presence of beneficial insects, including those responsible for pollination and predation services, something that has been noted in diverse, smaller gardens (but not yet studied in FF gardens; see Philpott & Bichier, 2017).

To date, few studies in this region have linked high plant diversity with food security, but it is a logical conclusion that agroforestry systems will augment nutrition levels in a given community, something that has already been documented in rural communities in the tropics (see Jose, 2009; Mburu et al., 2016; Mellisse et al., 2018). Even though edible tree species are often absent from municipal urban tree plans (see Brito & Borelli, 2020), their inclusion in these plans could help offset the low tree diversity often seen in urban areas, where city planners may select the most popular urban forest (UF) tree species, hoping to avoid certain risk factors, such

as breakage, maintenance costs, public ire, etc. (Barron et al., 2016; Castro et al., 2018; Kowalski & Conway, 2019; Paquette et al., 2006). Inevitably, this lack of diversity can put UFs at risk and reduces additional ecosystem services and benefits for community members.

We proposed to assess the tree species (or arborescent taxa; e.g., *Carica papaya*) richness, stem density, and canopy coverage of FF and neighboring UF plots in Miami-Dade County. Our aim with the study was to identify the potential contributions of these tree-based systems to provisioning (food production via the inclusion of edible taxa), regulating (canopy coverage), and supporting (species richness) services. Specifically, we ask:

1. Is species richness of arborescent taxa (≥5 cm diameter at breast height [dbh]) greater in the FF plots when compared with the species richness in UF plots, including a greater number of edible taxa?
2. Is stem density of arborescent species (≥5 cm dbh) higher in FF plots when compared with tree density in UF plots?
3. Is the percentage of canopy cover of FF plots comparable with those of UF plots?

2. Methods

2.1. Study Site

The study was conducted in Miami-Dade County, Florida (US), an area of approximately 6,300 km^2 that includes a diverse mix of metropolitan sprawl, natural areas, and agricultural lands (see Figure 1). The region is characterized by wet (May–October) and dry (November–April) seasons, with warm subtropical summers and mild winters, similar to other areas of the Caribbean. Economic and ecological challenges (e.g., rapid development, sea-level rise, vulnerability to hurricanes, and a high diversity of invasive tropical plant and animal species) are prevalent in the region (see Dawson, 2017; Groves et al., 2019; Keenan et al., 2018; Staudhammer et al., 2015). For example, sea-level rise has begun to push wealthy homeowners from locations such as Miami Beach and Fisher Island to the less-affluent neighborhoods sitting on the mainland's oolitic limestone Miami Rock Ridge. Long-term residents in these neighborhoods (many of them immigrants from the Caribbean and Latin America) are then dispersed, often to the outer reaches of the city, where housing prices are more affordable (Keenan et al., 2018).

Flocks et al. (2011) highlight the need for increased tree canopy cover in these disenfranchised neighborhoods, pointing to the higher tree diversity and density in wealthier neighborhoods, such as Coconut Grove and Coral Gables. Currently, the urban center of Miami-Dade County claims an overall canopy coverage of 20% (Hochmair et al., 2020), with recent canopy loss noted in some of the incorporated cities where our study sites are located (e.g., Hialeah). This amount is well below the 40–60% goal previously proposed by urban tree advocates like American Forests (Nowak & Greenfield, 2018), a trend that will be hard-pressed to curb, given the rapid population growth in the Miami-Dade County. According to a recent USDA Forest Service study (Nowak & Greenfield, 2018), Florida claims some of the highest rates of urban growth in the US, much of it centered in the southern portion of the state. Rapid urbanization in this subtropical urban landscape makes the

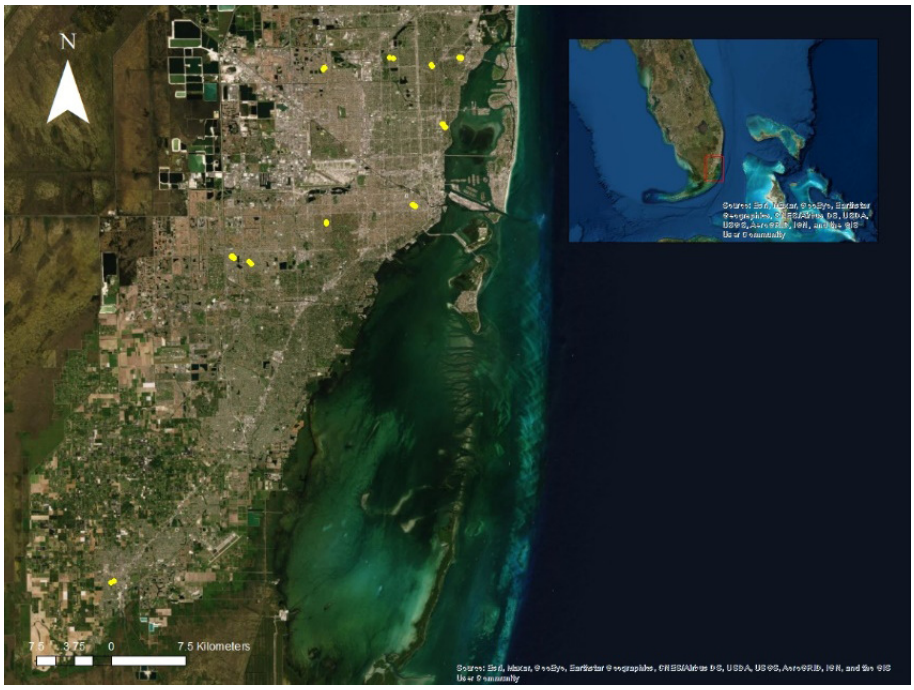

Figure 1. Miami-Dade County, Florida. Yellow dots indicate sites (10) where FF and UF plots were installed.

need to define and implement management plans for resilient UFs and urban growing systems even more critical (Barron et al., 2016; Ferreira et al., 2018; Ordóñez & Duinker, 2014).

2.2. Data Collection

Data were collected from February 2018 to October 2021 in FF gardens located in 10 Miami-Dade County public schools (see Figure 1). The size of the FF gardens in this study ranges from 0.10 to 0.40 ha, while the age of the gardens varies from one to six years. The FF gardens were designed and installed by The Education Fund's "Food Forests for Schools" program (https://www.educationfund.org/what-we-do/programs/food-forests-for-schools/food-forests-for-schools.html). Since 2015, the "Food Forests for Schools" program engages students at 26 Miami-Dade County public schools, elementary and K-8, to plant and maintain FFs on school grounds. The schools use the FFs to promote healthy eating habits and nutritional knowledge, and to create soothing outdoor sanctuaries while growing enough produce for school meals and homebound use. Typically, a rich variety of tropical edible species are cultivated in these perennial gardens (see Figure 2), including Filipino spinach (*Talinum fruticosum*), cranberry hibiscus (*Hibiscus acetosella*), papaya (*Carica papaya*), chaya (*Cnidoscolus aconitifolius*), katuk (*Sauropus androgynus*), sissoo spinach (*Alternanthera sissoo*), yuca (*Manihot esculenta*), bananas (*Musa* spp.), moringa (*Moringa oleifera*), longevity spinach (*Gynura procumbens*), and pigeon pea (*Cajanus cajan*; see McCoy et al., 2021).

Our field team established 10 20 × 20 m FF plots in the FF gardens, in which all arborescent (trees or tree-like) species with a dbh ≥ 5 cm were documented, mapped, and identified. Typically, the individuals in this size category were, on average, at least 4 m tall. Plot locations were selected based on a grid system, in which a plot location was chosen randomly using random number sequences (Laferrière, 1987). A potential plot site was only rejected if it centered on an impervious substrate (i.e., without vegetation). Nonetheless, due to the locations of the gardens within or adjacent to school buildings, some of the 20 × 20 m FF plots included parts of the schools' buildings (see Figure 3), a typical occurrence in garden studies (e.g., Philpott & Bichier, 2017). Neighboring 20 × 20 m UF plots were randomly located at least 100 m away from the FF plots. Similar to the FF plots, potential UF plot locations were rejected if they centered on an impervious substrate (e.g., only street substrate represented the plot). Locations of the plots were required to either have public access or (if on private property) to be of a reasonable distance from the street to ensure confident identification of the species in question. In the UF plots, all arborescent species with a dbh ≥ 5 cm were also documented, mapped, and identified. Species richness was determined to be the total number of taxa with a dbh ≥ 5 cm per plot (e.g., Gotelli & Colwell, 2001). Stem density was calculated using the total number of arborescent stems ≥ 5 cm across the entire 400 m^2 plot and multiplied by the conversion factor (25) to generate stem density ha^{-1}.

Canopy size estimates of the FF and UF plots were determined using the USDA Forest Service's web-based urban tree canopy assessment tool *i-Tree Canopy* V.7 (https://www.itreetools.org). The photo interpretation method of *i-Tree Canopy* uses a random point sampling protocol that interfaces with Google Maps™, enabling the user to estimate the percentage of different land cover types, including tree canopy (Hwang & Wiseman, 2020; Nowak et al., 2018). US Forest Service protocol recommends sample sizes of 500 and 1,000 points, assuming a standard urban municipal area coupled with an average tree canopy cover (US Forest Service, 2011). Boundaries were projected for each 400 m^2 plot area onto a Google Maps™ image of the study area. For our relatively small study areas, we opted to use 30 survey points that were randomly generated for each plot

Figure 2. One of the Miami-Dade County Public Schools' FF gardens surveyed in this study.

Figure 3. 20 × 20 m plots located in FF gardens at two of the participating Miami-Dade County Public Schools.

(Figure 4). Points were categorized as "tree" or "non-tree." For the purpose of this study, tall herbaceous plants (e.g., papaya and banana) were also included under the "tree" category, given their height, which was comparable to neighboring woody stems. Canopy from trees outside of the plots was not included since these stems were excluded from the species richness and stem density estimates.

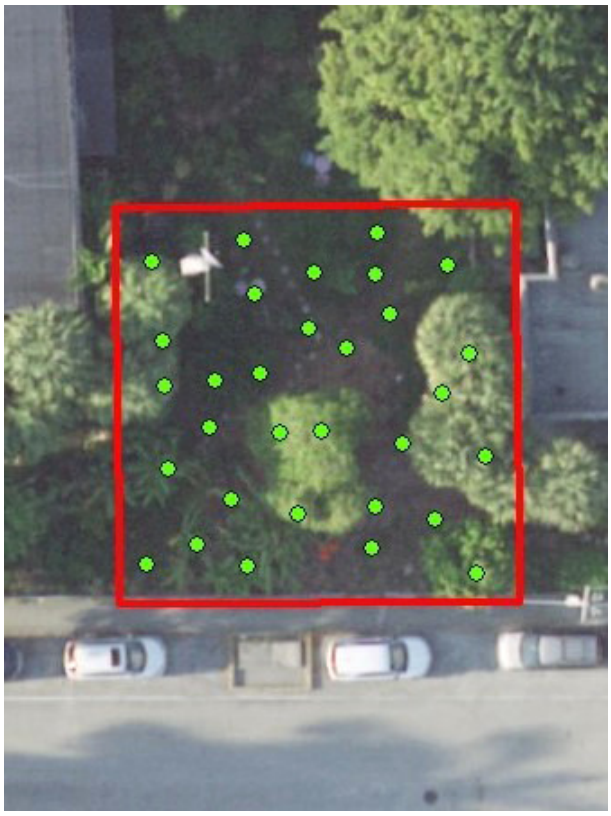

Figure 4. An example of the 30 points that were randomly generated by *i-Tree Canopy* tool in the 20 × 20 m plots.

2.3. Data Analysis

We compared differences in species richness, stem density, and canopy coverage across all 20 FF and UF plots using paired student t-tests in the R 3.4.2 platform (https://www.R-project.org). In addition to verification of plant species using the online New York Botanical Garden *C. V. Starr Virtual Herbarium* (http://sweetgum.nybg.org/science/vh), we also verified the native and invasive status of plant taxa using the Florida Plant Atlas (https://florida.plantatlas.usf.edu), as well as the Florida Invasive Species Council (FISC) website (https://floridainvasivespecies.org). The FISC list characterizes invasive plants as Category I (capable of altering native plant communities) or Category II (increased in abundance but not altering native plant communities).

3. Results

We documented 36 arborescent species across the FF and UF plots (see Table 1), with only 17 species associated with the UF plots, and 28 species in the FF plots. Of those taxa, four FISC Category I species (*Albizia lebbeck*, *Cupaniopsis anacardioides*, *Schefflera actinophylla*, and *Schinus terebinthifolia*) and three Category II species (*Cocos nucifera*, *Koelreuteria elegans*, and *Terminalia catappa*) were identified. While most of the individual invasive stems (n = 11) were located in UF plots, four (*A. lebbeck*, *C. nucifera*, *C. anacardioides*, and *T. catappa*) were found in FF plots. With the exception of the coconut palm, we assume that most of these invasive stems were presumably "volunteers" (or plants that occur naturally due to seed dispersal) that were left to grow and reproduce. Of the 36 species associated with this study, nine were determined to be South Florida natives (*Bursera simaruba*, *Carica papaya*, *Ficus aurea*, *Hamelia patens*, *Lysiloma latisiliquum*, *Pimenta racemosa*, *Quercus virginiana*, *Sabal palmetto*, and *Swietenia mahogani*), of which four were found in UF plots (*B. simaruba*, *F. aurea*, *Q. virginiana*, and *S. mahogani*), and eight were documented in the FF plots (*B. simaruba*, *C. papaya*, *H. patens*, *L. latisiliquum*, *P. racemosa*, *Q, virginiana*, *S. palmetto*, and *S. mahogani*). Only 16 of the 36 taxa recorded in this study are considered "edible," including the invasive *S. terebinthifolia*, which is commonly used as a spice in Caribbean cookery. While this aggressive species is typically present in the urban landscape via the easy dispersal of its seed (often through frugivorous birds), it is actively cultivated in some neighborhoods in Miami-Dade County (Cara A. Rockwell's personal observations). Of the 16 edible taxa, five were found in the UF plots (see Table 1). In only one case did we find an edible species in a UF plot that was absent in the FF plots (*Mangifera indica*). *Musa* spp. was the most abundant edible species (found only in the FF plots), with 51 identified stems (or as in the case of proper botanical terminology, "pseudo-stems"), although it is possible that some of these "individual" banana plants were actually offshoots of the original banana pseudo-stems. Even though cultivated bananas reproduce through "suckers" from the underground rhizome network, we counted these clonal genets as individual stems, rather than as one entire banana plant.

3.1. Species Richness

Average species richness was determined to be significantly higher in the FF plots ($p = 0.02$; see Table 2 and Figure 5), with approximately 5.5 arborescent species in each FF plot, and 2.8 in the UF plots. Given the total number of 28 species in the FF plots, this relatively low number of species per plot suggests that species composition varies significantly across the 10 FF sites, at least per unit area. Indeed, in some cases, the 400 m^2 surveyed represents a small fraction of the total area (e.g., the largest FF garden surveyed in this study is close to 4,000 m^2), so presumably, our sampling likely missed other arborescent species present in the gardens. Even though the more popular cultivated species (e.g., *C. papaya*, *Musa* spp.) are generally represented by multiple stems across the FF gardens, we did encounter clustering of certain species, potentially leading to underestimation (or overestimation in some cases) of some taxa within the 20 × 20 m plots.

Table 1. Identified species, South Florida native status, FISC category, and number of stems in 10 FF and 10 UF plots in Miami-Dade County, Florida.

Species	Common Name	Family	Edible	South Florida Native	FISC Category	FF	UF	Total
Adonidia merrillii	Christmas palm	Arecaceae				7	2	9
Albizia lebbeck	Golden silk tree	Fabaceae			I	1	1	2
Averrhoa carambola	Starfruit	Oxalidaceae	✓			1	1	2
Bursera simaruba	Gumbo limbo	Burseraceae		✓		5	1	6
Carica papaya	Papaya	Caricaceae	✓	✓		19		19
Chrysophyllum cainito	Caimito	Sapotaceae	✓			1		1
Citrus hystrix	Kaffir lime	Rutaceae	✓			1		1
Cnidoscolus aconitifolius	Chaya, Mayan spinach	Euphorbiaceae	✓			2		2
Cocos nucifera	Coconut palm	Arecaceae	✓		II	1		1
Cupaniopsis anacardioides	Carrotwood	Sapindaceae			I	1		1
Diospyros digyna	Black sapote	Ebenaceae	✓			1		1
Eriobotrya japonica	Loquat, Japanese plum	Rosaceae	✓			1	1	2
Ficus aurea	Florida strangler fig	Moraceae		✓			1	1
Ficus religiosa	Sacred fig	Moraceae				1		1
Hamelia patens	Firebush	Rubiaceae		✓		4		4
Handroanthus sp.	Trumpet tree/ipê	Bignoniaceae				1		1
Koelreuteria elegans	Flamegold rain tree	Sapindaceae			II		2	2
Ligustrum sp. *	Privet	Oleaceae					1	1
Lonchocarpus sp.	Lancepod	Fabaceae					1	1
Lysiloma latisiliquum	False tamarind	Fabaceae		✓		1		1
Mangifera indica	Mango	Anacardiaceae	✓				2	2
Moringa oleifera	Moringa	Moringaceae	✓			9	1	10
Morus nigra	Black mulberry	Moraceae	✓			3		3
Muntingia calabura	Jamaican cherry, strawberry tree	Muntingiaceae	✓			2		2
Musa spp.	Banana	Musaceae	✓			51		51
Peltophorum pterocarpum	Yellow poinciana	Fabaceae					1	1
Pimenta racemosa	Bay rum	Myrtaceae	✓	✓		1		1
Quercus virginiana	Live oak	Fagaceae		✓		2	12	14
Sabal palmetto	Sabal palmetto	Arecaceae		✓		12		12
Schefflera actinophylla	Queensland umbrella tree	Araliaceae			I		1	1
Schinus terebinthifolia	Brazilian pepper	Anacardiaceae	✓		I		3	3
Sesbania grandiflora	Hummingbird tree	Fabaceae	✓			2		2
Swietenia mahagoni	West Indian mahogany	Meliaceae		✓		1	3	4
Terminalia buceras	Black olive	Combretaceae				2	6	8
Terminalia catappa	Tropical almond	Combretaceae			II	1		1
Veitchia arecina	Montgomery palm	Arecaceae				6		6
Total						140	40	180

Notes: Category I—capable of altering native plant communities; Category II—increased in abundance but not altering native plant communities. * There are two FISC-listed Category I invasive *Ligustrum* species in Florida (*L. lucidum* and *L. sinense*), but we have refrained from listing this individual as an invasive, given that we were unable to identify it to species without flowers.

Table 2. Student t-test results for comparison of 10 FF and 10 UF plots in Miami-Dade County, Florida.

	Sample Mean		Student t-Test Results
	FF (pre-hurricane)	UF (post-hurricane)	
Species richness	5.5	2.8	df = 9; t = 2.8; p = 0.02
Stem density ha^{-1}	350	100	df = 9; t = 4.5; p ≤ 0.01
Canopy (%)	51.3	46.7	df = 9; t = 0.6; p = 0.57

3.2. Stem Density

Stem density between the FF and UF plots differed significantly (p ≤ 0.01; see Table 2 and Figure 5). The total number of stems across the ten FF plots was calculated to be 140 (dbh ≥ 5 cm), and the total number of stems across the 10 UF plots was 40. However, it must be noted that the average girth of the UF trees tended to be larger than the FF plants (the most common UF tree was the large canopy species, *Q. virginiana*), thus allowing for fewer trees within the 400 m^2 area, given above- and belowground competition limitations. The mean number of stems in the FF plots was found to be 14 (350 stems ha^{-1}), and four (100 ha^{-1}) in the UF plots.

3.3. Canopy Coverage

Canopy coverage did not differ between FF ($\bar{x}$ = 51.3%) and UF ($\bar{x}$ = 46.7%) plots (p = 0.57; see Table 2 and Figure 5), despite the higher number of stems and species richness in the FF plots.

4. Discussion and Conclusions

Our research represents an important case study about urban FF systems and their importance in urban landscapes. While we did not specifically measure long-term food security in these neighborhoods as a function of high species diversity, we did confirm that our FF plots had a high number of edible arborescent species (14 of the 28 FF species, or 50%), as well as a significant number of edible taxa stems (95 of the total 140 stems found in the FF plots, or 68%). One could therefore make a strong case that the inclusion of edible species in a front yard or an urban park (as opposed to a UF with none) could benefit food security (and potentially nutrition). In the UF plots, we documented several edible taxa (*Averrhoa carambola*, *Eriobotrya japonica*, *M. indica*, *Moringa oleifera*, and *S. terebinthifolia*), but four of these were found only in the front yard of one private residence. This lack of edible species in the UF plots (particularly in the case of plots that were located in the public right-of-way) suggests that there may be some reticence on the part of local governments to plant edible tree species (see Hajzeri & Kwadwo, 2019; Kowalski & Conway, 2019; Ortez, 2021). Certainly, data collection from Florida International University's Grove ReLeaf UF project (https://pg-cloud.com/ictb) confirms that few edible trees exist in the public right of way in Coconut Grove, a prominent neighborhood in the center of the city of Miami. According to their unpublished data set, only 45 of the total 319 arborescent species (which includes the herbaceous taxa *C. papaya* and *Musa* spp., as well as multiple palm species) are considered edible taxa. Of these taxa, *C. nucifera* (or coconut palm) is the most common edible species (326 occurrences in the database), although planting of *C. nucifera* is now prohibited by the City of Miami, due to the hazard it poses from falling fruits. Additionally, it has been identified by FISC as a Category II invasive plant. As another local example, the Miami-Dade County Street Tree Master Plan lists 63 recommended street trees, but only six taxa (*Celtis laevigata*, *Coccoloba diversifolia*, *Coccoloba uvifera*, *Noronhia emarginata*, *Pimenta dioica*, *Podocarpus* sp.) have edible or medicinal properties (Miami-Dade County, 2007).

Given the potential contributions of FF gardens to food security, lack of emphasis on edible species cultivation may be missing an important opportunity to address local food production, especially given the increased levels of food insecurity due to Covid-19 (see Gundersen et al., 2021; Niles et al., 2020). Indeed, edible tree species are often overlooked for urban canopy enhancement recommendations by municipal governments, despite the inclusion of FFs in the Food and Agriculture Organization's Guidelines on Urban and Peri-urban Forestry, which highlights their role in addressing hunger (Salbitano et al., 2016). In the case of the FFs in this study, certain species are known for high levels of production, depending on local site conditions, weather, management prescription (e.g., fertilization), and variety of the species in question. As an example, researchers from University of Florida's Institute of Food and Agricultural Sciences have determined that a mature grafted mango tree is capable of producing up to 100–150 kg/year (Crane et al., 2020), and the herbaceous papaya plant of producing 27–36 kg/year (Crane, 2018). Despite these obvious benefits, some of the hesitancy in planting edible species may have to do with concerns of maintenance, as well as urban pests, such as rats. A recent study from Brazil points to the low number of municipalities that encourage edible species, despite the increasing levels of food insecurity in Brazilian cities. Only five of the 49 municipalities surveyed considered the positive aspects of planting edible species in the UF; the rest of the UF management plans actively prohibited the planting of edible taxa (see Brito & Borelli, 2020).

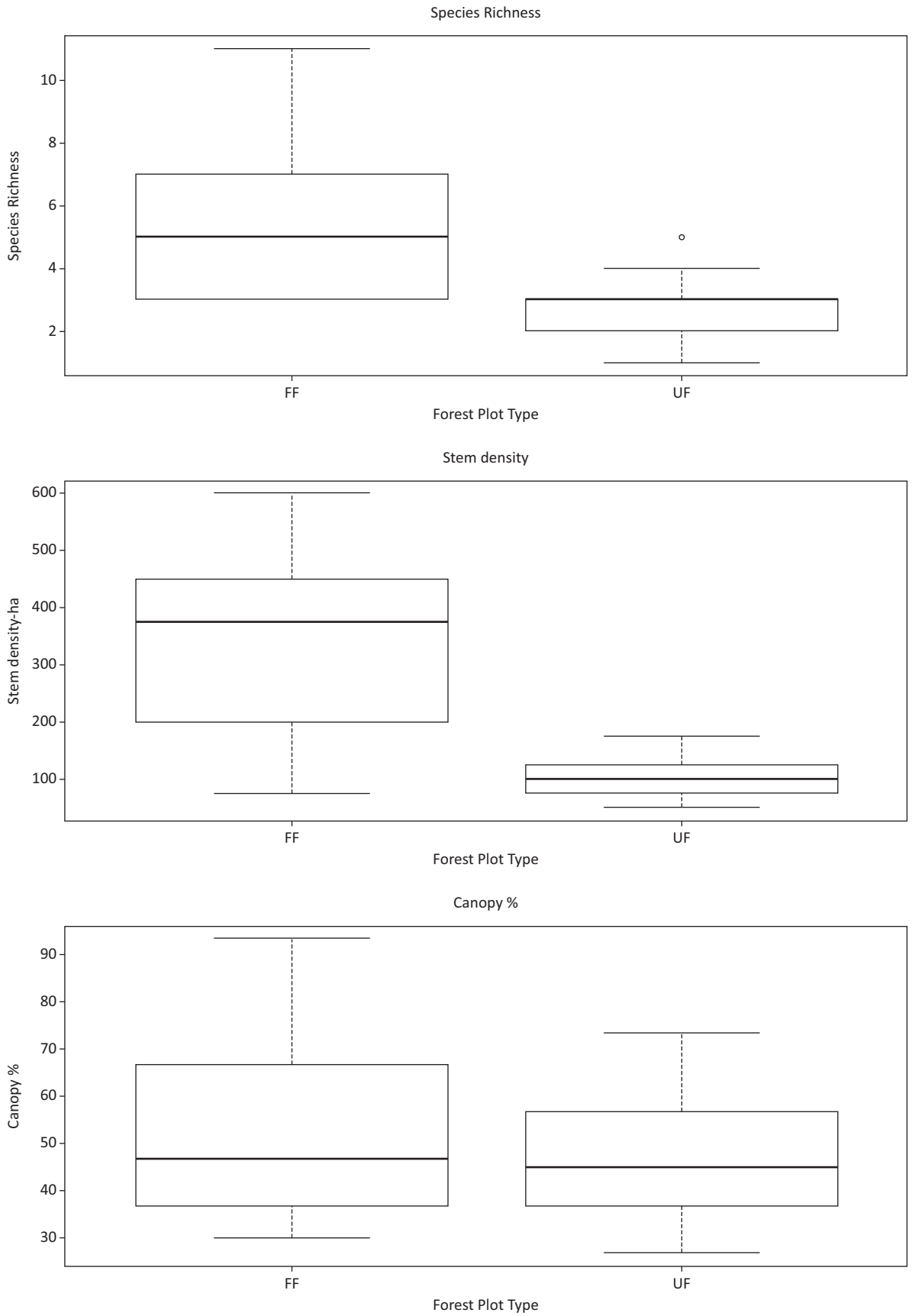

Figure 5. Paired student t-test results for species richness (number of species per hectare; p = 0.02), stem density (number of stems dbh ≥ 5cm per hectare; p ≤ 0.01), and canopy coverage (in %; p = 0.57) for 10 FF plots and 10 UF plots in Miami-Dade County, Florida.

The potential contributions of FF-based ecosystem services to food security are merely one aspect of this urban agroforestry system. The mix of edible and native species that we documented in the FF gardens compels us to discuss the integration of the native landscape concept with an edible garden focus. Indeed, there very well may be a benefit for FF gardens to include native taxa. For example, the Florida native firebush (*Hamelia patens*, of which we found four examples in one of the FF sites) is known to attract a rich diversity of pollinators, including hummingbirds, butterflies, and bees. Most of our sites are located in former pine rockland, an endangered habitat that now only exists in small patches (outside of Long Pine Key in Everglades National Park; see Possley et al., 2014). Presumably, planting native taxa in an edible garden, or even encouraging some of the native weeds, such as Spanish needles (*Bidens alba*; see Kleiman et al., 2021), could provide other ecosystem services, such as sources of food for native pollinators. This aspect of food forestry has not been fully explored, although it has been noted in more recent articles on the subject. Park et al. (2018) expressed the importance of using FFs to enhance native habitat restoration, even though FFs have not historically relied on native plant taxa. At the same time, this inclusion of native species has the potential to integrate FFs into a sustainable urban green infrastructure framework that reaches beyond the food security benefits. In a sense, these relatively small spaces could be viewed as "ecological stepping stones" that provide a buffer for native habitat patches in the relatively artificial urban environment, as long as the cultivation of potentially invasive species is avoided.

Nevertheless, the presence of FISC-listed invasive plant taxa in both the FF and UF plots was notable (seven out of a total of 36 species identified in this study, or 19%). The subtropical climate and high levels of urbanization in South Florida lend well to the establishment and persistence of aggressive exotic taxa (Staudhammer et al., 2015). In most cases, the individual invasive plants documented in our study are likely volunteers that were not removed before they became reproductive. Some of this reticence to cut down invasive tree species could be due to lack of knowledge. Alternatively, the failure to act could be stemming from an actual appreciation of certain characteristics of the tree that led it to be introduced to the region in the first place. For example, *S. terebinthifolia* has long been favored by South American and Caribbean cultures for its medicinal properties (Dvorkin-Camiel & Whelan, 2008; Muhs et al., 2017) and for its spicy fruits, which can add a peppery flavor to traditional dishes (Jones, 1997). In at least one UF plot (an empty lot), the presence of *Schinus* is likely due to bird-related dispersal. In the other case (a middle school parking lot), it appeared as if the shrubs were planted as a hedge (see Figure 6). The school is located in a neighborhood known for its Haitian population, members of the community that would likely recognize the edible and medicinal properties of the species. Regardless, the importance of reducing the number of invasive taxa in urban areas cannot be overstated,

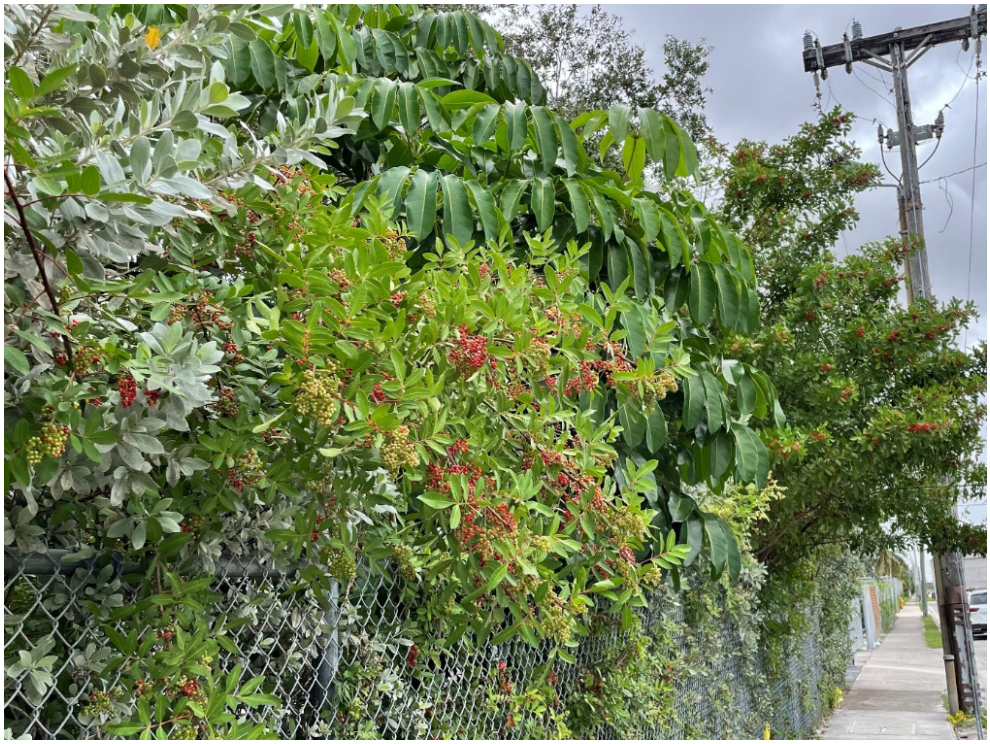

Figure 6. Planted hedge in one of the UF plots. Note the presence of the Brazilian pepper (red fruits, *Schinus terebinthifolia*), planted next to the Florida native, buttonwood (far left, *Cornocarpus erectus*), and the invasive Queensland umbrella tree (in between two stems of *S. terebinthifolia*; *Schefflera actinophylla*).

especially in the case of Category I species, which have the potential to outcompete (and displace) native plants and impact ecosystem services (Escobedo et al., 2010).

Additionally, we determined that canopy coverage in the FF plots was comparable to that of neighboring urban plots. While the FF canopy coverage did not surpass that of the neighboring UF plots, at the very least, our results suggest that FFs can potentially contribute towards the much-needed canopy cover in urban landscapes. Increased canopy cover in metropolitan areas has been demonstrated to reduce the urban heat island effect (Loughner et al., 2012; Ziter et al., 2019). As well, agroforestry studies in the pantropical regions of the world have long highlighted shade benefits of diverse edible tree-based systems, including links to sub-canopy plant health, water loss, and dietary diversity (e.g., Baudron et al., 2019; Tscharntke et al., 2011). Understandably, large crown woody species are typically favored for urban canopies, but for those residents seeking to gain both shade and food benefits around their house, other species could be considered. Additionally, many temperate and tropical sub-canopy species require partial shade conditions. For example, banana and papaya were common taxa in this study. While they are herbaceous plants, their large size allows them to be considered "canopy" species, at least in the FF system. While it is doubtful that as individual plants they could provide the same amount of canopy as a large, long-lived live oak tree, they do provide a certain amount of shade. Few studies have looked at the benefits of urban cooling as it relates to the height of the trees, but at least one recent tropical study (Blaser-Hart et al., 2021) determined that low and elevated-canopy trees in cacao agroforestry systems were equally effective at mitigating climate extremes. Certainly, we may look to more research examples in tropical agroforestry systems for insights into the benefits of tree-based systems that are characterized by variable canopy heights.

Along those lines, one of the major critiques of the photographic interpretation method utilized by *i-Tree Canopy* is the reliance on visual assessment of the image by the user. Admittedly, visual interpretation is prone to error, primarily due to the variable quality of the Google Maps™ image (especially when focusing on smaller subsets of the landscape), which can lead to misinterpretation (Hwang & Wiseman, 2020). In our case, given our familiarity with the ground data (e.g., number of stems, locations of impermeable surfaces), we believe that we mitigated this risk of misinterpretation. Nevertheless, canopy coverage in a FF garden is admittedly variable when compared with the crown cover of a more typical UF. While the specific traits of canopy coverage (e.g., height, continuity, age) were not a focus in this study, we did observe patchy shade conditions in the FF gardens. We believe that the non-contiguous FF shade in our plots is primarily due to a combination of factors: (a) the variable height of upper and mid-canopy species, (b) the diverse leaf traits of certain FF species (e.g., the small leaflets of the bipinnate or tripinnate leaves of *M. oleifera*), and (c) the design of the FF itself (i.e., heterogeneous distribution of multiple canopy layers; see Jacke & Toensmeier, 2005).

Few studies on urban FFs have explored the biological components (e.g., biodiversity, nutrient cycling, predator services, etc.) of these systems (but see Björklund et al., 2019; Park et al., 2018; Russo et al., 2017), even though their popularity is growing at a very rapid rate across global metropolitan areas. Indeed, several studies have highlighted the contributions of urban gardens and FFs to social resilience (see Chan et al., 2015; Shimpo et al., 2019), but the ability of urban agroforests to enhance ecological resilience and maintain ecosystem services in the urban landscape (especially in the face of climate change) is less certain. Recent studies have pointed to the importance of the FF design, which incorporates three-dimensional vegetation layers into the garden layout, facilitating the availability of multiple niches for both plants and associated organisms (Björklund et al., 2019; Cannell et al., 1996; Park et al., 2018). Additionally, there is a growing need to adapt agroforestry systems to extreme climate events (presumably already a significant factor in warmer climates; see Barona et al., 2020; Dawson et al., 2010; Luedeling et al., 2014). Providing alternate forms of small-scale food production under canopy cover will have extensive applicability to other grassroots efforts across the nation, informing policymakers, practitioners, and urban community members about the efficacy of urban food generating efforts. We know that annual gardens can mitigate urban heat islands and benefit food security (see Andersson et al., 2019), but these ecosystem services are likely to be magnified in a perennial system that incorporates trees.

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Conflict of Interests

The authors declare no conflict of interests.

References

Ahern, J. (2013). Urban landscape sustainability and resilience: The promise and challenges of integrating ecology with urban planning and design. *Landscape Ecology*, *28*(6), 1203–1212.

Albrecht, S., & Wiek, A. (2021). Food forests: Their services and sustainability. *Journal of Agriculture, Food Systems, and Community Development*, *10*(3), 91–105.

Andersson, E., Langemeyer, J., Borgström, S., McPhearson, T., Haase, D., Kronenberg, J., Barton, D. N., Davis, M., Naumann, S., Röschel, L., & Baró, F. (2019). Enabling green and blue infrastructure to improve contributions to human well-being and equity in urban systems. *BioScience*, *69*(7), 566–574. https://doi.org/10.1093/biosci/biz058

Barona, C. O., Devisscher, T., Dobbs, C., Aguilar, L. O., Baptista, M. D., Navarro, N. M., da Silva Filho, D. F., & Escobedo, F. J. (2020). Trends in urban forestry research in Latin America & the Caribbean: A systematic literature review and synthesis. *Urban Forestry & Urban Greening*, *47*, Article 126544. https://doi.org/10.1016/j.ufug.2019.126544

Barron, S., Sheppard, S. R., & Condon, P. M. (2016). Urban forest indicators for planning and designing future forests. *Forests*, *7*(9), Article 208.

Baudron, F., Tomscha, S. A., Powell, B., Groot, J. C. J., Gergel, S. E., & Sunderland, T. (2019). Testing the various pathways linking forest cover to dietary diversity in tropical landscapes. *Frontiers in Sustainable Food Systems*, *3*. https://doi.org/10.3389/fsufs.2019.00097

Berkes, F., Colding, J., & Folke, C. (Eds.). (2008). *Navigating social-ecological systems: Building resilience for complexity and change*. Cambridge University Press.

Björklund, J., Eksvärd, K., & Schaffer, C. (2019). Exploring the potential of edible forest gardens: Experiences from a participatory action research project in Sweden. *Agroforestry Systems*, *93*(3), 1107–1118.

Blaser-Hart, W. J., Hart, S. P., Oppong, J., Kyereh, D., Yeboah, E., & Six, J. (2021). The effectiveness of cocoa agroforests depends on shade-tree canopy height. *Agriculture, Ecosystems & Environment*, *322*, Article 107676.

Bowler, D. E., Buyung-Ali, L., Knight, T. M., & Pullin, A. S. (2010). Urban greening to cool towns and cities: A systematic review of the empirical evidence. *Landscape and Urban Planning*, *97*, 147–155.

Brito, V. V., & Borelli, S. (2020). Urban food forestry and its role to increase food security: A Brazilian overview and its potentialities. *Urban Forestry & Urban Greening*, *56*, Article 126835. https://doi.org/10.1016/j.ufug.2020.126835

Brown, K. H., & Jameton, A. L. (2000). Public health implications of urban agriculture. *Journal Public Health Policy*, *21*, 20–39.

Brundtland, G. H., & Khalid, M. (1987). *Our common future*. Oxford University Press.

Buchmann, C. (2009). Cuban home gardens and their role in social-ecological resilience. *Human Ecology*, *37*, 705–721.

Campbell, L. K. (2014). Constructing New York City's urban forest: The politics and governance of the MillionTreesNYC campaign. In L. A. Sandberg, A. Bardekjian, & S. Butt (Eds.), *Urban forests, trees and greenspace: A policy perspective* (pp. 242–260). Routledge.

Cannell, M. G. R., Van Noordwijk, M., & Ong, C. K. (1996). The central agroforestry hypothesis: The trees must acquire resources that the crop would not otherwise acquire. *Agroforestry Systems*, *34*(1), 27–31.

Castro, J., Ostoic, S. K., Cariñanos, P., Fini, A., & Sitzia, T. (2018). "Edible" urban forests as part of inclusive, sustainable cities. *Unasylva*, *69*(250), 59–65.

Chan, J., DuBois, B., & Tidball, K. G. (2015). Refuges of local resilience: Community gardens in post-Sandy New York City. *Urban Forestry & Urban Greening*, *14*(3), 625–635.

Clark, K. H., & Nicholas, K. A. (2013). Introducing urban food forestry: A multifunctional approach to increase food security and provide ecosystem services. *Landscape Ecology*, *28*, 1649–1669.

Crane, J. H. (2018). *Papaya growing in the Florida home landscape*. Institute of Food and Agricultural Sciences. https://edis.ifas.ufl.edu/pdf/MG/MG05400.pdf

Crane, J. H., Wasielewski, J., Balerdi, C. F., & Maguire, I. (2020). *Mango growing in the Florida home landscape*. Institute of Food and Agricultural Sciences. https://edis.ifas.ufl.edu/pdf/MG/MG21600.pdf

Dawson, A. (2017). *Extreme cities: The peril and promise of urban life in the age of climate change*. Verso Publishing.

Dawson, I. K., Vinceti, B., Weber, J. C., Neufeldt, H., Rus-

sell, J., Lengkeek, A. G., Kalinganire, A., Kindt, R., Lillesø, J.-P. B., Roshetko, J., & Jamnadass, R. (2010). Climate change and tree genetic resource management: Maintaining and enhancing the productivity and value of smallholder tropical agroforestry landscapes. A review. *Agroforestry Systems*, *81*(1), 67–78. https://doi.org/10.1007/s10457-010-9302-2

Dvorkin-Camiel, L., & Whelan, J. S. (2008). Tropical American plants in the treatment of infectious diseases. *Journal of Dietary Supplements*, *5*(4), 349-372.

Eiden, S. (2021). *The place of community food forests: A review and case study of community food forests and their untapped potential* [Master's thesis, University of Montana]. ScholarWorks. https://scholarworks.umt.edu/etd/11745

Escobedo, F., Giannico, V., Jim, C. Y., Sanesi, G., & Lafortezza, R. (2019). Urban forests, ecosystem services, green infrastructure and nature-based solutions: Nexus or evolving metaphors? *Urban Forestry & Urban Greening*, *37*, 3–12.

Escobedo, F., Kroeger, T., & Wagner, J. E. (2011). Urban forests and pollution mitigation: Analyzing ecosystem services and disservices. *Environmental Pollution*, *159*(8/9), 2078–2087.

Escobedo, F., Varela, S., Zhao, M., Wagner, J. E., & Zipperer, W. (2010). Analyzing the efficacy of subtropical urban forests in offsetting carbon emissions from cities. *Environmental Science & Policy*, *13*(5), 362–372.

Ferreira, A. J. D., Guilherme, R. I. M. M., & Ferreira, C. S. S. (2018). Urban agriculture, a tool towards more resilient urban communities? *Current Opinion in Environmental Science & Health*, *5*, 93–97.

Flocks, J., Escobedo, F., Wade, J., Varela, S., & Wald, C. (2011). Environmental justice implications of urban tree cover in Miami-Dade County, Florida. *Environmental Justice*, *4*(2), 125–134.

Food and Agriculture Organization of the United Nations. (2013). *Resilient livelihoods: Disaster risk reduction for food and nutrition security*. https://www.fao.org/3/a-i3270e.pdf

Gao, J., & O'Neill, B. C. (2020). Mapping global urban land for the 21st century with data-driven simulations and shared socioeconomic pathways. *Nature Communications*, *11*(1), Article 2302.

Gotelli, N. J., & Colwell, R. K. (2001). Quantifying biodiversity: Procedures and pitfalls in the measurement and comparison of species richness. *Ecology Letters*, *4*(4), 379–391.

Groves, D. G., Knopman, D., Berg, N., Bond, C. A., Syme, J., & Lempert, R. J. (2019). *Adapting land use and water management plans to a changing climate in Miami-Dade and Broward Counties, Florida*. Rand Corporation.

Gundersen, C., Hake, M., Dewey, A., & Engelhard, E. (2021). Food insecurity during Covid-19. *Applied Economic Perspectives and Policy*, *43*(1), 153–161.

Hajzeri, A., & Kwadwo, V. O. (2019). Investigating integration of edible plants in urban open spaces: Evaluation of policy challenges and successes of implementation. *Land Use Policy*, *84*, 43–48.

Hart, R. (1996). *Forest gardening: Cultivating an edible landscape*. Chelsea Green Publishing.

Hochmair, H. H., Benjamin, A., Juhasz, L., Olivas, P., Gann, D., & Zhaohui, J. F. (2020). *Miami-Dade County urban tree canopy assessment*. American Forests.

Hope, D., Gries, C., Zhu, W., Fagan, W. F., Redman, C. L., Grimm, N. B., Nelson, A. L., Martin, C., & Kinzig, A. (2003). Socioeconomics drive urban plant diversity. *Proceedings of the National Academy of Sciences*, *100*(15), 8788–8792. https://doi.org/10.1073/pnas.1537557100

Hwang, W. H., & Wiseman, P. E. (2020). Geospatial methods for tree canopy assessment: A case study of an urbanized college campus. *Arboriculture & Urban Forestry*, *46*(1), 51–65.

Jacke, D., & Toensmeier, E. (2005). *Edible forest gardens: Ecological design and practice for temperate-climate permaculture* (Vol. 2). Chelsea Green Publishing.

Jensen, P. D., & Orfila, C. (2021). Mapping the production-consumption gap of an urban food system: An empirical case study of food security and resilience. *Food Security*, *13*(3), 551–570.

Johnson, O. W., Han, J. Y. C., Knight, A. L., Mortensen, S., Aung, M. T., Boyland, M., & Resurrección, B. P. (2020). Intersectionality and energy transitions: A review of gender, social equity and low-carbon energy. *Energy Research & Social Science*, *70*, Article 101774.

Jones, D. (1997). Economic uses. In A. Ferriter & D. Clark (Eds.), *Brazilian pepper management plan for Florida* (pp. 9–10). Florida Exotic Pest Plant Council.

Jose, S. (2009). Agroforestry for ecosystem services and environmental benefits: An overview. *Agroforestry Systems*, *76*(1), 1–10.

Keenan, J. M., Hill, T., & Gumber, A. (2018). Climate gentrification: From theory to empiricism in Miami-Dade County, Florida. *Environmental Research Letters*, *13*(5), Article 054001.

Kleiman, B., Koptur, S., & Jayachandran, K. (2021). Beneficial interactions of weeds and pollinators to improve crop production. *Journal of Research in Weed Science*, *4*(2), 151–164.

Kowalski, J. M., & Conway, T. M. (2019). Branching out: The inclusion of urban food trees in Canadian urban forest management plans. *Urban Forestry & Urban Greening*, *45*, Article 126142.

Laferrière, J. E. (1987). A central location method for selecting random plots for vegetation surveys. *Vegetatio*, *71*(2), 75–77.

Landry, S. M., & Chakraborty, J. (2009). Street trees and equity: Evaluating the spatial distribution of an urban amenity. *Environment and Planning A*, *41*(11), 2651–2670.

Leong, M., Dunn, R. R., & Trautwein, M. D. (2018). Biodiversity and socioeconomics in the city: A review

of the luxury effect. *Biology Letters*, *14*(5), Article 20180082.

Locke, D. H., Hall, B., Grove, J. M., Pickett, S. T. A., Ogden, L. A., Aoki, C., Boone, C. G., & O'Neil-Dunne, J. P. M. (2021). Residential housing segregation and urban tree canopy in 37 US cities. *npj Urban Sustainability*, *1*, Article 15. https://doi.org/10.1038/s42949-021-00022-0

Loughner, C. P., Allen, D. J., Zhang, D. L., Pickering, K. E., Dickerson, R. R., & Landry, L. (2012). Roles of urban tree canopy and buildings in urban heat island effects: Parameterization and preliminary results. *Journal of Applied Meteorology and Climatology*, *51*(10), 1775–1793.

Lovell, S. T., Dupraz, C., Gold, M., Jose, S., Revord, R., Stanek, E., & Wolz, K. J. (2017). Temperate agroforestry research: Considering multifunctional woody polycultures and the design of long-term field trials. *Agroforestry Systems*, *92*, 1397–1415.

Luedeling, E., Kindt, R., Huth, N. I., & Koenig, K. (2014). Agroforestry systems in a changing climate: Challenges in projecting future performance. *Current Opinion in Environmental Sustainability*, *6*, 1–7.

Magis, K. (2010). Community resilience: An indicator of social sustainability. *Society and Natural Resources*, *23*(5), 401–416.

Mburu, S. W., Koskey, G., Kimiti, J. M., Ombori, O., Maingi, J. M., & Njeru, E. M. (2016). Agrobiodiversity conservation enhances food security in subsistence-based farming systems of Eastern Kenya. *Agriculture & Food Security*, *5*(1), Article 19.

McCoy, L., Crow, A., Perez, J., Guimarães, E. R., La Belle, D., Recinos, E., Pink, M., Herrera Osorio, B., Baraloto, C., Jungman, N., & Rockwell, C. A. (2021). *Common tropical food forest plants of South Florida*. FIU Institute of Environment; The Education Fund. https://www.educationfund.org/file_download/inline/96a21b03-266f-48f8-beaf-f9ef6ade0ee9

McLain, R., Poe, M., Hurley, P. T., Lecompte-Mastenbrook, J., & Emery, M. R. (2012). Producing edible landscapes in Seattle's urban forest. *Urban Forestry & Urban Greening*, *11*(2), 187–194.

Meléndez-Ackerman, E. J., Trujillo, A., Nitch, C., Ramsey, M., Branoff, B., & Olivero-Lora, S. (2018). *Ecological vulnerability of urban green infrastructure to Hurricanes Irma and Maria in Puerto Rico*. US Forest Service.

Mellisse, B. T., Descheemaeker, K., Giller, K. E., Abebe, T., & van de Ven, G. W. (2018). Are traditional home gardens in southern Ethiopia heading for extinction? Implications for productivity, plant species richness and food security. *Agriculture, Ecosystems & Environment*, *252*, 1–13.

Miami-Dade County. (2007). *A greenprint for our future: Miami-Dade County street master plan*.

Michon, G., Mary, F., & Bompard, J. (1986). Multistoried agroforestry garden system in West Sumatra, Indonesia. *Agroforestry Systems*, *4*(4), 315–338.

Miller, R. P., & Nair, P. K. R. (2006). Indigenous agroforestry systems in Amazonia: From prehistory to today. *Agroforestry Systems*, *66*(2), 151–164.

Miller, R. W., Hauer, R. J., & Werner, L. P. (2015). *Urban forestry: Planning and managing urban greenspaces*. Waveland Press.

Moll, G. (1989). In search of an ecological urban landscape. In G. Moll & S. Ebenreck (Eds.), *Shading our cities: A resource guide for urban and community forests* (pp. 13–24). Island Press.

Muhs, A., Lyles, J. T., Parlet, C. P., Nelson, K., Kavanaugh, J. S., Horswill, A. R., & Quave, C. L. (2017). Virulence inhibitors from Brazilian peppertree block quorum sensing and abate dermonecrosis in skin infection models. *Scientific Reports*, *7*(1), Article 42275.

Nair, V. D., & Graetz, D. A. (2004). Agroforestry as an approach to minimizing nutrient loss from heavily fertilized soils: The Florida experience. *Agroforestry Systems*, *61*, 269–279.

Niles, M. T., Bertmann, F., Belarmino, E. H., Wentworth, T., Biehl, E., & Neff, R. (2020). The early food insecurity impacts of Covid-19. *Nutrients*, *12*(7), Article 2096.

Nowak, D. J., & Crane, D. E. (2002). Carbon storage and sequestration by urban trees in the USA. *Environmental Pollution*, *116*(3), 381–389.

Nowak, D. J., & Greenfield, E. J. (2018). Declining urban and community tree cover in the United States. *Urban Forestry & Urban Greening*, *32*, 32–55. https://doi.org/10.1016/j.ufug.2018.03.006

Nowak, D. J., Maco, S., & Binkley, M. (2018). i-Tree: Global tools to assess tree benefits and risks to improve forest management. *Arboricultural Consultant*, *51*(4), 10–13.

Ordóñez, C., & Duinker, P. N. (2014). Assessing the vulnerability of urban forests to climate change. *Environmental Reviews*, *22*(3), 311–321.

Ortez, P. (2021). *Foraging in Tucson's parks: Interest, barriers, and opportunities* [Bachelor's dissertation, University of Arizona]. The University of Arizona Libraries. https://repository.arizona.edu/handle/10150/658254

Paquette, A., Bouchard, A., & Cogliastro, A. (2006). Survival and growth of under-planted trees: A meta-analysis across four biomes. *Ecological Applications*, *16*(4), 1575–1589.

Park, H., & Higgs, E. (2018). A criteria and indicators monitoring framework for food forestry embedded in the principles of ecological restoration. *Environmental Monitoring and Assessment*, *190*(3), Article 113.

Park, H., Turner, N., & Higgs, E. (2018). Exploring the potential of food forestry to assist in ecological restoration in North America and beyond. *Restoration Ecology*, *26*(2), 284–293.

Philpott, S. M., & Bichier, P. (2017). Local and landscape drivers of predation services in urban gardens. *Ecological Applications*, *27*(3), 966–976.

Possley, J. E., Maschinski, J. M., Maguire, J., & Guerra, C.

(2014). Vegetation monitoring to guide management decisions in Miami's urban pine rockland preserves. *Natural Areas Journal*, *34*(2), 154–165.

Russo, A., Escobedo, F. J., Cirella, G. T., & Zerbe, S. (2017). Edible green infrastructure: An approach and review of provisioning ecosystem services and disservices in urban environments. *Agriculture, Ecosystems & Environment*, *242*, 53–66.

Salbitano, F., Borelli, S., Conigliaro, M., & Chen, Y. (2016). *Guidelines on urban and peri-urban forestry*. Food and Agriculture Organization of the United Nations.

Schell, C. J., Dyson, K., Fuentes, T. L., Roches, S. D., Harris, N. C., Miller, D. S., Woelfle-Erskine, C. A., & Lambert, M. R. (2020). The ecological and evolutionary consequences of systemic racism in urban environments. *Science*, *369*(6510). https://doi.org/10.1126/science.aay4497

Shimpo, N., Wesener, A., & McWilliam, W. (2019). How community gardens may contribute to community resilience following an earthquake. *Urban Forestry & Urban Greening*, *38*, 124–132.

Soemarwoto, O. (1987). Homegardens: A traditional agroforestry system with a promising future. In H. A. Steppler & P. K. R. Nair (Eds.), *Agroforestry: A decade of development* (pp. 157–170). International Council for Research in Agroforestry.

Staudhammer, C. L., Escobedo, F. J., Holt, N., Young, L. J., Brandeis, T. J., & Zipperer, W. (2015). Predictors, spatial distribution, and occurrence of woody invasive plants in subtropical urban ecosystems. *Journal of Environmental Management*, *155*, 97–105.

Tendall, D. M., Joerin, J., Kopainsky, B., Edwards, P., Shreck, A., Le, Q. B., Kruetli, P., Grant, M., & Six, J. (2015). Food system resilience: Defining the concept. *Global Food Security*, *6*, 17–23. https://doi.org/10.1016/j.gfs.2015.08.001

Thiesen, T., Bhat, M. G., Liu, H., & Rovira, R. (2022). An ecosystem service approach to assessing agroecosystems in urban landscapes. *Land*, *11*(4), Article 469.

Tscharntke, T., Clough, Y., Bhagwat, S. A., Buchori, D., Faust, H., Hertel, D., Hölscher, D., Juhrbandt, J., Kessler, M., Perfecto, I., Scherber, C., Schroth, G., Veldkamp, E., & Wanger, T. C. (2011). Multifunctional shade-tree management in tropical agroforestry landscapes: A review. *Journal of Applied Ecology*, *48*(3), 619–629. https://doi.org/10.1111/j.1365-2664.2010.01939.x

US Forest Service. (2011). *i-Tree Canopy technical notes*.

Wu, J. (2010). Urban sustainability: An inevitable goal of landscape research. *Landscape Ecology*, *25*(1), 1–4.

Zhang, W., Dulloo, E., Kennedy, G., Bailey, A., Sandhu, H., & Nkonya, E. (2018). Biodiversity and ecosystem services. In C. Campanhola & S. Pandey (Eds.), *Sustainable food and agriculture: An integrated approach* (pp. 137-152). Food and Agriculture Organization of the United Nations.

Ziter, C. D., Pedersen, E. J., Kucharik, C. J., & Turner, M. G. (2019). Scale-dependent interactions between tree canopy cover and impervious surfaces reduce daytime urban heat during summer. *Proceedings of the National Academy of Sciences*, *116*(15), 7575–7580.

About the Authors

Cara A. Rockwell holds a PhD in tropical forest ecology from University of Florida. She is currently a research faculty member at Florida International University's Institute of Environment. Cara worked in South America for more than 15 years, investigating the impacts of timber harvesting on bamboo-dominated forest stands and Brazil nut-rich forests, as well as forest restoration through post-harvest silvicultural techniques. In addition to her ongoing projects in the Southwestern Amazon region, she has begun developing projects in South Florida, where she is focusing on ecosystem services in urban agroforestry systems, as well as recovery of native ecosystems post-disturbance.

Alex Crow graduated with a B.S. in environmental studies in 2019 from Florida International University's Department of Earth and Environment. Born and raised in Miami, he loves the unique blend of culture, people, and food that his city has to offer. He has a passion for the Everglades, and his research interests include native insect ecology, tropical and subtropical forestry, and apiculture. Alex worked in the Miami-Dade County Public School food forests from 2018–2021. He is now a restoration biologist with the Institute for Regional Conservation in Delray Beach, Florida.

Érika R. Guimarães holds a bachelor's degree in environmental engineering from Federal University of Rio de Janeiro, Brazil. In her thesis, Érika researched wastewater treatment with plants, using evapotranspiration beds. In Miami, she has volunteered on projects focused on the evaluation of ecosystem services in food forests. Érika is a co-author of the booklet *Common Tropical Food Forest Plants of South Florida*, published by FIU Institute of Environment and The Education Fund. She is now pursuing her Master of Science degree in environmental studies in the Department of Earth and Environment at Florida International University.

Eduardo Recinos, senior program manager for The Education Fund's Food Forests for Schools is an artist and teacher of 10+ years who earned a BFA and Teaching Certificate from Florida International University. He is an expert school gardener, having previously served as the lead garden teacher at Twin Lakes Elementary in Hialeah, Florida where he created a food forest that became integrated into all classroom lessons and where he led the innovative school-wide use of garden produce in the cafeteria. Eddie continues to apply his knowledge of curriculum, forest gardening, and nutrition to build the program, including the design of each Food Forest, integration of Food Forests in daily lessons across all subjects, and oversight of a dozen expert gardeners who visit schools to maintain and team-teach.

Deborah La Belle, program manager for The Education Fund's Food Forests for Schools, is a classically trained chef who worked with renowned James Beard awardee Michele Bernstein. A graduate of Johnson & Wales College of Culinary Arts, Deborah's knowledge of nutrition and our unique crops has propelled our program forward. Prior to joining The Education Fund, she taught cooking classes to Miami-Dade County Public Schools students, and ran her own home farm from which she created products for sale. Deborah's knowledge and skills allow her to work effectively with teachers, students, parents, as well as cafeteria personnel applying her knowledge of cooking, forest gardening, and nutrition to build the program.

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Commentary

From Desk to Field: Countering Agrourbanism's "Paper Landscapes" Through Phenomenology, Thick Description, and Immersive Walking

Robert France

Department of Plant, Food, and Environmental Sciences, Dalhousie University, Canada; rfrance@dal.ca

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Abstract
The primary focus of the urban agriculture literature has been on landscapes as biophysical spaces in which to grow food rather than on them as humanized places in which to grow experience. There is a need to leave the desk behind and enter the field to invigorate case study descriptions through the reflexive tool of narrative scholarship.

Keywords
landscape phenomenology; thick description; walking methodology

Issue
This commentary is part of the issue "From Smart Urban Forests to Edible Cities: New Approaches in Urban Planning and Design" edited by Alessio Russo (University of Gloucestershire) and Francisco J. Escobedo (USDA Forest Service).

1. Problematic Paper Landscapes

> In virtually all the academic literature it is quite striking how disembodied written landscapes become. This is because virtually everything written about landscape is not only written on paper; it is principally derived from paper. Landscape is not bodily experienced….Bodies remain at the desk rather than in the field….What we are left with is paper landscapes, paper perspectives. (Tilley, 2004, p. 27)

Although the literature on urban agriculture has expanded voluminously (Bohn & Viljoen, 2014; France & Mougeot, 2016), emphasis continues to be placed on urban gardens, food markets, educational farms, commercial enterprises, and agrarian heritage locations as conceptual spaces to be studied from afar rather than as experiential *places* to be engaged in situ. With rare exception (Coles, 2014; France, 2022), the lack of an embodied perspective in much of the urban agriculture literature means that, as Tilley (2004, p. 28) found for archeology publications, "they can only provide us with abstract models for thinking landscapes rather than models *of* landscapes that are sensuously lived." The result is a literature in which urban agriculture projects are presented as sensorially impoverished "paper landscapes." Given that the emerging field of agrourbanism (de la Salle & Holland, 2010; France, 2022; Gottero, 2021) concerns placemaking, this focus on inert spaces rather than inhabited places remains problematic. "Space" and "place" are *not* the same thing (Creswell, 2004). Abstract space, when humanized, becomes value-laden, and is transformed through the process into place (Tuan, 2001). A solution to the problem with respect to urban agriculture is adopting the research tool of narrative scholarship though employing its constituent modes of phenomenology, thick description, and walking.

2. Sensorial Embodied Experience

Rooted in the relational philosophical method of Merleau-Ponty and Heidegger, phenomenology concerns the lived and immediate—not pre-meditated—utilization of the senses to interact with, and acquire knowledge about, the world (Brown & Toadvine, 2003; Wylie, 2012). It is about experiencing with deliberate intention rather than through casual impression, and is based on the meaning and value inherent in the body's relation to its surroundings (Bannon, 2016).

The idea of using the embodied experience of landscape (Tilley, 2004) is to create sensuous maps of socially embedded aesthetics or "sensecapes" (Degen, 2008).

These sensory dimensions of atmosphere are useful for describing the relational dynamics of people and place (Degen & Lewis, 2020; Thibaud, 2015). Phenomenology addresses that which resonates when we get a "feel" or a "sense" of a place, and uses writing and photography to craft sensuous stories regarding the perceptions and emotions of bodily engaging with nature. As Tilley (2004, p. 26) describes, "from a phenomenological perspective, language flows from the body rather than the mind, or rather, from a mind that is embodied, bound up with the sensorial world." And the way to capture this flow of bodies, words, and images is through use of "thick description.''

3. Thick Description

There is need to exploit alternative forms of writing and representing the intertwined geographies of people and place. For many geographers, landscapes have become disembodied entities that are studied from afar rather than through direct immersion (Wylie, 2012). In contrast to richly textured, carnal descriptions of experiencing landscape, the standard fare in virtually all academic journals are sensorially sterile, analytical accounts (Tilley, 2004). A counter to this approach is thick description, whereby clear pictures of the environment are conveyed through self-reflective essays whose goal is to make one's experiences concrete for readers through use of evocative language that shows rather than merely tells (Geertz, 1973).

Thick description provides detailed narratives and interpretations of situations observed and experienced by researchers, and can be supplemented with background information (Ponterotto, 2006). The approach, which has become a standard tool in autoethnography (Adams et al., 2015; Humphries, 2005), moves beyond presenting facts and overt appearances, and instead provides details, context, emotions, and underlying meanings and intentions in its attempt to describe the interactions of people and place, making the experiences of the former visible to a reader so that s/he can better appreciate the latter.

At its core, thick description is "sensemaking" or topographic "site-writing," the process of giving meaning to experience (Coles, 2014; Ponterotto, 2006). It can take a variety of forms, such as switching between first-person and second-person narration through "layered accounts" in which the researcher writes from the perspective of more than a single voice (Hermann, 2012). This expanded form of phenomenology (Wylie, 2012), which combines immediate embodied experience with other forms of analysis, such as archival research and critical evaluation of the pertinent literature, represents an alternative mode of landscape scholarship (Tilley, 1994, 2004).

Because thick description endeavours to paint a clear picture of an environment or situation, it often relies upon the visual ethnography research method of linking words and photos (Harper, 1987; Johnsen et al., 2008; Kharel, 2015). The subjective understanding provided by participant observation research of visually-augmented thick description conveys commentary and interpretation. Unlike documentary films, however, photos need voice, the challenge being to organize words and images in such a way to recount the *story* of the experience (Geertz, 1973). These approaches have newfound purpose in visual narratives of urban walks (Degen & Rose, 2012; Mason & Davies, 2009; Middleton, 2010). As Coles (2014, p. 519) describes, "the sequenced images provoke phenomenological and narrative modes that go beyond individual images to frame a collection of narratives…[that encapsulate] the inherent complexity of place." And for many, the implicit reflexivity of visual/textual vignettes for examining the feelings, reactions, and motives that influence an impression of a place is best undertaken through the simple act of pedestrianism.

4. Walking Methodology

The conjoined act and art of walking and wordsmithing has a long-established tradition (Coverley, 2012; France, 2020) and is regarded as the key means by which to feel, describe, and understand landscape (Ingold, 2004, 2011). As a modern social science methodology (Bates & Rhys-Taylor, 2017), walking makes urban places both commendable and comprehendible (Aoki & Yashimizu, 2015; Kusenbach, 2003; Middleton, 2010, 2011; Svensson, 2020; Vergunst, 2010). Urban walking as aesthetic practice (Careri, 2017) has its roots in the concept of the *flâneur* (Jenks & Neves, 2000), something which has been reborn in the experiential discipline of psychogeography (Bassett, 2004; Richardson, 2015). The "walk-with-me" or "go-along" method is a qualitative ethnographic research tool based in phenomenology that uses walks buttressed by opinions of others garnered through interviews or readings to explore everyday experience related to environmental perception, spatial practices, and social expressions of landscape form and function (Doring & Ratter, 2021; France & Campbell, 2015; Kusenbach, 2003).

By engaging the senses, walking is integral to perceiving surroundings (Degen, 2008; O'Neill & Roberts, 2020), thereby enabling "place-learning" (Springgay & Truman, 2018). This is a flourishing field of scholarship. For example, a conference held in the United Kingdom on "walking stories" and "walking ethnography" was based on idea that the land evokes conversations, reflections, and narrations that take place only through movement. As well, the 2021 "The Nature of Cities" conference hosted online field trips in which attendees watched live-narrated, formerly-filmed recordings of walks in urban riverscapes in London, Beirut, and Melbourne, city forests in India, British Columbia, and Oregon, and neighbourhoods, parks, playgrounds, canals, and landfills in England, Scotland, New York, California, Hawaii, and

Argentina. Walking offers possibilities for more evocative and creative forms of academic writing wherein personal experiences provide opportunity to comment upon wider questions (Wylie, 2012). Place-learning this way involves sensory inquiry and embodiment of experience that connects mind, body, and environment (Springgay & Truman, 2018), and is becoming increasingly utilized in descriptive landscape studies (Clarke & Jones, 2001; Edenson, 2000; Sidaway, 2009; Wylie, 2002, 2005).

More than providing transportation, walking is therefore an elemental way of perceiving place (Wunderlich, 2008), and is part of the relational study of landscape (Doring & Ratter, 2021). As Tilley (2004, p. 26) states, "places and landscapes are created and experienced through mobility." In this regard, landscape is not a physical constant but is something that is *created* through relationships to its inhabitants via their perceptions and embodied experiences (Ingold, 2011). In short, through walking, landscapes are woven into life while in turn lives are woven into landscapes (Tilley, 1994). Walking represents the process of appropriating topography, whereby the sensate and kinaesthetic attributes of the physical process allow it to be a placemaking practice that showcases how we interpret our surroundings and our position therein (O'Neill & Roberts, 2020). Urban walking is an aesthetic process that creates place from space, with the ensuing "walkscapes" being likened to architectural creations based on perceiving and conceiving part of the world (Careri, 2017). Such walkscapes are art projects traced upon the topography of a landscape through use of the body in much the same way a painter uses a brush upon a canvas.

"Mind–walking" (Ingold, 2011) creates "paths of observation" in which perception is a function of movement (Wunderlich, 2008). As Gibson (1979, p. 46) states, "cognition should *not* be *set off* from locomotion along the lines of a division between head and heels, since walking is itself a form of circumambulatory knowing." Once this is recognized, he continues, "a whole new field of inquiry is opened up in which our knowledge of the environment is altered by techniques of footwork." More than cognition, it is locomotion that underscores and facilitates perception and is a "form of circumambulatory knowing" (Ingold, 2002, 2004). Although walking has developed into the visual activity of scanning, it is really much more. And so, while the feet serve to ground us in space, we perceive through our *entire* bodies, not just the eyes, all contributing to the haptic perception of place. Walking, therefore, integrates the senses of sight, sound, smell, and touch (Lund, 2006). Both Ingold (2002) and Tilley (2004) refer to the synaesthesia of the experience and acknowledge the bias of the Western tradition that privileges sight over other senses as sources of human knowledge.

Not only is the walking experience multi-sensorial (Ingold, 2002, 2011; Wunderlich, 2008), it is also multi–conceptual in that it fosters peripatetic ponderings (Middleton, 2010). For as O'Neill and Roberts (2020, p. 216) describe:

> A walk in a garden is a phenomenological sensual experience and a physical activity, but one also set within memory experience—with invocations and resonance that draw us towards, or that we search out through, our senses and our emotions. A garden walk is also a joint, relational experience—a 'conversation' not merely with oneself, but also a 'dialogue' with oneself and the environment.

Landscapes exist in the mind as much as they do on the ground; in other words, they are cultural constructs just as they are natural objects (Creswell, 2004), thereby being places of memory (Schama, 1996). As cultural phenomena, landscapes are built from subjective experience, à la Heidegger's *Dasein* or "being there," facilitated by the concordant flows of bodies, perceptions, and conceptions along "emotional pathways" (Viik, 2011). And it is for this reason that the sensory experiencing and perceptual memory of urban design is best facilitated through the act of walking (Degen & Rose, 2012).

5. Conclusion

It is only by being attentive to sensescapes as revealed by walking and as relayed through a raconteur that the value of agrourbanism placemaking can be truly appreciated and comprehensively assessed (France, 2022). In order to avoid succumbing to a form of collective "nature-deficit disorder" (Louv, 2008), urban agriculture scholars need to limit their "screen time" and to immerse themselves in real, not paper, landscapes. For it is outside where the experiential "magic" of everyday life lies (Stilgoe, 2005).

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Conflict of Interests

The author declares no conflict of interests.

References

Adams, T. E., Jones, H., & Elles, C. (2015). *Autoethnography: Understanding qualitative research*. Oxford University Press.

Aoki, J., & Yashimizu, A. (2015). Walking histories, un/making places: Walking tours as ethnography of place. *Space and Culture*, *18*(3), 273–284.

Bannon, B. E. (2016). *Nature and experience: Phenomenology and the environment*. Rowman Littlefield.

Bassett, K. (2004). Walking as an aesthetic practice and a critical tool: Some psychogeographic experiments. *Journal of Geography in Higher Education*, *28*(3), 397–410.

Bates, C., & Rhys-Taylor, A. (Eds.). (2017). *Walking through social research*. Routledge.

Bohn, K., & Viljoen, A. (2014). CPUL repository. In A. Viljoen & K. Bohn (Eds.), *Second nature urban agriculture: Designing productive cities* (pp. 257–260). Routledge.

Brown, C. S., & Toadvine, T. (2003). *Eco-phenomenology: Back to the Earth itself*. State University of New York Press.

Careri, F. (2017). *Walkscapes: Walking as aesthetic practice*. Culicidae Architectural Press.

Clarke, P., & Jones, O. (2001). Dwelling, place and landscape: An orchard in Somerset. *Environment and Planning A*, *33*(4), 649–666.

Coles, B. F. (2014). Making the market place: A topography of Borough Market, London. *Cultural Geographies in Practice*, *21*(3), 515–523.

Coverley, M. (2012). *The art of wandering: The writer as walker*. Oldcastle Books.

Creswell, T. (2004). *Place: A short introduction*. Blackwell.

de la Salle, J., & Holland, M. (2010). *Agricultural urbanism: Handbook for building sustainable food & agriculture systems in 21st century cities*. Green Frigate Books.

Degen, M. M. (2008). *Sensing cities: Regenerating public life in Barcelona and Manchester*. Routledge.

Degen, M., & Lewis, C. (2020). The changing feel of place: The temporal modalities of atmosphere in Smithfield Market, London. *Cultural Geographies*, *27*(4), 509–526.

Degen, M. M., & Rose, G. (2012). The sensory experiencing of urban design: The role of walking and perceptual memory. *Urban Studies*, *49*(15), 3271–3287.

Doring, M., & Ratter, B. (2021). "I'll show you *my* coast…"—A relational study of coastscapes in the North Frisian Wadden Sea. *Maritime Studies*, *20*(3), 317–327.

Edenson, T. (2000). Walking in the countryside: Reflexivity, embodied practices and ways to escape. *Body and Society*, *6*(3/4), 81–116.

France, R. (2020). *Waymarking Italy's influence on American environmental imagination while on pilgrimage to Assisi*. Cambridge Scholars Publishing.

France, R. (2022). *Regenerative agrourbanism: Experiencing edible placemaking transforming neglected or damaged landscapes, lives, and livelihoods*. Wageningen Academic Publishers.

France, R., & Mougeot, L. (2016). Reading urban gardens and farms: Literature, layering and largesse. In R. France (Ed.), *Integrated urban agriculture: Precedents, practices, prospects* (pp. 15–38). Libri.

France, R. L., & Campbell, J. B. (2015). Payment for agro–ecosystem services: Developmental case-history descriptions of Canada's grassroots "ALUS" programs. *Research Journal of Agriculture and Environmental Management*, *4*(9), 405–431.

Geertz, C. (1973). *Thick description: Toward an interpretive theory of culture*. Basic Books.

Gibson, J. J. (1979). *The ecological approach to visual perception*. Houghton Mifflin.

Gottero, E. (2021). *Agrourbanism: Tools for governance and planning of agrarian landscape*. Springer.

Harper, D. (1987). The visual ethnographic narrative. *Visual Anthropology*, *1*(1), 1–19.

Hermann, A. (2012). Criteria against ourselves? Embracing the opportunities of qualitative research. *International Review of Qualitative Research*, *5*(2), 135–152.

Humphries, M. (2005). Getting personal: Reflexivity and autoethnographic vignettes. *Qualitative Inquiry*, *11*(6), 840–860.

Ingold, T. (2002). *The perception of the environment: Essays on livelihood, dwelling and skill*. Taylor and Francis.

Ingold, T. (2004). Culture on the ground. The world perceived through the feet. *Journal of Material Culture*, *9*(3), 315–340.

Ingold, T. (2011). *Being alive: Essays on movement, knowledge and description*. Routledge.

Jenks, C., & Neves, T. (2000). A walk on the wild side: Urban ethnography meets the flaneur. *Cultural Values*, *4*(1), 1–17.

Johnsen, S., May, J., & Cloke, P. (2008). Imag(in)ing "homeless places": Using auto–photography to (re)examine the geographies of homelessness. *Area*, *40*(2), 197–207.

Kharel, D. (2015). Visual ethnography: Thick description and cultural representation. *Dhaulagiri Journal of Sociology and Anthropology*, *9*, 147–160.

Kusenbach, M. (2003). Street phenomenology: The go–along as ethnographic research tool. *Ethnogeography*, *4*(3), 455–485.

Louv, R. (2008). *Last child in the woods: Saving our children from nature-deficit disorder*. Algonquin Books.

Lund, K. (2006). Seeing in motion and the touching eye: Walking over Scotland's mountains. *Anthropological Journal*, *18*(1), 27–42.

Mason, J., & Davies, K. (2009). Coming to our senses? A critical approach to sensory methodology. *Qualitative Research*, *9*(5), 587–603.

Middleton, J. (2010). Sense and the city: Exploring the embodied geographies of urban walking. *Social & Cultural Geography*, *11*(6), 575–595.

Middleton, J. (2011). Walking in the city: The geographies of everyday pedestrian practices. *Geography Compass*, *5*(2), 90–105.

O'Neill, M., & Roberts, B. (2020). *Walking methods: Research on the move*. Routledge.

Ponterotto, J. G. (2006). Brief note on the origins, evolution, and meaning of the qualitative research concept thick description. *Qualitative Report*, *11*(3), 538–549.

Richardson, T. (2015). *Walking inside out: Contemporary British pychogeography*. Rowman Littlefield.

Schama, S. (1996). *Landscape and memory*. Vintage.
Sidaway, J. (2009). Shadows on the path: Negotiating geopolitics on urban sections of Britain's South West Coast Path. *Environment and Planning D*, *27*(6), 1091–1116.
Springgay, S., & Truman, S. E. (2018). *Walking methodologies in a more-than-human world*. Routledge.
Stilgoe, J. R. (2005). *Outside lies magic*. Bloomsbury.
Svensson, M. (2020). Walking in the historic neighbourhoods of Beijing: Walking as an embodied encounter with heritage and urban developments. *International Journal of Heritage Studies*, *27*(8), 792–805.
Thibaud, J. P. (2015). The backstage of urban ambiance: When atmospheres pervade everyday experience. *Emotion, Space and Society*, *15*, 39–46.
Tilley, C. (1994). *A phenomenology of landscape: Places, paths and movements*. Berg.
Tilley, C. (2004). *The materiality of stone: Explorations in landscape phenomenology*. Berg.
Tuan, Y.-F. (2001). *Space and place: The perspective of experience*. University of Minnesota Press.
Vergunst, J. (2010). Rhythms of walking: History and presence in a city street. *Space and Culture*, *13*(4), 376–388.
Viik, T. (2011). Human spatiality: A cultural phenomenology of landscapes and places. *Problemos*, *79*, 103–114.
Wunderlich, F. M. (2008). Walking and rhythmicity: Sensing urban space. *Journal of Urban Design*, *13*(1), 125–139.
Wylie, J. (2002). An essay on ascending Glastonbury Tor. *Geoforum*, *33*(4), 441–454.
Wylie, J. (2005). A single day's walking: Narrating self and landscape on the South West Coast Path. *Transactions Institute of British Geographers*, *30*(2), 234–247.
Wylie, J. (2012). *Landscape and phenomenology*. Routledge.

About the Author

Robert France is an environmental scientist and landscape scholar who has studied natural systems from the tropics to the High Arctic and who has participated in urban planning and design charrettes around the world. He is the author of over two hundred technical papers and two dozen books, many concerned with issues related to water health. His publications have been cited more than ten thousand times in the professional literature.

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Article

Factors and Strategies for Environmental Justice in Organized Urban Green Space Development

Dillip Kumar Das

Civil Engineering, University of KwaZulu-Natal, South Africa; dasd@ukzn.ac.za

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Abstract
Increased demand for land for economic and residential purposes has engendered tensions among different land users in Indian cities. Consequently, the development and management of environmentally just and organized green spaces involve major challenges. In this article, using the context of three Indian cities (Bhubaneswar, Cuttack, and Kolkata), the factors that contribute to environmentally unjust development and management of organized green spaces were examined and various strategies that would lead to environmental justice were evaluated. A survey research method was used to collect data, followed by factor analysis and ordinal regression modelling. Findings suggest that factors under five principal components contributed to environmental injustice, including: community features and infrastructure related to organized green space; the economics of development and management of organized green space; linking green space to environment and health; spatial development, land use, and accessibility; and land availability and governance of the supply of green space. Strategies such as community-led, green space development and management; fair and equitable distribution of green spaces; improvement of accessibility; connecting green spaces to benefits of health; and mandatory linkage of built infrastructure with the provision of green spaces would ensure environmental justice.

Keywords
accessibility; economy; environmental justice; green space; India; land use

Issue
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1. Introduction

Organized green space is one of the essential uses of land for sustainable cities. However, increasing population leads to higher demands for land for economic, residential, transportation, and civic purposes which cause significant tensions among different land uses in Indian cities. Consequently, it is possible that land allocation for organized green spaces has been undermined. Furthermore, compromising of land use policies has been observed (Anand & Deb, 2017) and the challenges of insufficient green spaces and their differential development and management have been experienced (Mohapatra & Mohamed, 2015). For instance, in some cases, organized green spaces that were allocated for public purposes have allegedly been used for developing residential buildings or commercial activity centres. Similarly, in many residential areas of large and medium cities in India, organized green spaces have been found to be scarce, although, generally, some cities might have one or two large central green spaces. Further, since the value of land has increased significantly in most cities in recent decades, provision of adequate, organized green spaces, according to the norms for residential areas, specifically where most of the socially and economically disadvantaged sections of society live, has been found to be meagre (Praharaj, 2019). In addition, large construction activities have encroached on green spaces (Mishra, 2016; Praharaj, 2019). To add to the challenges, although provision has been made for organized green spaces in the planning of land use, sometimes, due emphasis has not been given to their development, management,

operation, and maintenance, leading to their misuse and degeneration (Mishra, 2016; Mohapatra & Mohamed, 2015; Praharaj, 2019).

It has been argued that this undermining of the provision of adequate and equitable development and management of organized green spaces leads to environmental injustice (Jennings et al., 2012; Kronenberg et al., 2020). Environmental justice is compromised in terms of inappropriate land use, skewed allocation of green space, and the occurrence of land, air, water, and solid-waste pollution, specifically in the areas occupied by the disadvantaged sections of society (Jennings et al., 2012; Venter et al., 2020). Essentially, this leads to a lack of social inclusiveness, as a large segment of the population remains bereft of organized green spaces (Ramirez-Andreotta, 2019).

Although according to the concept of environmental justice the differential exposure to environmental burdens and access to environmental benefits experienced by different socio-economic groups is highlighted (Schweitzer & Stephenson, 2007), the reality is broader and more complex (Jennings et al., 2012). Environmental injustice stems from claims that environmental burdens, such as landfills, toxic-emitting facilities, and other environmental hazards, are disproportionately located near socially disadvantaged groups (Bullard, 2000; Jennings et al., 2012). While unequal access to urban green spaces was not considered generally in research about traditional environmental justice, recent conceptualizations have been expanded to include issues such as equitable access to urban parks and other natural resources because of their association with economic, psychological, and cultural benefits (Leonard & Pelling, 2010; Rigolon et al., 2018).

Environmental justice encompasses distributive, procedural, and interactional (recognition) justice. Distributive justice is focused on the fair allocation of, or access to, benefits for all social groups. Procedural justice advocates the fair integration of all affected groups into decision-making processes. Interactional justice recognizes the interests of all stakeholders in a safe, fair, and non-discriminatory environment (Kronenberg et al., 2020; Low, 2013). Concerning environmental justice in green space development and management, several issues in different contexts have been identified and investigated. The issues range from unequal distribution to the design and placement of green spaces in different social areas in the Global North (Jennings et al., 2012; Kabisch et al., 2016). Similarly, in the Global South, issues included inadequacy of green spaces, unequal distribution, and lack of participation in decision making and recognition of people's needs, aspirations, values, etc. (Mohammed et al., 2021; Mohapatra & Mohamed, 2015; Nero, 2017; Venter et al., 2020).

In the Indian context, lack of adequate green spaces, their inequitable distribution (Kaur et al., 2021), and lack of inclusion of different social strata in development and management are observed (Mohapatra & Mohamed, 2015). Conjoined with the inequitable distribution and lack of access, specifically in under-privileged areas, an increase in land values and limited supply of land has led to tension between the use of land for green spaces and more lucrative residential projects and commercial activities (Zerah, 2007). Furthermore, the lower priority given to management, maintenance, and operation of green spaces in the budgets of developmental authorities reduces their quality. The combined effect of inadequate availability, access, and poor condition of the green spaces reduces the propensity of people to use them. This offers an opportunity to the pressure groups advocating the use of land or the transformation of green spaces for commercial purposes. Moreover, despite being within a democratic and participatory decision-making framework, factors such as the hegemony of political leaders, bureaucrats, and market forces predominate in the development and management process. Participation and recognition of people in the process of city development (Das, 2017), specifically green space development and management, are marginal. Thus, all three types of environmental injustice (distributional, procedural, and interactional) exist with regard to green spaces in Indian cities.

Consequently, there is a need to develop and manage environmentally just, organized green spaces in Indian cities. To achieve this aim, it is necessary to explore what factors influence the creation of such unjust scenarios and how the scenarios can be improved. Although several studies have been conducted around the world, such studies in the Indian context are limited, resulting in a significant knowledge gap. In this context, although several arguments and concerns have been raised (Praharaj, 2019; Riyan, 2019), very few scholarly research studies were found. For example, Mohapatra and Mohamed (2015) examined and discussed the urban processes for the planning and provision of urban open spaces and their impacts on cities. In another study, Mohapatra and Mohamed (2013) explored the association between recreational use and attachment to neighbourhood open space. Kaur et al. (2021) observed that there is an unequal distribution of green spaces among different social strata and argued for consideration of environmental justice in green spaces in the cities. Similarly, Singh et al. (2010) discussed the lessons learned from urban forests and open green spaces in a city of India.

Therefore, the objectives of this study were to examine the factors that contribute to environmentally unjust development and management of green spaces and to evaluate various strategies that would lead to the development of environmentally just, organized green spaces in Indian cities. For this purpose, the following research questions were examined:

1. What is the current status of organized green spaces in terms of actual allocation in relation to the recommended provisions made in different planning and development guidelines in Indian cities?

2. What are the perceptions of people towards the provision, development, and management of organized green spaces in Indian cities?
3. What are the principal components and factors that contribute to the development of environmentally unjust, organized green spaces in Indian cities?
4. What strategic interventions would create environmentally just, organized open spaces in Indian cities?

2. Literature Review

2.1. Concept of Environmental Justice

Environmental justice pertains to the fair treatment and meaningful involvement of all people, regardless of race, colour, national origin, or income, concerning the development, implementation, and enforcement of environmental laws, regulations, and policies. The challenges of environmental justice emanate from the existence of inequity in the distribution of environmental burdens in society (Schlosberg & Carruthers, 2010). In other words, the challenges of environmental justice are another form of social injustice where some communities incur more environmental risks than others (Dominelli, 2014; Seymour, 2012). However, the focus of environmental injustice has been expanded from inequity to a variety of issues that range from the generally unequal nature of environmental protection to the realm of distributional, procedural, and interactional injustices (Kronenberg et al., 2020; Low, 2013). For instance, the role of people's participation and engagement in the planning and decision-making, the needs, values, and aspirations of people, as well as universal access to health and safety, which are essential elements of social inclusivity, form a part of the discourse (Kubanza et al., 2016; Schlosberg, 2007; Seymour, 2012).

2.2. Environmental Justice in Organized Urban Green Space Development

Open green spaces include spaces that are characterized by vegetation and/or bodies of water, which contribute to biodiversity and multiple ecosystems. The green spaces that are systematically and legally planned, provided, and managed by public authorities in urban areas and form an integral part of urban land uses are defined as organized urban green spaces. Examples include parks at different levels of settlements, urban gardens, playgrounds, stadiums, bodies of water, green buffer zones (including green walls), plantations (including street-side trees), natural conservation areas, etc. (Grunewald et al., 2018).

The ecosystem services provided by organized green space for a sustainable built environment range from improving the environment, helping to reduce pollution, enhancing aesthetic value, providing health benefits, creating places for outdoor activities, to creating social cohesion. They also assist in flood control, groundwater recharging, preventing pollution, etc. (Rigolon et al., 2018; Wolcha et al., 2014). A sustainable relationship between green spaces and buildings, roads, and other public spaces would ensure sustainable urban development (Grunewald et al., 2018). However, in recent decades, a steady increase in settlement and transportation areas has been experienced to meet the demands of an increase in urban populations and activities, specifically in the Global South, including India. These changes in urban settlements have occurred at the expense of urban green spaces, compromising the health, safety, and ecosystems of the cities (Mahmoud & Gan, 2018).

Evidence from the literature from the Global South suggests that fair allocation, equitable development, and management of organized green spaces have been undermined (Ju et al., 2021; Mohammed et al., 2021; Nero, 2017). For example, in South Africa and Latin America, an inverse relationship between low-income areas or socio-economic status and the amount and condition of public green space has been observed (Jennings et al., 2012; Ju et al., 2021; Shackleton & Blair, 2013). Tendencies of differential availability of, access to, and quality of green spaces have been observed in India, Eastern Asia, and some African countries, such as Nigeria and Ghana (Mohammed et al., 2021; Mohapatra & Mohamed, 2015; Nero, 2017; Ye et al., 2018). In other words, disparities in the green space development according to socioeconomic status were observed across the Global South. Furthermore, the participation of people in decision-making was limited (Mohapatra & Mohamed, 2015). Also, due recognition is not given to people's needs, values, and preferences for a safe, fair, and non-discriminatory environment (Rigolon et al., 2018; Venter et al., 2020). Therefore, all three types of environmental injustice in organized green space exist in some form specifically in the Global South, although distributional injustice is largely highlighted. Therefore, all three types of environmental justice need to be addressed to develop environmentally just green spaces in cities of the Global South.

3. Study Context and Research Methods

3.1. Study Context

Three important cities in the eastern region of India—Bhubaneswar and Cuttack in the Odisha State, and Kolkata in West Bengal State—were chosen for this study because they provide regional and locational homogeneity and cultural similarity. These cities encompass significant commercial, industrial, and educational centres. Moreover, because of the emergence of a significant number of higher education institutions, specifically in professional domains, as well as ICT industries in all three cities, a significant, young, and active population is found in these cities. Concurrently, they offer structural, morphological, and functional heterogeneity. While

Bhubaneswar and Cuttack are medium-sized cities in the Indian context (tier 2; Ministry of Housing and Urban Affairs, n.d.), Kolkata is a mega-city (Torkington, 2016). Also, Bhubaneswar and Kolkata are sprawling cities, but Cuttack is compact. Functionally, Bhubaneswar and Kolkata are provincial capitals, whereas Cuttack is an old commercial centre in the region.

Large numbers of daytime visitors to the cities are experienced because of the significant, regional-level commercial activities that take place. The large, active age group of the population demands organized green spaces in the cities for various activities such as relaxation, health, and fitness, and rest during idle periods. Organized green spaces are located in the cities to some extent. Each city has some kind of central park located in an important centre. Similarly, smaller parks and children's playgrounds are found in some neighbourhoods (Bhubaneswar Development Authority, 2021; Cuttack Development Authority, 2021; Mohapatra & Mohamed, 2015). Although free access is provided to most of the green spaces, some of the large parks and gardens only offer paid access. However, skewed distribution of organized green spaces has been observed in the cities (Bhubaneswar Development Authority, 2021; Cuttack Development Authority, 2021; Mohapatra & Mohamed, 2015). Also, a majority of the green spaces are degenerating as a result of poor management and maintenance. It has been alleged that some of these had been used for other, more profitable land uses such as residential and commercial purposes. Therefore, these cities were considered to be important candidates for this study.

3.2. Data Collection

Data were collected from the study areas by means of surveys. Firstly, a survey was conducted among the households of the three cities to explore the respondents' perceptions of the provision, development, and management of organized green spaces, as well as the factors that influence environmental justice. Secondly, a Delphi survey was carried out to explore and evaluate the influence of strategic measures to improve environmental justice concerning organized green spaces.

3.2.1. Households Survey

The households survey was conducted by using a pretested questionnaire that consisted of two sections. The first section contained questions about the respondents' perceptions of various attributes related to the current provision, development, and management of organized green spaces. For this purpose, 11 attributes, which are used to evaluate the provision, distribution, adequacy, accessibility, and usage of green spaces by development authorities were chosen. These attributes were selected and included in the questionnaire based on discussions with the stakeholders responsible for planning, development, and management of urban green spaces, and experts. The second section included questions about the respondents' perceptions of various plausible factors that influence environmental justice in organized green spaces. In this section, the questions were asked on two levels. Firstly, respondents were asked whether a particular factor influences environmental justice. Secondly, respondents were asked to rate how influential each factor was on a scale of 1 (very low) to 5 (very high). However, the second level question was considered relevant and asked if the answer to the first level question was affirmative (see Appendix 1 in the Supplementary File).

A total of 670 questionnaires was administered, of which 610 completed responses were returned, giving a response rate of 91.04%. The survey was conducted by using a random sampling method and a semi-structured interviewing process. Interviews were conducted with households in various residential areas based on their willingness and availability to participate in the survey (see Table B in Appendix 3 in the Supplementary File). The areas were selected to represent geographical location, population, socio-economic and environmental heterogeneity, and availability of different types of organized green spaces. Care was taken to avoid bias towards any race, gender, or age of the respondents. Skewness to one group of respondents was avoided by deploying a proportional distribution of questionnaires among different groups of respondents.

The response rate of samples collected from Bhubaneswar, Cuttack, and Kolkata were 244 (90.37%), 162 (92.57%), and 204 (86.68%) respectively. The overall sample size was adequate (>385) at a confidence level of 95%, a confidence interval of 5%, and a worst-case percentage of 50%. Also, the sample size for respective cities was found to be adequate at a confidence interval ranging between 6.27% and 7.70% (Cochran, 1977; see Table A in Appendix 3 in the Supplementary File).

3.2.2. The Delphi Survey

A Delphi survey was carried out to explore and evaluate the influence of strategic measures to improve environmental justice concerning organized green spaces. For this purpose, 30 specialists were chosen based on their expertise, professional engagement, and experience in the development of cities, land-use allocation, and development of organized green spaces. The experts included: six architects, three landscape planners, seven urban planners, three entrepreneurs (real estate developers), two social activists, three civil engineers engaged in city development, two legal professionals, and four academics related to the field of study. The survey was conducted in two stages. In the first stage, the experts were asked to identify a set of strategies that could improve environmental justice. In the second stage, the experts were asked to rate the influence of the proposed strategies for improving environmental justice (see Appendix 2 in the Supplementary File).

The reasons for adopting the Delphi survey were two-fold. Firstly, not much structured, statistical data was available and expert opinion was relied upon to develop strategic interventions for this study through a rigorous analytical process. Secondly, a Delphi survey provides a structured communication process that enables a group of experts to address a complex problem effectively and which can provide more accurate answers to a question, based on triangulation and convergence of the opinions of various experts in an aggregated manner, compared with the opinions of individual experts or traditional/statistical groups in which judgements of non-interacting individuals are aggregated (Hsu & Sandford, 2007).

For both the households and Delphi surveys, a Likert scale ranging between 1 and 5 (1 = very low, 2 = low, 3 = fair, 4 = high, and 5 = very high) was used to measure the responses from the participants. In addition, secondary data about the norms and standards, as well as allocation of organized green spaces were obtained from the reports of various organizations related to the development of green spaces in the cities studied.

3.3. Data Analysis

Descriptive and inferential statistics, factor analysis, and an ordinal regression model estimation were used to quantitatively analyze the data. For this purpose, IBM SPSS 27, 2020 software was used. Also, qualitative narrative analyses of the opinions of experts were conducted.

Descriptive and inferential statistics, which included a perception index (PI), standard deviation (SD), and z-test, were used to assess the respondents' perceptions of the current provision, development, and management of green spaces in the cities. The mean Likert scale scores obtained from the responses were taken to represent the PI values. These values were calculated by assigning uniform weights to the response categories which remain unchanged for all items (Chakrabartty, 2014; Dithebe et al., 2019). The SD values were used to observe the consistency in the responses and the z-test results were used to establish the statistical significance of the attributes assessed. The z-test was used as the preliminary analysis of data and showed the Kurtosis values ranging between −0.873 and +0.911, and skewness ranging between −0.436 and +0.783 for all parameters (which are within the range −2 and +2), indicating normality (Hair et al., 2010; Kline, 2011). A PI greater than or equal to three and a p-value less than or equal to 0.05 indicate the performance of an attribute as being fair. Similarly, a PI greater than or equal to four and a p-value less than or equal to 0.05 indicate the performance as high. However, a PI less than three and a p-value greater than 0.05 imply the performance to be less than fair.

Factor analyses were conducted using principal component analysis to identify and examine the components and related factors that influence environmental justice. The factors which received affirmative responses from the majority of respondents of having plausible influences on environmental justice were used for factor analysis. Principal component analysis was used because it can simplify the complexity in high-dimensional data without compromising the trends and patterns (Velliangiri et al., 2019). Before the analyses were conducted, the adequacy of the sample size and validity and robustness of the model were checked using Kaiser-Meyer-Olkin (KMO) measure and Bartlett's tests. The principal components were extracted by using a scree plot. The results were interpreted according to communalities, total variance, and varimax rotation values, specifically to interpret the components and various factors under the components.

Ordinal regression model estimation was performed to evaluate the strategies to improve environmental justice. Also, a narrative analysis of experts' opinions was conducted to supplement the findings from the model estimation. Before the model estimation was done, the model was validated using model fitting information, the goodness of fit, and the test of parallel lines. The model fitting information indicates how well the model fits the data. The goodness of fit test indicates how well the data fits a distribution from a population with a normal distribution. The test of parallel lines is used to assess whether the assumption that the parameters are the same for all categories is reasonable (Williams & Quiroz, 2020). These are specific tests to check the validity and robustness of ordinal regression models, which rest on the ChiSquare test (non-parametric), thus avoiding the concerns for the non-normality of the data.

4. Results

4.1. Current Provision of Organized Green Space in the Selected Cities

According to the land-use regulation of Bhubaneswar Comprehensive Development Plan (2010–2030), 5 to 10% of the land should have been provided for organized green spaces. However, land for green spaces constituted only approximately 1.86% (Bhubaneswar Development Authority, 2010; Mohapatra & Mohamed, 2015). A similar trend was observed in Cuttack, in which land for green spaces varied between less than 0.5 and 2.0% in different zones, and, in Kolkata, the allocation ranged between 3 and 7% (Table 1). Thus, currently, the provision of organized green spaces in all three cities was significantly lower than the minimum recommended and appeared to have contributed to environmental injustice.

4.2. Respondents' Perceptions of the Provision, Development, and Management of Organized Green Space

The current scenario was assessed based on the perceptions of the respondents (Table 2). The results have been

Table 1. Provision of organized green space in the selected cities.

City	Green Space Allocation (% of Total Land)	Urban Development Plan Formulation and Implementation Land-Use Regulation (% of Total Land)	Remarks
Bhubaneswar	1.86	12–14 *	
Cuttack	<0.5–2.0	12–14	Varies between different zones of the city region
Kolkata	3–7	14–16	Varies between different municipal corporations in the metropolitan area

Note: * 5%–10% as per the *Comprehensive Development Plan (2010–2030) Guidelines* (Bhubaneswar Development Authority, 2010).

presented on an aggregate basis because similar trends of responses to all the aspects were observed across the three cities. According to respondents, although there has been a general allocation of land for organized green spaces, it was not adequate. Further, although these spaces had been developed to a certain extent, they were not fairly and equitably distributed throughout the cities. Similarly, low importance had been given to environmental considerations such as improving airflow, reducing air and noise pollution, urban groundwater management, creating buffer zones, etc. The management, governance, operation, and maintenance of these places were perceived to be less than fair. Furthermore, although these spaces were quite accessible to all classes of society, their usage by all classes of society was less than fair. Also, these spaces lacked adequate amenities and facilities. Many of these spaces, specifically those which were poorly managed and maintained, were misused, e.g., used for dumping wastes and encroached upon for unauthorized activities. Overall, inadequate provision, unfair and inequitable distribution, poor accessibility and usage, lack of concern for the environment, and misuse of organized green spaces were the major concerns.

4.3. Components and Factors That Influence Organized Green Space Development and Management for Environmental Justice and Social Inclusivity

An exploratory analysis of the principal components and factors was conducted to examine the ones which influence environmental justice in the study areas. A KMO measure of 0.934, significance value p = 0.000 (<0.05; Table 3), and communalities of all the factors greater than 0.5, except in two factors (creation of activities in the organized green spaces and management of microclimate; Table 4), indicated the adequacy and factorability of the sample. Further, the correlation coefficients among the factors were found to range between 0.009 and 0.7, showing that the chances of over-estimation

Table 2. Respondents' perceptions of the provision, development, and management of organized green space.

Attributes	PI	SD	Z-Test (p-value)
General allocation of land	3.38	0.92	0.000
Adequate allocation of land	2.81	0.90	0.998
Development of organized open space	3.22	0.88	0.000
Fair and equitable distribution in different areas of the city	2.58	0.79	0.998
Provision of organized green space in accordance with environmental considerations	2.87	0.80	0.999
Accessible to all classes of society	3.25	0.89	0.000
Usage by all classes of society	2.91	0.81	0.998
Availability of adequate and relevant amenities	2.95	0.81	0.902
Misuse of organized green spaces (e.g., poorly managed and maintained, used for dumping of wastes or encroachments)	3.47	0.96	0.000
Management and governance	2.80	0.95	0.999
Operation and maintenance	2.69	0.81	0.997

Table 3. Factor analysis validation parameters (KMO sampling adequacy and Bartlett's test of sphericity).

KMO Measure of Sampling Adequacy		0.934
Bartlett's Test of Sphericity	Approx. Chi-Square	36,004.967
	Degree of Freedom	703
	Significance	0.000

Table 4. Communalities indicating adequacy and factorability of the sample used for factor analysis.

Factor ID	Factors	Initial	Extraction
F1	Demographic characteristics	1.000	0.841
F2	Social receptiveness	1.000	0.971
F3	Crime/fear of crime	1.000	0.655
F4	Community feeling towards the availability and use of green spaces	1.000	0.643
F5	Infrastructure and services for green spaces	1.000	0.902
F6	Propensity to use open spaces	1.000	0.977
F7	Socio-economic inequality	1.000	0.878
F8	Preference for outdoor activities	1.000	0.715
F9	Community engagement and participation	1.000	0.845
F10	Unequal distribution of green spaces	1.000	0.642
F11	Demand for land for real estate	1.000	0.965
F12	Land value	1.000	0.924
F13	The economic return of the land	1.000	0.856
F14	Cost of development of organized open spaces	1.000	0.805
F15	Cost of management and maintenance of open spaces	1.000	0.768
F16	Cost of infrastructure development	1.000	0.879
F17	User fees	1.000	0.936
F18	Employment opportunities through the creation of commercial activities	1.000	0.812
F19	Aesthetics and beautification	1.000	0.740
F20	Creation of public congregation areas	1.000	0.812
F21	Providing space for recreation for different age and gender categories	1.000	0.946
F22	Providing space for outdoor and sporting activities	1.000	0.854
F23	Creation of urban forests and national parks	1.000	0.871
F24	Creation of urban gardens, neighbourhood parks, and children's playgrounds	1.000	0.786
F25	Reduction of pollution	1.000	0.968
F26	Creation of central parks	1.000	0.769
F27	Complementing different land use	1.000	0.936
F28	Solid-waste management	1.000	0.763
F29	Sustainable built environment	1.000	0.865
F30	Creation of urban activities	1.000	0.465
F31	Urban groundwater management	1.000	0.416
F32	Creation of buffer zones	1.000	0.810
F33	Management of micro-climate	1.000	0.280
F34	Accessibility of green spaces (vehicular, pedestrian, and digital)	1.000	0.792
F35	Creation of a healthy environment (space for airflow)	1.000	0.557
F36	The hegemony of political leaders and governing authorities for green space development and pressure on planners	1.000	0.877
F37	Availability of land	1.000	0.706
F38	Standards and norms for urban land use and urban activities	1.000	0.663

and co-linearity were limited (Pallant, 2010). Therefore, the factor analysis was found to be adequate and used for further analyses (Tucker & MacCallum, 1997).

Five components with eigenvalues of more than one were extracted using a scree plot (Figure 1). The total variance explained by each component extracted is shown in Table 5, with a cumulative variance percentage of 78.67%.

The factors under the five components that influence the environmental justice of organized green spaces were interpreted using varimax rotation (Table 6). The five principal components extracted and labelled were: (a) community features and infrastructure related to organized green space; (b) economics of development and management of organized green space; (c) linking green space to environment and health; (d) spatial development, land use, and accessibility; and (e) land availability and governance of supply of green space.

The community features of social structure, demographic characteristics, feelings, behaviour, engagement, etc. (Gavrilidis et al., 2019) were found to be the most important components that influenced environmental justice. However, the community features were linked to the availability of green space infrastructure (Gavrilidis et al., 2019; Kronenberg et al., 2020). So, they were being considered together as one component. Ten factors, which included factors F1 to F10 listed in Table 6, loaded onto this component. The second most predominant component was the economics of development and management of organized green space. The influential factors which loaded onto this component included F11 to F18 (Table 6), which contributed to the economics of just supply, creation, and development of green spaces. Linking organized green space to environment and health was found to be the third most important component. Eight factors, ranging from F18 to F26,

Table 5. Total variance explained showing eigenvalues and loadings used to extract principal comments.

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	14.24	37.47	37.47	14.24	37.47	37.47	8.74	23.00	23.00
2	7.23	19.02	56.49	7.23	19.02	56.49	8.35	21.98	44.98
3	4.57	12.03	68.52	4.57	12.03	68.52	6.76	17.78	62.77
4	2.09	5.49	74.02	2.09	5.49	74.02	3.75	9.87	72.63
5	1.76	4.63	78.65	1.76	4.63	78.63	2.29	6.02	78.67

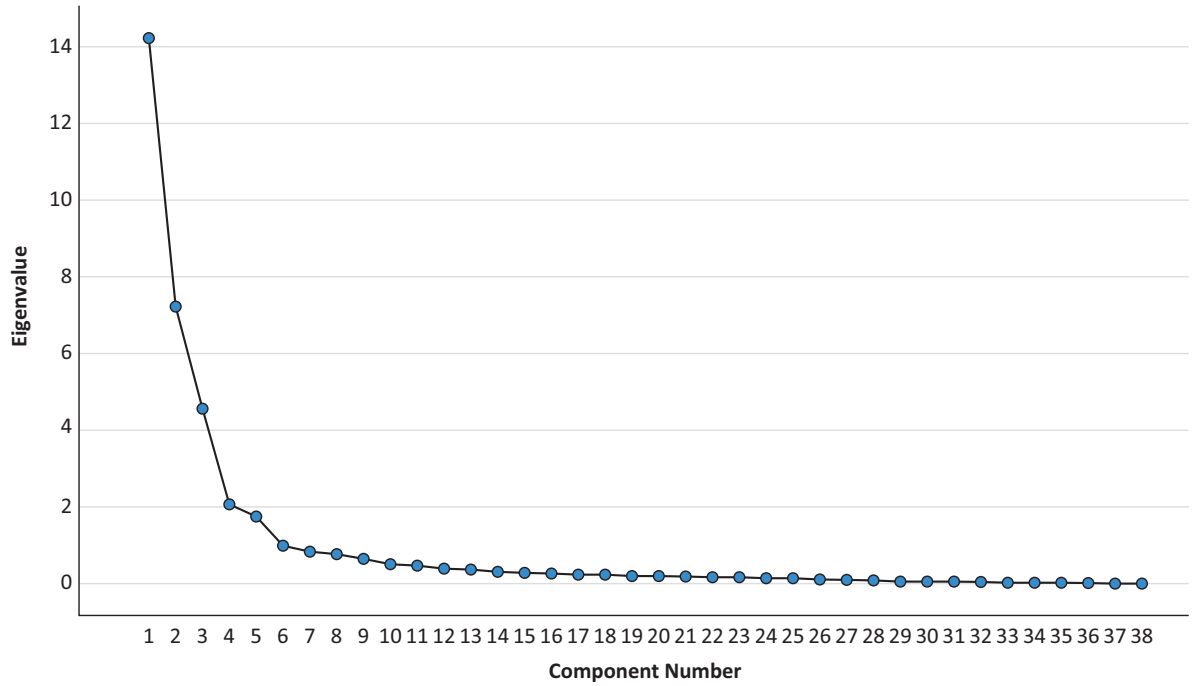

Figure 1. Scree plot with eigenvalues used for extracting components. Note: The components having an eigenvalue greater than one are retained as principal components.

Table 6. Rotated component matrix showing the factor loadings for each factor under different components.

		Component				
Factor ID	Factors	1	2	3	4	5
F2	Social receptiveness	0.938	0.071	0.183	0.073	−0.001
F3	Crime/fear of crime	0.959	0.059	0.219	0.077	0.009
F4	Community feeling towards the availability and use of green spaces	0.954	0.064	0.218	0.076	0.017
F6	Propensity to use open spaces	0.942	0.048	0.202	0.073	0.008
F7	Socio-economic inequality	0.904	0.026	0.207	0.054	0.037
F10	Unequal distribution of green spaces	0.879	0.060	0.170	0.070	0.036
F9	Community engagement and participation	0.871	0.072	0.148	0.068	0.047
F5	Infrastructure and services for green spaces	0.846	0.125	0.174	0.072	−0.023
F1	Demographic characteristics	0.835	0.053	0.189	0.061	−0.030
F8	Preference for outdoor activities	0.823	0.045	0.146	0.063	−0.018
F11	Demand for land for real estate	0.051	0.966	0.153	0.081	0.077
F12	Land value	0.056	0.963	0.154	0.078	0.067
F14	Cost of development of organized open spaces	0.048	0.953	0.147	0.088	0.072
F17	User/entrance fees	0.045	0.951	0.128	0.098	0.060
F15	Cost of management and maintenance of open spaces	0.102	0.915	0.099	0.071	0.090
F18	Employment opportunities through the creation of commercial activities	0.043	0.915	0.177	0.068	0.043
F13	Economic return of the land	0.114	0.876	0.109	0.039	0.105
F16	Cost of infrastructure development	0.059	0.873	0.113	0.059	0.055
F19	Aesthetics and beautification	0.342	0.143	0.868	0.106	−0.034
F22	Providing space for outdoor and sporting activities	0.348	0.181	0.844	0.108	−0.041
F20	Creation of public congregation areas	0.166	0.098	0.839	0.312	0.039
F24	Creation of urban gardens, neighbourhood parks, and children's playgrounds	0.338	0.166	0.836	0.114	−0.036
F21	Providing recreation space for different age and gender categories	0.204	0.160	0.823	0.363	0.031
F23	Creation of urban forest and national parks	0.158	0.128	0.823	0.303	0.047
F26	Creation of central parks	0.185	0.186	0.802	0.312	0.032
F25	Reduction of pollution	0.304	0.152	0.798	0.096	−0.032
F29	Sustainable built environment	0.024	−0.020	0.205	0.774	−0.013
F28	Solid-waste management	0.148	0.112	0.518	0.732	0.076
F34	Accessibility of green spaces (vehicular, pedestrian, and digital)	0.129	0.137	0.334	0.716	0.058
F27	Complementing different land use	0.142	0.141	0.415	0.706	0.066
F32	Creation of buffer zone	−0.014	−0.006	0.124	0.664	−0.089
F35	Creation of healthy environment (space for airflow)	0.155	0.235	0.372	0.570	0.115
F30	Creation of urban activities	0.058	0.060	−0.026	0.521	−0.012
F31	Urban groundwater management	0.078	0.770	0.018	0.027	0.233
F33	Management of micro-climate	0.026	0.639	0.067	0.042	0.032
F37	Availability of land	0.023	0.204	0.004	0.032	0.902
F38	Standards and norms for urban land use and urban activities	−0.011	0.084	0.001	0.043	0.872
F36	The hegemony of political leaders and governing authorities for green space development and pressure on planners	0.015	0.281	0.006	−0.051	0.749

Notes: The extraction method consisted of principal component analysis. Rotation: Varimax with Kaiser normalization, converged in seven iterations.

loaded onto this component (Table 6). Essentially these factors improved the environmental health and aesthetic value of the city as well as enabled people to use these spaces for their health benefits. Five factors—F27, F28, F29, F32, and F34 (Table 6)—loaded onto the fourth component (spatial development, land use, and accessibility). Although, in theory, organized green spaces have been given importance, in practice, they have been undermined as regards complementing different land uses and creating a sustainable built environment. Availability and supply of land for organized green spaces were found to be a challenge. Therefore, factors F36, F37, and F38 (Table 6), which influenced the development and management of organized green spaces, loaded onto the fifth component. It is necessary to address the factors under these five components to create environmentally just, organized green spaces in Indian cities.

4.4. Strategies for Improving Environmental Justice in Organized Green Space Development and Management

To improve environmental justice in the cities of India, six strategies were evaluated and compared with the current scenario. The current scenario under consideration was the allocation and development of uses of land in the current system, where adequate consideration had not been given to organized green space. The strategies were based on the evaluation of the ordinal regression model estimation and narrative analyses of experts' opinions. Tables 7 and 8 show the ordinal regression model validation and model parameter estimates, and significance of the strategies, respectively. The results in Table 7 indicated that the model validation parameters were acceptable and model estimation could be done. Five out of the six strategies were found to be statistically significant and likely to contribute to improving environmentally just, organized green space in Indian cities (Table 8).

The model parameter estimates suggested that community-led, green space development and management was the most important strategy (Table 8). Further, according to three experts (3, 8, and 12): "At the community level, when provided with responsibilities, they create rules, regulations, and procedures for the management, operation, and maintenance of the facilities. They remain vigilant for any misuse."

Ensuring a fair distribution of green spaces among different social areas was found to be the second most important strategy (Table 8). In this context, seven experts (1, 4, 14, 17, 18, 22, and 28) advocated that: "While planning and making land uses, fair distribution of green spaces among different social areas would improve their availability, access, and use," which is likely to improve environmental justice.

Mandatory linkage of built infrastructure with the provision of organized green spaces was the third most important strategy (Table 8). This strategy was expected

Table 7. Model validation parameters of ordinal regression model estimation.

Model Validation Parameters	Chi-Square	Significance	Remark
Model fitting information	67.166	0.000 (≤0.05)	Accepted
Goodness of fit	19.809	0.344 (>0.05)	Accepted
Test of parallel lines	19.809	0.344 (>0.05)	Accepted

Table 8. Strategies for improving environmental justice and social inclusivity in the development and management of organized green space.

Strategies	Parameter Estimate (B)	Exp (B)	Wald	Significance
Community-led, green space development and management	4.143	62.99	40.171	0.000
Ensuring a fair distribution of green spaces among different social areas	3.299	27.08	33.050	0.000
Improved accessibility including digital accessibility for green space use	1.796	6.03	11.704	0.001
Connecting green spaces to health benefits	2.417	11.21	19.271	0.000
Mandatory linkage of built infrastructure with provision of green spaces	2.871	17.65	25.765	0.000
Linking green space with micro-climate and environment	0.966	2.62	3.212	0.073 *
Current scenario for green space land-use allocation	0	1	—	—

Note: * Statistically not significant.

to attract people to these spaces and improve their use. Moreover, according to several experts (2, 5, 12, 16, and 23): "Built infrastructure and civic facilities, specifically recreational facilities, sporting elements, lavatories, food, and water facilities, etc., within or near the public parks or gardens, encourage people to visit the green spaces and use them frequently." In other words, it would contribute to environmental justice.

Connecting green spaces to health benefits was the fourth most important strategy that could improve environmental justice (Table 8). According to the majority of the experts, when the green spaces are linked to benefits of health and relevant elements, such as walking or jogging tracks, open gymnasium equipment for exercising and sporting activities are provided, and a fresh and aesthetic environment is created, people from all classes, ages, and gender are likely to visit these spaces.

Although to a relatively lesser extent, compared with the first four strategies, improved vehicular and pedestrian accessibility, including digital accessibility for green space use, was found to be significant (Table 8). According to several experts (3, 9, 11, 19, 24, and 27):

> Lack of accessibility both by vehicles and pedestrians including inadequate parking facilities acts as a barrier to attract people. Also, people may not have sufficient and real-time information about the activities and operation of the organized green spaces. The lesser use of such spaces leads to their degeneration creating environmental and social problems such as criminal activities.

5. Discussion

It has been argued that the development and management of organized green spaces in Indian cities have been undermined and the challenges of environmental injustice have been experienced. Five principal components and associated factors were found to influence environmental justice in the development and management of organized green spaces (Table 6). The most important component—community aspects, infrastructure, and the aligned factors—implied that, in addition to inadequate availability of organized green spaces, unequal distribution, poor infrastructure and services, socio-economic inequality, and crime were the major deterrents to the use of these spaces (Shackleton & Blair, 2013), which could contribute to environmental injustice (Gavrilidis et al., 2019). Concurrently, demographic characteristics, the receptiveness of society, the propensity of people towards the use of green spaces, their preference for outdoor activities, and community engagement and participation in making green spaces accessible require due consideration (Rigolon et al., 2018; Shackleton & Blair, 2013).

While the lack of green space infrastructural factors creates procedural and distributional injustice, community factors might lead to interactional injustice. Furthermore, since land is scarce and the cost of land is high, there is a high demand to use the land for activities that would offer a higher return. Also, owing to the limited availability of funds, the costs relegate the development of organized green spaces to lower priorities. So, the economics of development and management of organized green spaces play a crucial role in attaining environmental justice. The pressure for the use of green spaces for more commercially viable purposes because of the economic aspects related to development might lead to distributional injustice and should be recognized (Onose et al., 2020).

Factors (F18–F26; Table 6) that link green space to the environment and health are related to planning and regulations. Since these factors directly influence the community, their participation and opinions are important (Liu et al., 2017; Shackleton & Blair, 2013). Lack of consideration for a majority of these factors, except perhaps for the sporadic creation of urban gardens or parks in central locations, was found to contribute to both procedural and interactional environmental injustice.

Spatial development, land use, and accessibility were also observed to be crucial components for environmental justice. Land use and built environment dictate the provision of civic facilities and vehicular and pedestrian access. For example, in the absence of buffer zones and an adequate solid waste management system, environmental challenges are experienced. Despite the provision for these in planning guidelines and regulations, non-adherence causes procedural injustice. Furthermore, digital accessibility to organized green spaces through information, often real-time, could assist people to access and use these spaces. The lack of consideration of these factors, as argued by Kronenberg et al. (2020), could contribute to all three types of environmental injustice. Moreover, the scarce availability of land combined with the hegemony of pressure groups, compromising of the norms and standards, and improper allocation of land can also lead to all three types of environmental injustice (Onose et al., 2020; Zupan & Büdenbender, 2019). The study shows that the factors under the five principal components are essential for attaining all three types of environmental justice in India, which could be applied in similar contexts of the Global South. Consequently, emphasis on distributional justice as it is currently highlighted in many studies may be insufficient to ensure organized green space development in cities of the Global South (Mabon, 2020).

To create environmentally just, organized green spaces, five strategies could play significant roles (Table 8). The most prominent was the community-led, development and management of organized green spaces. Implementing this strategy is likely to require the demands and aspirations of the people to be considered while improving belongingness and ownership in alignment with the theories of environmental justice. This strategy could contribute to equitable and just distribution, access, and public satisfaction (Rigolon et al.,

2018; Shackleton & Blair, 2013). Also, it might break the hegemony of pressure groups for green spaces to be used for commercial purposes. Any environmental challenges, including solid-waste dumping, could also be eliminated by the vigilance of people, thereby improving the environment.

A strategy of ensuring a fair distribution of green spaces among different social areas would address the skewed development of green space among various social areas and, specifically, areas where disadvantaged sections of society live, which is prevalent in the Global South. Similarly, the strategy of mandatory linkage of built infrastructure with the provision of organized green spaces would eliminate the concerns of lack of adequate infrastructures, such as recreational facilities, sporting elements, civic elements, drainage systems, security systems, etc. Moreover, elements that would introduce health benefits in organized green spaces would attract people from all strata of society (Liu et al., 2017). The amalgamation of people from all groups of society, a healthy environment, and the enhanced use of these spaces is likely to contribute to the improvement of environmental justice (Kronenberg et al., 2020).

Both physical and digital access was found to be important. So, creating adequate vehicular and pedestrian access and parking facilities, as well as provision of real-time information, would assist in attracting people. Also, the use of real-time information through digital accessibility might enable policing and security agencies to monitor various unscrupulous activities remotely and take warranted actions, which can discourage criminal activities, thus improving the usage of these places (Das, 2021). It is argued thus that the combined effect of these strategies could improve the environmental justice of organized green spaces in Indian cities as well as cities that have similar contexts in the Global South.

6. Conclusion

Using the context of three cities of India, the principal components and factors influencing environmental justice were explored in this study, and a set of strategies was evaluated that could improve environmental justice in organized green spaces. However, the study is based on stakeholders' perception data in the absence of structured statistical data from three cities from one region of India, which is the limitation of the study. Further interlinkage among components and factors therein were not considered which is considered as the future scope of the research.

The findings revealed that environmental justice challenges are experienced in organized green spaces in Indian cities. Five important components, including community aspects and infrastructure; the economics of development and management of organized green space; linking green space to environment and health; spatial development, land use, and accessibility; and land availability and governance of supply of green space and associated factors were found to influence environmental justice and require redress. To overcome these concerns, five strategies were found to be significant: these include community-led, green space development and management; fair and equitable distribution of green spaces among different social areas; mandatory linkage of built infrastructure with provision of green spaces; connecting green spaces to benefits of health; and improvement of accessibility including digital accessibility for green space use. These strategies are likely to improve equitable availability of organized green spaces, participation, belongingness, and ownership of the community, and compatibility with the environment. They could also diminish the hegemony and motivation of pressure groups for the use of such spaces for commercial activities.

Consequently, the contributions of the factors under the five principal components should be addressed as relevant for creating environmentally just urban green spaces. Strategic interventions that could address the contributory factors by enabling both participation and recognition in addition to equitable distribution and access should be adopted. The proposed strategies should be effected in combination for plausible improvement of all three types of environmental justice in organized green spaces in India and similar contexts in the Global South.

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Conflict of Interests

The author declares no conflict of interests.

Supplementary Material

Supplementary material for this article is available online in the format provided by the author (unedited).

References

Anand, G., & Deb, A. (2017). *Planning, "violations," and urban inclusion: A study of Bhubaneswar*. Indian Institute for Human Settlements. http://yuvaindia.org/wp-content/uploads/2017/03/Bhubaneswar-Final_For-Printing_May-2017_compressed.pdf

Bhubaneswar Development Authority. (2010). *Comprehensive development plan (2010–2030) guidelines*.

Bhubaneswar Development Authority. (2021). *Projects*. https://www.bda.gov.in/projects/horticulture/4

Bullard, R. D. (2000). *Dumping in Dixie: Race, class and environmental quality.* Westview Press.

Chakrabartty, S. N. (2014). Scoring and analysis of Likert

scale: Few approaches. *Journal of Knowledge, Management and Information Technology*, *1*(2), 31–44.

Cochran, W. G. (1977). *Sampling techniques* (3rd ed.). Wiley.

Cuttack Development Authority. (2021). *Horticulture*. http://www.cdacuttack.nic.in/Horticulture.aspx

Das, D. (2017). Exploring the politico-cultural dimensions for development of smart cities in India. *International Review for Spatial Planning and Sustainable Development*, *5*(3), 79–99. http://dx.doi.org/10.14246/irspsd.5.3_79

Das, D. (2021). Revitalising South African city centres through ICT. *Urban Planning*, *6*(4), 228–241. https://doi.org/10.17645/up.v6i4.4381

Dithebe, K., Aigbavboa, C., Thwala, W., & Oke, A. (2019). Analysis on the perceived occurrence of challenges delaying the delivery of water infrastructure assets in South Africa. *Journal of Engineering, Design and Technology*, *17*(3), 554–571.

Dominelli, L. (2014). Promoting environmental justice through green social work practice: A key challenge for practitioners and educators. *International Social Work*, *57*(4), 338–345.

Gavrilidis, A. A., Niță, M. R., Onose, D. A., Badiu, D. L., & Năstase, I. (2019). Methodological framework for urban sprawl control through sustainable planning of urban green infrastructure. *Ecological Indicators*, *96*, 67–78. https://doi.org/10.1016/j.ecolind.2017.10.054

Grunewald, K., Li, J., Xie, G., & Kümper-Schlake, L. (Eds.). (2018). *Towards green cities—Urban biodiversity and ecosystem services in China and Germany*. Springer.

Hair, J., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis: A global perspective* (7th ed.). Pearson.

Hsu, C.-C., & Sandford, B. A. (2007). The Delphi technique: Making sense of consensus. *Practical Assessment, Research and Evaluation*, *12*, Article 10. https://doi.org/10.7275/pdz9-th90

Jennings, V., Gaither, C. J., & Gragg, R. S. (2012). Promoting environmental justice through urban green space access: A synopsis. *Environmental Justice*, *5*(1), 1–7. https://doi.org/10.1089/env.2011.0007

Ju, Y., Moran, M., Wang, X., Avila-Palencia, I., Cortinez-O'Ryan, A., Moore, K., Slovic, A. D., Sarmiento, O. L., Gouveia, N., Caiaffa, W. T., Aguilar, G. A. S., Sales, D. M., De Pina, M. D. F. R. P., Coelho, D. M., & Dronova, I. (2021). Latin American cities with higher socioeconomic status are greening from a lower baseline: Evidence from the SALURBAL project. *Environmental Research Letters*, *16*(10), Article 104052. https://doi.org/10.1088/1748-9326/ac2a63

Kabisch, N., Strohbach, M., Haase, D., & Kronenberg, J. (2016). Urban green space availability in European cities. *Ecological Indicators*, *70*, 586–596. https://doi.org/10. 1016/j.ecolind.2016.02.029

Kaur, N., Kaur, M., Padhi, S. S., & Singh, K. K. (2021). Geospatial analysis of the distribution of urban green spaces: A study of four Indian cities. *Cities & Health*. Advance online publication. https://doi.org/10.1080/23748834.2021.1941722

Kline, R. B. (2011). *Principles and practice of structural equation modeling* (5th ed.). The Guilford Press.

Kronenberg, J., Haase, A., Taszkiewicz, E., Antal, A., Baravikova, A., Biernacka, M., Dushkova, D., Filčak, R., Haasee, D., Ignatieva, M., Khmara, Y., Niţă, M. R., & Onose, D. A. (2020). Environmental justice in the context of urban green space availability, accessibility, and attractiveness in post-socialist cities. *Cities*, *106*, Article 102862.

Kubanza, N. S., Das, D. K., & Simatele, D. (2016). Some happy, others sad: Exploring environmental justice in solid waste management in Kinshasa, the Democratic Republic of Congo. *Local Environment*, *22*(5), 595–620. https://doi.org/10.1080/13549839.2016.1242120

Leonard, L., & Pelling, M. (2010). Mobilisation and protest: Environmental justice in Durban, South Africa. *Local Environment*, *15*(2), 137–151.

Liu, H., Li, F., Li, J., & Zhang, Y. (2017). The relationships between urban parks, residents' physical activity, and mental health benefits: A case study from Beijing, China. *Journal of Environmental Management*, *190*, 223–230.

Low, S. (2013). Public space and diversity: Distributive, procedural and interactional justice for parks. In G. Young & D. Stevenson (Eds.), *The Ashgate research companion to planning and culture* (pp. 295–310). Ashgate.

Mabon, L. (2020). Environmental justice in urban greening for subtropical Asian cities: The view from Taipei. *Singapore Journal of Tropical Geography*, *41*, 432–449.

Mahmoud, S. H., & Gan, T. Y. (2018). Impact of anthropogenic climate change and human activities on environment and ecosystem services in arid regions. *Science of the Total Environment*, *633*, 1329–1344.

Ministry of Housing and Urban Affairs. (n.d.). *Number of cities towns by city size class*. http://45.115.99.205/moud/cms/number-of-cities–towns-by-city-size-class.php

Mishra, S. (2016, May 11). Bhubaneswar's skyline to turn green: Govt plans extensive plantation drive over next five years. *The Telegraph India*. https://www.telegraphindia.com/odisha/bhubaneswar-s-skyline-to-turn-green/cid/1505641

Mohammed, M., Dukku, S. J., Babanyara, Y. Y., Muhammad, I., & Mohammed, J. K. (2021). Comparative analysis of environmental justice among urban neighbourhoods. *Journal of Inclusive Cities and Built Environment*, *1*(2), 27–40.

Mohapatra, B., & Mohamed, A. R. (2013). Exploring the associations between recreational use and attachment to neighbourhood open space. *International Journal of Ecology & Development*, *24*(1), 95–108.

Mohapatra, B., & Mohamed, A. R. (2015). The effect

of social and spatial processes on the provision of urban open spaces. *International Journal of Green Economics*, *9*(1), 1–23.

Nero, B. (2017). Urban green space dynamics and socio-environmental inequity: Multi-resolution and spatiotemporal data analysis of Kumasi, Ghana. *International Journal of Remote Sensing*, *38*(23), 6993–7020 https://doi.org/10.1080/01431161.2017.1370152

Onose, D. A., Iojă, C., Niță, M. R., Badiu, D. L., & Hossu, C. A. (2020). Green struggle: Environmental conflicts involving urban green areas in Bucharest City. In J. Breuste, M. Artmann, C. Iojă, & S. Qureshi (Eds.), *Making green cities: Concepts, challenges and practice* (pp. 484–526). Springer.

Pallant, J. (2010). *SPSS survival manual: A step by step guide to data analysis using SPSS* (4th ed.). Allen & Unwin.

Praharaj, M. (2019, June 5). More greenbelts needed for Bhubaneswar air quality. *The Pioneer*. https://www.dailypioneer.com/2019/state-editions/more-greenbelts-needed-for-bhubaneswar-air-quality.html

Ramirez-Andreotta, M. (2019). Environmental justice. In M. L. Brusseau, I. L. Pepper, & C. P. Gerba (Eds.), *Environmental and pollution science* (3rd ed., pp. 573–583). Elsevier.

Rigolon, A., Browning, M., Lee, K., & Shin, S. (2018). Access to urban green space in cities of the Global South: A systematic literature review. *Urban Science*, *2*(3), Article 67. https://doi.org/10.3390/urbansci2030067

Riyan, R. V. (2019, July 7). More parks to lend green cover to Bhubaneswar denuded by Fani. *The Times of India*. https://timesofindia.indiatimes.com/city/bhubaneswar/more-parks-to-lend-green-cover-to-bhubaneswar-denuded-by-fani/articleshow/70114366.cms

Schlosberg, D. (2007). *Defining environmental justice: Theories, movements, and nature*. Oxford University Press.

Schlosberg, D., & Carruthers, D. (2010). Indigenous struggles, environmental justice, and community capabilities. *Global Environmental Politics*, *10*(4), 12–35.

Schweitzer, L., & Stephenson, M. (2007). Right answers, wrong questions: Environmental justice as urban research. *Urban Studies*, *44*, 319–337. https://doi.org/10.1080/00420980601074961

Seymour, M. (2012). Just sustainability in urban parks. *Local Environment: The International Journal of Justice and Sustainability*, *17*(2), 167–185.

Shackleton, C. M., & Blair, A. (2013). Perceptions and use of public green space is influenced by its relative abundance in two small towns in South Africa. *Landscape and Urban Planning*, *113*, 104–112.

Singh, V. S., Pandey, D. N., & Chaudhry, P. (2010). *Urban forests and open green spaces: Lessons for Jaipur* (RSPCB Occasional Paper No. 1/2010). Rajasthan State Pollution Control Board.

Torkington, S. (2016). *India will have 7 megacities by 2030, says UN*. World Economic Forum. https://www.weforum.org/agenda/2016/10/india-megacities-by-2030-united-nations

Tucker, L. R., & MacCallum, R. C. (1997). *Exploratory factor analysis*. University of California. https://labs.dgsom.ucla.edu/hays/files/view/docs/factor.pdf

Velliangiri, S., Alagumuthukrishnan, S., & Joseph, T. S. I. (2019). A review of dimensionality reduction techniques for efficient computation. *Procedia Computer Science*, *165*, 104–111. https://doi.org/10.1016/j.procs.2020.01.079

Venter, Z. S., Shackleton, C. M., Van Staden, F., Selomane, O., & Masterson, V. A. (2020). Green apartheid: Urban green infrastructure remains unequally distributed across income and race geographies in South Africa. *Landscape and Urban Planning*, *203*, Article 103889. https://doi.org/10.1016/j.landurbplan.2020.103889

Williams, R. A., & Quiroz, C. (2020). Ordinal regression models. In P. Atkinson, S. Delamont, A. Cernat, J. W. Sakshaug, & R. A. Williams (Eds.), *SAGE research methods foundations* (pp. 1–25). SAGE. https://www.doi.org/10.4135/9781526421036885901

Wolcha, J. R., Byrne, J., & Newell, J. P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities "just green enough." *Landscape and Urban Planning*, *125*, 234–244.

Ye, C., Hu, L., & Li, M. (2018). Urban green space accessibility changes in a high-density city: A case study of Macau from 2010 to 2015. *Journal of Transport Geography*, *66*, 106–115. https://doi.org/10.1016/j.jtrangeo.2017.11.009

Zerah, M. H. (2007). Conflict between green space preservation and housing needs: The case of the Sanjay Gandhi National Park in Mumbai. *Cities*, *24*(2), 122–132.

Zupan, D., & Büdenbender, M. (2019). Moscow urban development: Neoliberal urbanism and green infrastructures. In T. Tuvikene, W. Sgibnev, & C. S. Neugebauer (Eds.), *Post-socialist urban infrastructures* (pp. 125–141). Routledge.

About the Author

Dillip Kumar Das (Prof.) has a PhD in urban and regional planning with a civil engineering and city planning background. Currently, he is involved in teaching, research, and community engagement activities at the University of KwaZulu-Natal, South Africa. His research and consulting interests under sustainable urban and regional development include systems analysis, system dynamics modelling, infrastructure planning and management, smart cities, and transportation planning. He has co-authored two books as the lead author and published several peer-reviewed research articles.

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Article

Citizen Participation in Urban Forests: Analysis of a Consultation Process in the Metropolitan Area of Rouen Normandy

Charlotte Birks *, Damien Féménias, and Charly Machemehl

Institute of Transformation of Physical and Sports Activities (CETAPS), University of Rouen Normandy, France

* Corresponding author (charlotte.birks@univ-rouen.fr)

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Abstract
The article examines the results of a "citizen consultation" organised by local public officials through a questionnaire-based consultation approach to the management of urban and peri-urban forests. The study shows how forests are at the same time strong, complex, and ambivalent policy levers in a public consultation process. The article, first of all, specifies the economic context of the case study, namely that of a metropolis in the north of France with a population of 500,000 people. It then presents the methods and the occasionally divergent results of the metropolitan "dialogue" survey (dated 2020, n = 375) on the one hand, and a university survey (dated 2020, n = 774) on the other. The results obtained reveal the challenges, difficulties, and limits of a participatory approach, given the high degree of ambivalence and contrast in the way population groups relate to woodland and the representative/participatory systems. The article highlights the complexity involved in the management of woodlands and their use as part of a political process that is both participatory and sustainable.

Keywords
citizen consultation; city; environment; Normandy; public participation; Rouen; urban forest; woodland

Issue
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1. Introduction

Citizen participation in environmental decision-making in France began to develop in the 1990s. For social scientists, it revives three existing debates (Claeys-Mekdade, 2006). The first one re-examines the place of citizen participation in environmental policy-making, considering that the socially biased view of elected officials and experts requires the use of a broader system of representation. The second one questions the role of the sociologist in relation to the public authorities and the conditions of objectivity and involvement. The third debate questions the growing permeability between politics and science in decision-making (for example, the risk of technocratic treatment of social issues, questioning of scientific legitimacy within public environmental decisions by the voluntary community). In line with these questions, this article shows how forests are ambivalent resources for "establishing territory" in a public dialogue process. On the one hand, elected officials and local agents cannot ignore the opinion of the residents on the management of a public "asset" in the form of a forest which is part of their living environment and, on the other hand, they must take into account the different levels of knowledge and involvement of the population.

Recently, the depoliticisation of climate issues has been pointed out in case study format (Comby, 2015). This phenomenon describes how the public authorities tend to take charge of an ecological challenge (politicisation) while removing the possibility of their being called into question so as not to jeopardize their existence and relegating the ecological problem to individual

responsibility, or technical or economic considerations (Comby, 2019). The local consultation process studied in this article effectively shows how the population groups consulted are invited to express their views on forestry problems that do not fall within the competence of the Metropolis (in the economic or security spheres, for example). It also shows how the institution wishes to strengthen its environmental actions in the name of good governance of a local political community.

The Rouen Normandy Metropolis (RNM), Normandy, France, presents an interesting case of an inter-municipal grouping (71 municipalities for a population of 492,681; INSEE, 2018). It is a port and industrial area undergoing a transition in social and ecological terms and boasts a green belt comprising 25,600 hectares of woodland. The analysis concerns the consultation process carried out in the context of the drafting of the 4th Forest Management Charter and the associated action plan. It examines the meaning and results of two quantitative surveys designed to inform the drafting of these documents. The first survey was conducted in 2020 "for the purpose of initiating dialogue" with the residents of the region by the RNM (n = 375). The second survey, also carried out in 2020 (n = 774), was set up by a university team to produce knowledge about the tensions between private uses and perceptions of woodland as "public property." The results obtained by the RNM' participatory approach reveal strong involvement and desires for change, but also create many blind spots. The data from the university survey show more ambivalent and contrasting relationships with forest areas, which reflect highly differentiated concerns, knowledge, and levels of appropriation, depending on the practices and social characteristics of the respondents. These two surveys are also part of a social and political context that should be described to gain a better understanding of the issues at stake in the approaches being implemented. While the reception of the public and political participation change the reference points of foresters on the one hand, and of elected officials on the other, the results reveal population groups that do not fit into the same frames of reference, nor into the same "public problems," nor into the same desire for participation or "delegation."

The position adopted here is determined to remain outside the classic dichotomy, which consists of either facile criticism of opinion polls (Dobré & Caraire, 2000, p. 11) or defense of the ideas the lay population seeks to put forward in a public debate (Callon et al., 2001). This article is intended to help identify the limits inherent in a citizen participation mechanism, which is as necessary as it is difficult to implement, and to foster and support hybrid exchanges, combining lay and scholarly knowledge (Claeys-Mekdade, 2006, p. 8; Geddes, 1904), to encourage the emergence of relevant public problems (Dewey, 2010) and fine-tuned public actions (Lascoumes & Le Galès, 2018).

2. Method and Context

2.1. Scale of Analysis: Rouen, a Norman Metropolis

In France, since the law on the reform of territorial authorities in 2010, the MAPTAM law in 2014, and the NOTRe law in 2015, some twenty metropolises have been created, constituting groupings of municipalities with more than 400,000 inhabitants. Among the areas of competence exercised as of right within their perimeter (economy, housing, water, sanitation, etc.), the metropolises also exercise their competence in the field of spatial and environmental planning in connection with the enhancement of the living environment, the fight against pollution, and energy management. Of the ten urban areas in France that have major woodlands, the RNM has the largest population. As Figure 1 shows, with three state forests and large areas of forest freely available to the public, woodland accounts for a third of the surface area of the region, producing oxygen and acting as a "green lung."

The RNM has been announcing since 2020 that it has the ambition of turning this region into "the epicentre of the social-ecological transition" and the "capital of the World After" (RNM, 2020). The "after" emerges in unusual socio-historical conditions, against a background of elections, around which revolves a protest against the government's social policy (the Yellow Vests of 2018–2019), a major industrial accident (Lubrizol in 2019), and a health emergency (Covid-19, as of 2020–2021). These three elements refer to multidimensional crises (ecological, social, and representation in a democracy) that have increased rapidly over the last three years, and which have taken on particular importance locally regarding the subject under study.

The Yellow Vests movement (GJ after the original *gilets jaunes*) was important in the Rouen region and left its mark on the people. This movement—named after the jackets worn by the protesters—emerged in October 2018 outside of the intermediate bodies, from the protest at the increase in fuel prices, and its framing in the protest register of independent liberals (Spire, 2018). Very quickly, as the protest grew (Sebbah et al., 2018), the collective subject that made itself evident defined itself, above all, as people from the working poor (Guerra et al., 2019), people in employment, "prevented" from earning a real living from their work, coming from the working class (Collectif d'enquête sur les Gilets jaunes, 2019) and the middle classes (Dormagen et al., 2021; Hoibian et al., 2019). Despite the violence and repeated violent clashes with the police, the movement enjoyed a majority and significant support among the French population for several months (six to seven months), according to the polling institutes. The movement is a statement of a crisis of political representation and calls for institutional reforms while making visible an unprecedented level of mistrust of the principles of representative democracy, the consequence of a feeling

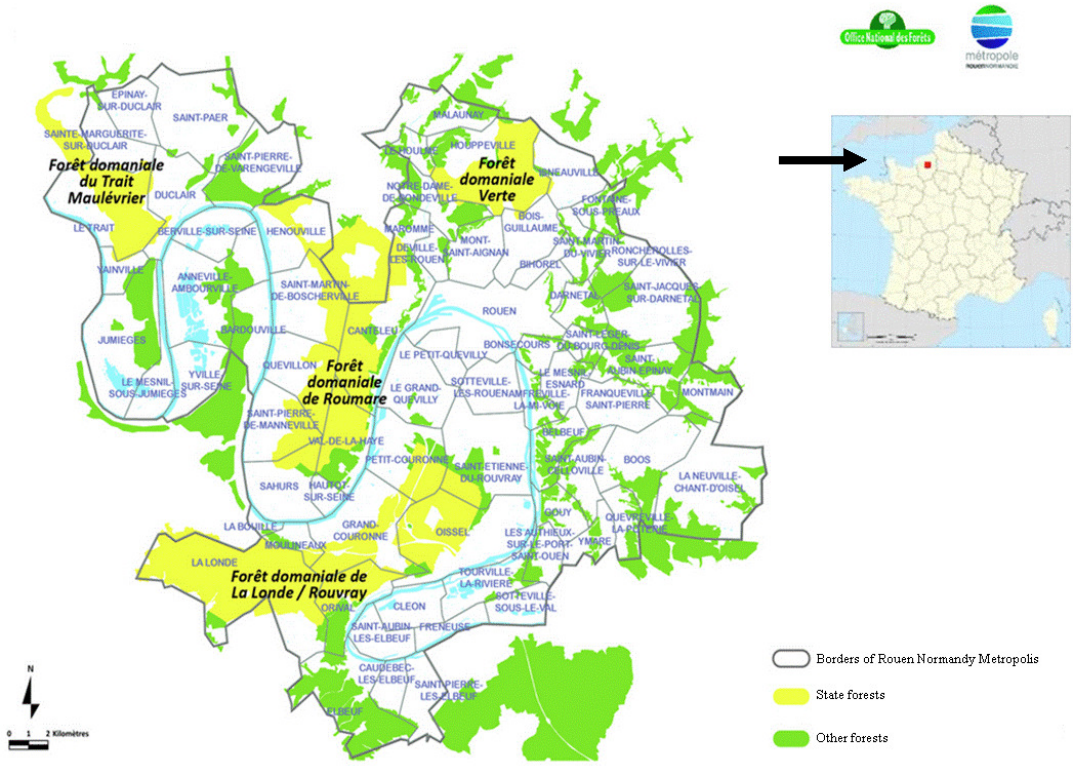

Figure 1. Forests of the RNM and its 71 municipalities. Source: Map by the Deputy Environment Directorate, taken from the RNM (n.d.) website and adapted by the authors.

that demands are not being heard or of contempt for the material living conditions of citizens (Rosanvallon, 2021). The GJ movement gives visibility to the advent of a "democracy of the public" (Manin, 1996; Noiriel, 2018), which is competing with party democracy, given that the visibility and voice of citizens, relayed by social media and the mass media, does not need intermediate bodies.

The city of Rouen was also marked by an industrial accident: the fire of the lubricant additive stocks of the Lubrizol company, which occurred in Rouen starting on 26 September 2019. A cloud several tens of kilometers wide formed and spread soot over residential areas and agricultural land. Management of the accident triggered various measures to protect the population (confinement, closure of schools, suspension of certain agricultural activities, etc.). Communication from the state authorities was reassuring but had difficulty publicising measurements of air and water quality that were precise and complete. The opinions given contradicted local perceptions, insofar as testimonies of nausea, headaches, vomiting (etc.) were abundant. The publication of the list of products involved in the fire was not made known immediately, which raised suspicion. Once the list had been published, questions remained about what might not have been measured. The consequences of the accident for public health, the environment, and the economy, led, on a symbolic level, to legal proceedings and the launch of a parliamentary fact-finding commission. Groups formed rapidly, expressing various dissatisfactions, addressing elected officials, and calling on candidates in the campaign for the upcoming municipal elections, forcing them to take a stand. At the same time, the candidates and parties expressed their opinions about the place of industry in the city, the risks involved, how it contributes to employment, and promoted the question of the living environment and the place of nature in the city. The local context accentuates the "local" agenda of the ecological transition, what is at stake industrially, and the region's economic path.

From mid-March 2020, the Covid-19 epidemic lead to a "state of health emergency" being declared and lockdown measures being imposed. For the people living in the urbanised RNM, the areas of nature, especially the public state forests, are seen as prime recreational resources. At the same time, the health crisis is increasing the attention paid to the living environment and shakes up the agendas of candidates and the calendar for the municipal elections, the second round of which was postponed from March to June 2020.

It is against this background of a global crisis that the municipal elections took place in France. After the two rounds of voting, the candidate elected as mayor of Rouen, the leader of a plural majority (socialist-ecologist), also became president of the RNM. As soon as he took office in September 2020, the RNM undertook to "design the city of tomorrow" through a series of lectures, debates, and citizen dialogue mechanisms. In the spirit of their electoral campaign, based on a project for social and ecological transition, the elected representative proposes to make Rouen the "capital of the World

After," and to rely on a concerted approach to action, across subjects (Nicodème, 2020).

The idea, for the elected representatives, is to lead the ecological transition in a port and industrial city, which is reflecting on what its appealing features are, what its strategic positioning is (and its relative decline among other French and European metropolises), on its industry and its economy, its image, and its living environment. Poorly identified by the population since it was created, and despite the boost it was given in 2015, the metropolitan political-administrative layers make use of the forests to produce an attractive brand image.

In Rouen, this mobilising strategy relies on a forestry resource that is unusual in terms of extensive area (25,000 ha) and composition. Seventy percent of Rouen's metropolitan forest is public, whereas the proportion of forest that is public in France as a whole is only 28.4% (Lepillé, 2017, p. 98). Three of the woodlands in the Rouen area have been awarded the Forêt d'Exception® label, which was created by the French National Forests Office in 2007 and now recognises 14 forests throughout France. There have been numerous actions in favour of the protection of biodiversity that have rallied stakeholders to endeavour to preserve the future of these three forest areas: the creation of a biological reserve, sites in the Natura 2000 network of nature protection areas, a sensitive natural area, a territorial forest charter, and urban planning documents. In an effort to reduce land pressure, part of the state forest of La Londe-Rouvray and the forest of Roumare have been classified as "forests to be protected." For the community, the forest, and by extension the environment, become a means, that is, at first sight, rather consensual, to "create a regional identity." The Forêt d'Exception® label, obtained on the basis of an application file, is an integral part of a marketing strategy that aims to strengthen the attraction of the town and allow political actors to show everyone that the forest environment has been successfully protected and run (if the criteria of the label are to be believed) by the Office National des Forêts, the RNM, and their partners.

2.2. Two Separate Surveys

In order to show the limits of the citizen participation process, we can compare two surveys conducted in 2020. The first was produced by the RNM in a process described as a "public dialogue," with a view to drawing up the next forestry charter. Emanating from the 2001 Forestry Orientation Law, the charters are initiated by local players such as local authorities. They aim to carry out a multi-annual programme of forestry actions on a number of themes—economic, social, environmental, tourism, etc. Consultation and dialogue with elected representatives and local players are the preliminary stages to the final drafting of the charter which, in this case for the RNM, has been established for the period 2021 to 2026. As part of the procedure, the metropolis issued invitations to answer an online questionnaire, which was made freely available on their website. The second survey was carried out by the authors of this article in a university setting and examines the uses and forms of management Normandy combines in its forestry policies.

The overall university survey (n = 1526) was carried out among people visiting all the forests in the Boucles de la Seine Normande nature reserve. The sampling strategy implemented in the university survey seeks above all to collect data on the different sports activities practised in the woodlands of Normandy. Face-to-face interviews allowed us to go into the woodland to meet those present, i.e., essentially individuals with non-institutionalised practices (not affiliated to clubs). This was combined with the same questionnaire distributed online by email or face-to-face via 32 sports clubs and groups (including hunters) institutionally-structured (university clubs but also professional, competitive ones), via a forum of associations and the Boucles de la Seine Normande Regional Nature Park (at the reception, online, and during events). Using targeted and controlled networks for the survey made it possible to interview individuals who would have been difficult to approach in the woods to answer a questionnaire, such as horse riders, mountain bikers, and runners. The random face-to-face survey carried out in the forest, for its part, presented the advantage of reaching people who did not necessarily consider themselves to have legitimacy for responding and, consequently, tended to exclude themselves from spontaneous online participation (as for the public "consultation"). Spreading the survey over eight months made it possible to collect responses from individuals who use the forest during off-peak periods (winter and weekdays), and peak periods (summer, weekends, and events), as well as during and outside of health lockdowns. To compare the results of this global survey (n = 1526) with those of the public consultation (n = 375), we extracted from the university survey 774 questionnaires filled in only by inhabitants of the RNM (cf. third column of Table 1).

The university survey also includes a series of semi-structured interviews (n = 21). They are not at the heart of the analysis, but they have allowed us to gain a deeper knowledge of the points of view of the actors involved, either closely or at a distance, in opening up the forest to the general public: foresters, public and private owners, organisers of forest competitions, etc.

The factor analysis (see Figure 3) is based on the 1,526 questionnaires collected within the scope of the global university survey and was created with the software Modalisa. After checking the reliability of the correlations (Chi² test) within cross-referencing, we carried out a factor analysis based on the intersection of the following four variables: *respondent's gender* (in blue; two possible answers); *place of residence in town or country* (in purple; recoding of the declared place of residence into two answers); *most common sporting activity practised in the forest* (in red; 25 possible answers recoded

Table 1. Characteristics of the two surveys.

	RNM public dialogue (n = 375)	University survey targeting the population of the RNM (n = 774) extracted from the global survey carried out among users of the Seine Normande forests (n = 1526)
Purpose	Public "consultation"	Scientific
Survey technique and sampling	Online, open to all on the Metropolitan area's website	Hybrid and controlled: limited distribution to users of the Seine Normande forests
Duration	March 2020—November 2020 (9 months)	June 2020—January 2021 (8 months)
Number of questions	45	51
Organisers	RNM's Environment and Participation and Citizenship departments and the Office National des Forêts	Lecturers and researchers at the University of Rouen
Additional collections	Two other online questionnaires Participatory workshops in the forest	Interviews (n = 21)
Time spent drafting the questionnaire	About 15 hours for the three questionnaires (92 questions)	Approximately 20 hours for 51 questions
Testing of the questionnaire during the preparation	Only when put online to check how it works	Yes

into nine answers); and *perception of the forest as public property* (in green; four possible answers).

3. Results

3.1. Two Surveys, Two Samples

While giving voice to some residents inevitably means silencing others (Callon et al., 2001, p. 190), the RNM survey offers very little information on the characteristics of the respondents who expressed their opinions. The only data available is limited to the age and gender of the respondents. Very little information is available on this active minority of 357 people (out of a total population of 492,000), who considered themselves entitled to legitimately take part in the public debate on forests. It is therefore impossible to know how to relate this sample to the resident population in all its diversity and to claim to have overcome the possibly biased point of view of elected officials and professionals through this method of consultation. The aims of this survey did not include the identification of the respondents' levels of education, their social status, their housing conditions, their commitment in terms of ecology (see Table 2), or, quite simply, whether or not they actually frequent the woodlands. Women are slightly over-represented in this survey (58% of respondents), which may explain why the results show a demand for more monitoring and policing of the forest. Indeed, we know that men frequent forests more than women, and that women report being more "worried about their safety" in forests than men (Cordellier & Dobré, 2015; Lepillé, 2017; Lewis, 2007).

By comparison, with 52% men, the university survey sample is true to the gender of the people who most frequent French forests (Cordellier & Dobré, 2015; Kalaora, 1993; Lepillé, 2017). The educational levels and professional positions of people who frequent forests are often higher than those of the general population (Cordellier & Dobré, 2015; Kalaora, 1993; Lepillé, 2017), which is also the case in the university survey sample but to a greater extent. The university survey also shows that the most popular sports activities, namely walking, jogging, mountain biking, and hiking, correspond to those described in other comparable works of research (Cordellier & Dobré, 2015; Lepillé, 2017). The over-representation of respondents under 34 years of age in the university survey can be explained by a survey method focused on sports

Table 2. Characteristics of the samples compared to the 2018 Metropolitan Population Census.

Criteria	RNM public dialogue (n = 375)	University survey (n = 774)
Gender	Over-representation of women (+5 pts)	Over-representation of men (+3 pts)
Age	Under-representation of under 34s (−11 pts) and over 65s (−8 pts) Over-representation of 35–49-year-olds (+19 pts)	Over-representation of under 34s (+10 pts) Under-representation of over 65s (−10 pts)
Resident in the RNM	93% of respondents	100% of respondents
Occupation or socio-professional category	Not surveyed	Under-representation of workers (−17 pts) and intermediate occupations (−19 pts) Over-representation of executives and higher intellectual professions (+35 pts)
Diplomas	Not surveyed	Under-representation of people with no qualifications (−22 pts) and people with a vocational qualification (CAP, BEP or equivalent; −15 pts) Over-representation of people with a baccalaureate (+14pts) and higher education (+26pts)
Sports activity	Not surveyed	Walking, jogging, mountain biking, hiking, etc.
Grey areas	Who responded to the survey (occupations, credentials, uses of the forest, etc.)?	No data on people who do not frequent the woodlands
Limits	Method that emphasises the "engaged" or "concerned" prism	Methods that accentuate the "sports," "family outings with children," and "northern plateau" aspects of the Metropolis

Note: Over- or under-representation is only indicated when there is a difference of three points or more compared to the census.

activities during which a large number of young people were interviewed during their sports competitions in the forest or during orienteering, running, and mountain biking training as part of their academic curriculum (bachelor's degree in science and techniques of physical and sports activities [*licence de sciences et techniques des activités physiques et sportives*]).

3.2. Metropolitan Area "Dialogue": The Manufacture of Opinions

Surveys often reveal more about the political subconscious of the interviewers than about the respondents (Champagne, 2015, p. 36.). The RNM's "digital dialogue" is no exception to this observation. While the local authority wishes to develop, target and prioritise its action in the forest, the tool built by the agents of the "environment" and "dialogue" departments reveals multiple ambiguities, which we can reveal and examine.

Many of the questions are presented as follows: "In your opinion, which areas should be given priority for action to improve the social role of the forest?" The wording introduces two presuppositions, which guide the respondent: on the one hand, "action" is required and, on the other hand, it is necessary to "improve the social role of the forest," without defining said "social role." Similarly, the survey asks: "What action would you propose to encourage people who never go to the forest to go there?" This question is based on the premise that people "should" necessarily go to the forest more and that it is appropriate to take action in this direction. Formulating the questions in this way shows underlying interpretations of the missions of public service (duty to "take action" and "animate" the forests) and fails to take into account, for example, the consequences on the environment that certain forms of frequentation sometimes cause (trampling, erosion, noise, disturbance of the fauna, withdrawal or imbalance of plant coverage, etc.). One might consider that these formulations explain why a minority of respondents answer "Other" when this type of response is offered. Nine respondents (out of 375) replied in a similar way: "More animated: definitely not!", "The forest comes alive on its own," "A forest is not a city…", "The woodland is not an amusement park.''

Other forms of "prompting" or "guiding" responses can be identified, such as the "actions" that are proposed and on which respondents are invited to "vote" on a scale from 0 to 5. The "actions" are expressed in the infinitive as follows: "Prohibit access to certain areas to protect them." This proposal is given as an assertion, which evacuates or ignores any prior questioning such as: "Should there be prohibitions?" Sixty-eight percent of respondents ticked 4 to 5 "stars" for "prohibiting access" to "certain areas" of the forest. Starting from a similar formulation, 46% of respondents "voted" 4 to 5 stars in favour of "boosting monitoring and policing." What "results" like this mean can only be a subject for speculation. We shall see that they do not converge with those obtained as part of the university survey, which are expanded on in the next section.

The "results" constructed in this way show differences in the preferences of the respondents and suggest a very wide disparity in the levels of knowledge of the environment. Deadwood in forests fulfils many useful ecosystem functions, serving as a crucial refuge and food source for many species, allowing for the decomposition of organic matter, etc. The action worded as "keep more deadwood in exploited forests" was liked by 38% of respondents, who voted 4 to 5 stars, and seemed to repel 33% of respondents, who voted 0 to 1 star. With no knowledge of the reasons behind these preferences, we assume that 33% of respondents were not aware of all the uses of deadwood. These results show the gaps in knowledge within the population groups consulted (Dobré & Caraire, 2000, p. 33). The respondents in the RNM survey were also "against" the exploitation of wood for energy production (59% were 4- and 5-star responses) and "in favour" of the conservation of old trees (62% were 4- and 5-star responses). The majority of respondents were interested in taking part in public discussions, and 59% would like to be informed of the next stages of citizen dialogue on forests. To sum up, the participatory approach reveals that there are more women involved and people of intermediate ages (35 to 49 years old), who are against the exploitation of wood for fuel, but a third of whom know relatively little about how a forest ecosystem works. On the one hand, there emerges the image of a heritage forest (mature trees) to be preserved and, on the other, a landscape forest to be maintained and animated.

3.3. The University Survey: Results That Are Less Clear-Cut

The university survey yielded results that are in some respects quite similar to those of the RNM survey. For example, the university survey also reveals a wide disparity in levels of knowledge of the forest ecosystem among forest users. One thing that is remarkable above all is that 91% of respondents to the university survey consider forest management to be a public matter, involving elected representatives, experts, and users. Only 5% of respondents feel that management should be exclusively left to the owner. And so even with large differences in the levels of knowledge of the ecosystem, 60% of the respondents to the university survey believe that the management of the forest (flora, fauna, public) concerns everyone and implies participation on their part. This "desire for participation" echoes the results of the RNM's "dialogue" procedure. In both cases, the geographical context of Rouen must be taken into consideration, that is to say, a life setting consisting of 70% public forests and exceptional woodlands rendered even more precious by the health crisis.

There are numerous differences between the surveys, however, and the university survey cross-references questions on both fact and opinion. On the issue of forest guards and security, the university survey asked whether people had ever been troubled "by the presence of other users." While 34% of respondents stated that they had already been inconvenienced, the problems encountered had multiple causes (occupation of space, noise pollution, degradation of the place, etc.). Only 15% of respondents said that they had come across "security" problems (118 out of 774 respondents, including non-responses). As a reminder, the RNM survey indicates that 46% of its respondents are in favour of boosting monitoring and policing missions. Similarly, when the university survey asks respondents whether they would like the forest to be better equipped, more managed and monitored, only 15% agree with the suggestion and 78% would prefer the forest remain as it is.

In other words, the layout of the RNM's citizen dialogue methods and the way they are organised seems to bring out "needs" that a non-action-oriented survey does not identify in the same way. The university survey shows actors who believe that this is neither a need nor a realistic action, both in the quantitative part and in the use made of interviews. "We're not going to put a guard behind every tree," is expressed in the same way (in separate interviews) by a mayor in charge of a municipal forest (also chair of the Regional Natural Park) and the private owner of a 315-hectare forest (also vice-chair of the Regional Centre of Forest Property). Beyond the cost of surveillance, which would be too high, the actors prefer to encourage mediation and awareness-raising rather than repressive measures and say they would prefer to create more spaces (within or outside the woodlands) that are adapted to channelling the troublesome activities (motorbikes, quad bikes, paintballs, rave parties) rather than having to exclude categories of users deemed unwelcome.

The RNM survey highlighted the desire, which was apparently widely shared (68%), to prohibit access to certain areas of the forest to protect it, although it was not clear from whom or from what. The university survey poses the question in a different way, asking respondents to give their opinion on the way ownership relates to accessibility regarding woodland areas. The results are different—in fact, quite opposite. In Figure 2, the

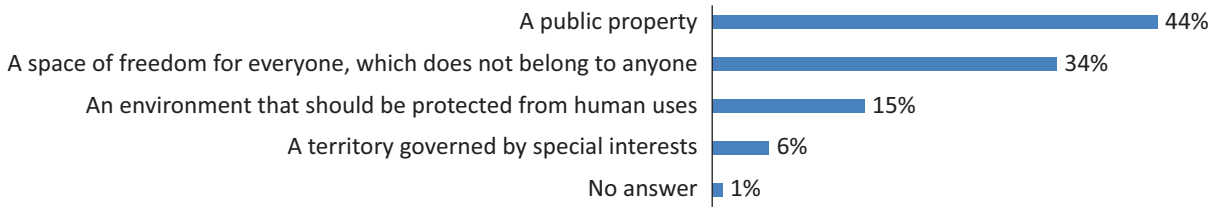

Figure 2. Possible answers to complete the sentence: "For me the forest is…."

following results appear when respondents are asked to choose from among a selection of possible answers to complete the sentence: "For me the forest is…":

The majority response (44% of respondents) sees the forest as "public property." Thirty-four percent of respondents see it as "a space of freedom for all that does not belong to anyone." If we add up these two results, it appears that for 78% of the respondents the accessibility of the forest for all seems to be a priority or fundamental. Only 6% of respondents perceive the forest as a territory governed by specific interests—this compares with the 5% of respondents who believe that forest management is the business of the forest owner. While 15% of respondents are in favour of protecting all or part of the forest from human use, this figure is considerably lower than the 68% of respondents in the RNM survey.

The contrasting results of the two surveys are not only due to the way the questions were formulated, nor only to the way they were carried out. Sampling (or the lack of it in the case of the RNM survey) is again important. The factor analysis to follow (Figure 3), conducted this time using data from the same university survey but on a global scale (metropolis n = 1526), shows that women are more likely to feel that the forest is an environment that should be protected from human users. However, women are over-represented in the RNM survey, which also partly explains why the ban on certain areas in the forest gains all the more approval in this survey.

It should be noted that the position of the forest considered "public property," located near the centre of the factorial design, shows that this conception is relatively independent of gender and the type of sport practised in the forest. On the other hand, the other two conceptions of the forest ("a territory governed by specific interests" and "a space of freedom for all") are related

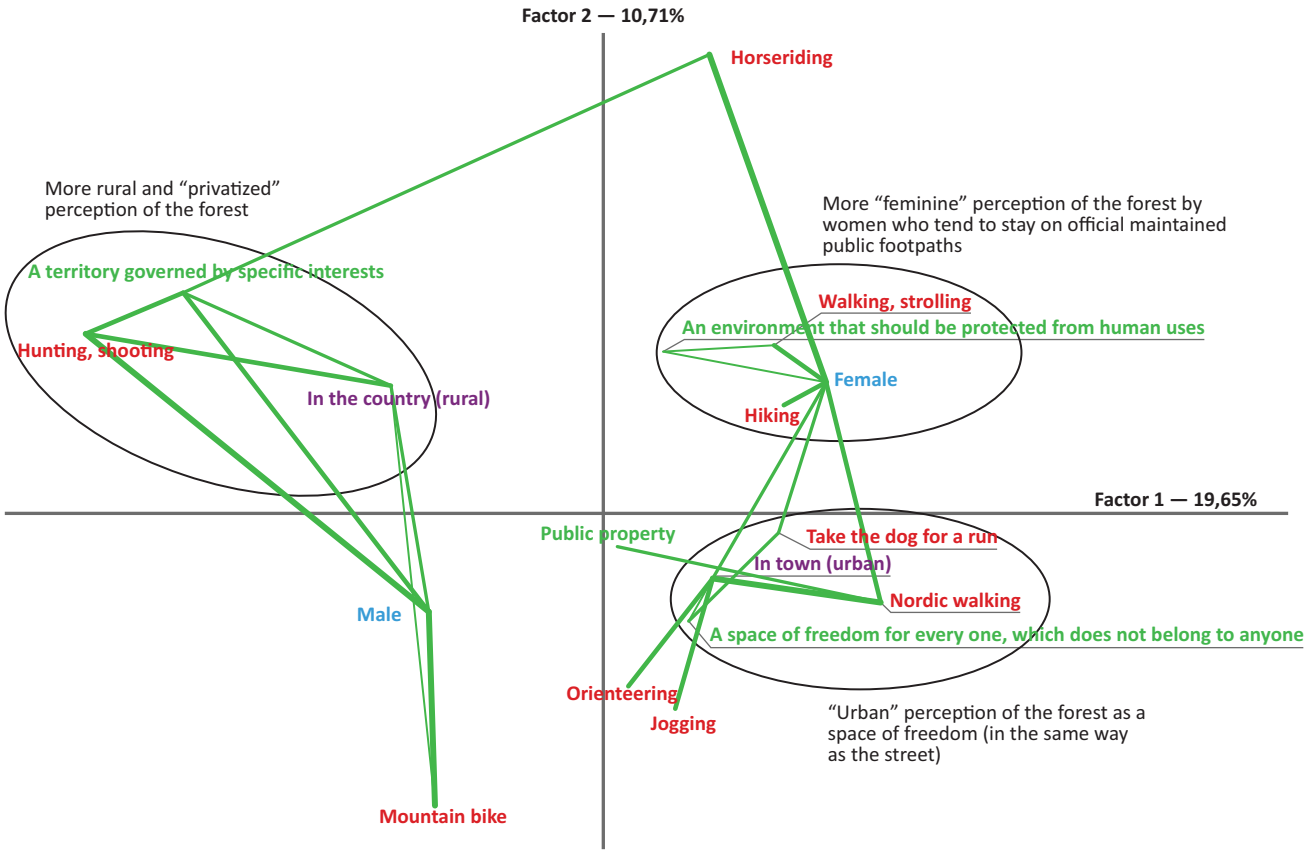

Figure 3. Factor analysis of forest design by gender and type of activity, based on the scope of the global university survey (n = 1,526).

to sports practices and the location of the respondent's main residence (in the country/town): Hunters have a better perception of the property relations that govern forest areas, whereas urban dwellers see woodland as a kind of "extended" public garden.

Allowing the population to express their opinions in a public debate assumes the sharing of references and a common language (Desrosières, 2010, p. 407). What can we say about the knowledge of the people about the bans on access in certain areas of the forest? Are those who take part in the discussions aware of the consequences of their use of the forest environment? When asked about the regulations in force (knowledge of the forestry code), the participants in the university survey gave their opinion on what they could do when walking their dog in the forest.

The results presented in Figure 4 show that only 16% of respondents knew the forestry code (answer "yes, in the vicinity of his master during the authorised period"). However, this does not mean that those individuals who know there are regulations are really aware of their meaning and implications. Not everyone understands, for example, the way pets disturb the fauna and flora along the sides of paths (stress during the birthing of mammals, abandoning of breeding sites, etc.). We can see clearly, here, that "one of the most pernicious effects of the opinion poll consists precisely in making people give answers to questions they did not ask themselves" (Bourdieu, 2002, p. 226). In the case in point, people were asked about protection and prohibiting access to certain areas in the forest, whereas the majority of them do not seem to be aware of the consequences of their presence or that of their dogs on the edges of the paths.

4. Discussion

While the environment is a global issue, on a local level, the two surveys deployed showed members of the population who wish to express themselves and "participate" in the political decisions that concern their living environment. Collecting and taking into account these individual situations seems legitimate, but implicitly one expects responses that come from a citizen's position, which take into account the general interest (Desjardins, 2020). This can be seen as a source of misunderstanding. The analyses also showed wide disparities in the levels of knowledge of the respondents, which makes it more difficult to take their answers into consideration. However, it would be absurd to compare lay knowledge and scholarly knowledge (Callon et al., 2001, p. 135) insofar as, over and above the fact that each person has specific knowledge that can be enriched and complement each other (Callon et al., 2001, p. 62), what remains at stake for all policy decisions remains, fundamentally, the need to bring about the emergence of a world that is both diverse and shared (Latour, 2005). For all that, organising a participatory approach implies control over the meaning and importance of the instruments used to govern (Lascoumes & Le Galès, 2005). It also requires that a distinction be made between consultation and dialogue, and that public speaking/communication is organised in terms of meaning and place.

When an online questionnaire is presented as a tool for "digital dialogue" this tends, on the one hand, to confuse the instrument and the approach, and, on the other hand, to make an implicit promise that may be difficult to keep if we are not able to obtain a minimum amount of information on the people expressing their opinions, because we have no visibility over the sample of respondents and, at the same time, over the extent to which they are out of step or in line with the overall population. The other major problem with the approach analysed lies in the nature of the suggested answers, which provide little information on the intentions or motives behind the "likes" or "approvals/disapprovals." This gives the impression that planned actions are being submitted for popular approval rather than discussion and deliberation. The way actions are expressed and the respondents then invited to "vote" heavily influences the answers, at the risk of distorting the results but, at the same time, this has the merit of setting up a sort of trial for testing concrete proposals. In the end, with these results, it is difficult to gain an understanding of what is being expressed, beyond the actual subject of the question-response. This article does not claim to find a solution to these classic difficulties, which are inherent to the mechanisms of democratic participation; we are merely pointing out that there is a fairly systematic use of the term "dialogue" when in fact the process is more akin to a "consultation." We also identify the risk inherent in this method, which may tend to produce clear-cut and fixed "opinions" somewhat artificially, when it should be fuelling contradictory expressions, with a concern to enter into

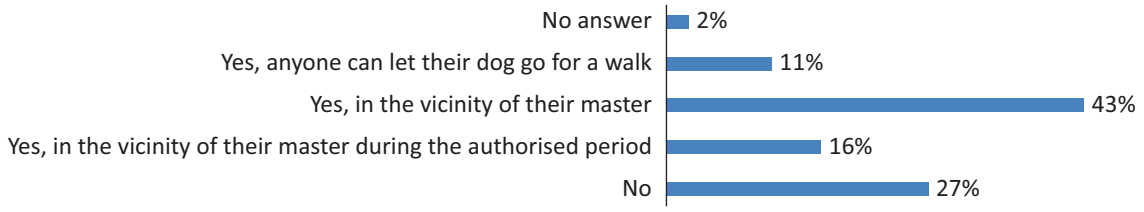

Figure 4. Possible answers to the sentence: "In the forest that I frequent, people can allow their dogs to walk around freely?"

an ethical consideration of discussion and deliberation (Habermas, 1983, 1991). Over and above any issues regarding the sampling and how the questions are formulated, it appears that the cross-referencing of factual questions and opinion questions makes it possible to relate uses and opinions, and to nuance the expression of the latter. For example, the perception of how woodland is threatened varies with the social origin of the respondent, but also according to the frequency of their visits (Dobré & Caraire, pp. 141–142).

5. Conclusion

The planning pioneer Patrick Geddes affirmed the central role of sociological enquiry (de Biase et al., 2016). In his opinion, the "science of cities" is based on the ability to observe them, because they cannot be built without the knowledge of their inhabitants, nor without the latter feeling concerned and being involved in the future of their city. By looking at the participation process implemented in the framework of the drafting of the 4th Forest Management Charter, our study shows how a metropolis explores, or even "creates" its own courses of action, its responsibilities, and ultimately "politicises" forest management. While the literature points to a progressive depoliticisation of ecological issues (Comby, 2015), we have shown how, in the case of urban forest management, a community with a high budgetary capacity, when seeking to vitalise and create an identity for a region, can on the contrary endeavour to become involved in the problem issues of woodland management. This even sometimes means "overplaying" divergences or requirements, as shown by the comparison of the consultation questionnaires and the university survey. If the formulation of questions and answers plays a part in the politicisation-de politicisation of social issues into "public issues," the question remains of how to carry out this work of formatting/contenting, which is potentially pedagogical or educational for the participants.

At the risk of having to change its internal organisation and its relationship with the National Forestry Organisation, the local authority wanted to know if the respondents thought it was necessary "to adapt forest management so that it takes greater account of ecological issues" as a priority field of action "to improve the environmental role of the forest." Fifty-five percent of the respondents answered "yes." Remarkably, 91% of respondents to the university survey consider forest management to be a public matter, which concerns elected representatives, experts and users. Only 5% of respondents feel that management should be exclusively left to the owner. Sixty percent of respondents to the university survey believe that forest management (flora, fauna, and the public) is everyone's business and implies their participation; 21% believe that it is the business of elected officials and experts and 11% that it is the business of elected officials and that they should consult users. All of these indicators seem to converge, arguing not only for "greener" policies but also for more "participatory" approaches.

Having come thus far, it should be remembered that the participatory management of forest areas in our case, as in the case of natural parks, is often driven by the technical managers who are not, we insist, elected representatives. One might think that they do not necessarily have their "dialogue" protocols validated by their elected representatives, and wonder what would happen to the "results" of these digital dialogues if the people surveyed showed a concern to have their opinions transformed into concrete action. While consultation allows for dialogue, there is no guarantee that it will be taken into account, nor does it allow residents to give advice or make proposals. To overcome this state of "symbolic cooperation," it is undoubtedly possible to envisage—on the model of what is done in town planning (Donzelot & Epstein, 2006)—forms of delegation of power and citizen control at the level of the drafting of the forest management charter as well as the implementation of the action plan.

In the RNM, as in other areas, some residents do not hesitate to intervene directly in the management of forest areas by demolishing hunting lodges, setting up (sometimes dangerous) roadblocks on paths used by mountain bikers, or by contesting clear-cuts. These direct interventions are an invitation to rethink institutionalised participation at all stages of planning and management and beyond mandatory participation instruments. These interventions are not insignificant and, as the comparison between our two surveys shows, encourage wider participation. In this way, we will seek to increase our level of mutual knowledge to define a common order made up of shared references and futures (Desjardins, 2020). To strengthen local society, we can only lean in favour of the proposal of setting up participatory committees that are more open, as close to the ground as possible, that cannot be reduced to their "spokespersons." Their membership should be not frozen but open to individuals interested in the management of their living environment—the region lived in (Rech & Mounet, 2011). Increasing the level of participation obviously implies questioning the conditions for greater delegation of power and the exercise of control by residents (Donzelot & Epstein, 2006).

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Conflict of Interests

The authors declare no conflict of interests.

References

Bourdieu, P. (2002). *Questions de sociologie* [Questions of sociology]. Les Éditions de Minuit.

Callon, M., Lascoumes, P., & Barthe, Y. (2001). *Agir dans un monde incertain. Essai sur la démocratie technique* [Acting in an uncertain world. Essay on technical democracy]. Seuil.

Champagne, P. (2015). *Faire l'opinion* [Making opinion]. Les Éditions de Minuit.

Claeys-Mekdade, C. (2006). La participation environnementale à la Française: Le citoyen, l'Etat… et le sociologue [French-style environmental participation: Citizen, state… and sociologist]. *VertigO*, *7*(3). https://doi.org/10.4000/vertigo.8446

Collectif d'enquête sur les Gilets jaunes. (2019). Enquêter in situ par questionnaire sur une mobilisation en cours: Une étude sur les Gilets jaunes [Investigating in situ by questionnaire on an ongoing mobilization: A study of the Yellow Vests]. *Revue française de science politique*, *69*(5/6), 869–892.

Comby, J.-B. (2015). *La question climatique. Genèse et dépolitisation d'un problème public* [Climate issue. Genesis and depoliticization of a public problem]. Raisons d'agir.

Comby, J.-B. (2019). Retour sur la dépolitisation des enjeux écologiques [Review of the depoliticization of ecological issues]. In La Découverte (Eds.), *Manuel indocile de sciences sociales* [Uncompliant textbook of social sciences] (pp. 470–480). La Découverte.

Cordellier, M., & Dobré, M. (2015). *Usages et images de la forêt en France, Enquête "forêt et société"* [Uses and images of the forest in France, "forest and society" survey] (Research Report). ONF; CERReV. https://draaf.nouvelle-aquitaine.agriculture.gouv.fr

de Biase, A., Levy, A., & Castrillo Romón, M. A. (2016). Patrick Geddes en héritage [Patrick Geddes' contribution]. *Espaces et sociétés*, *4*(167), 7–25. https://doi.org/10.3917/esp.167.0007

Desjardins, X. (2020). *Planification urbaine. La ville en devenir* [Urban planning. The city in the making]. Armand Colin.

Desrosières, A. (2010). *La politique des grands nombres, histoire de la raison statistique* [The politics of large numbers: A history of statistical reasoning]. La Découverte.

Dewey, J. (2010). *Le public et ses problèmes* [The public and its problems]. Gallimard.

Dobré, M., & Caraire, C. (2000). *La sensibilité écologique des Français à travers l'opinion public* [Ecological sensitivity of the French through public opinion]. IFEN.

Donzelot, J., & Epstein, R. (2006). Démocratie et participation: L'exemple de la rénovation urbaine [Democracy and participation: The example of urban renewal]. *Esprit*, *7*, 5–34.

Dormagen, J. Y., Michel, L., & Reungoat, E. (2021). Le mouvement des Gilets jaunes, un mouvement anti-écologie? [Yellow Vests movement, an anti-ecology movement?]. *Écologie & politique*, *62*.

Geddes, P. (1904). *Civics. An applied sociology* [Speech transcript]. Gutenberg. http://www.gutenberg.org/files/13205/13205-h/13205-h.htm

Guerra, T., Alexandre, C., & Gonthier, F. (2019). Populist attitudes among the French Yellow Vests. *Populism*, *3*(1), 1–12.

Habermas, J. (1983). *Morale et communication* [Moral consciousness and communicative action]. Flammarion.

Habermas, J. (1991). *De l'éthique de la discussion* [The ethics of discourse]. Flammarion.

Hoibian, S., Briera, T., Croutte, P., Gauthier, R., Jauneau-Cottet, P., & Muller, J. (2019). *Le mouvement des Gilets jaunes ou les limites d'un modèle de société* [The Yellow Vest movement and the limits of a model of society] (CAHIER DE RECHERCHE N° 349). CRÉDOC. https://www.credoc.fr/download/pdf/Rech/C349.pdf

INSEE. (2018). *Intercommunalité–Métropole de Métropole Rouen Normandie* [Rouen Normandy Metropolis intermunicipality]. https://www.insee.fr/fr/statistiques

Kalaora, B. (1993). *Le musée vert: Radiographie du loisir en forêt* [The green museum: Radiography of recreation in forests]. L'Harmattan.

Lascoumes, P., & Le Galès, P. (2005). *Gouverner par les instruments* [Governing by instruments]. Puf.

Lascoumes, P., & Le Galès, P. (2018). *Sociologie de l'action publique* [Sociology of public action]. Nathan.

Latour, B. (2005). *Un monde pluriel mais commun* [A plural but common world]. L'aube.

Lepillé, R. (2017). *Forêts urbaines de loisirs. Usages récréatifs et manières d'habiter* [Recreational urban forests. Recreational uses and ways of living] [Unpublished doctoral thesis]. University of Lyon.

Lewis, N. (2007). Les femmes et la forêt, un regard partagé entre peur et sociabilité [Women and woodland, a position between fear and sociability]. *RDV Techniques de l'ONF*, *17*, 68–72.

Manin, B. (1996). *Principes du gouvernement représentatif* [The principles of representative government]. Flammarion.

Nicodème, M. (2020). *Le maire Nicolas Mayer-Rossignol veut faire de Rouen la "capitale du Monde d'après"* [The Mayor Nicolas Mayer-Rossignol wants to make Rouen the "Capital of the World After"]. 76 Actu. https://actu.fr/societe/le-maire-nicolas-mayer-rossignol-veut-faire-de-rouen-la-capitale-du-monde-d-apres_35917192.html

Noiriel, G. (2018). *Les gilets jaunes et les "leçons de l'histoire"* [The Yellow Vests and "lessons of history"]. Fondation Copernic. https://noiriel.wordpress.com/2018/11/21/les-gilets-jaunes-et-les-lecons-de-lhistoire

Rech, Y., & Mounet, J. P. (2011). Les sports de nature en débat [Outdoor sports in debate]. *Développement*

durable & territoires, *2*(3). http://developpementdurable.revues.org/9085

Rosanvallon, P. (2021). *Les épreuves de la vie. Comprendre les français autrement* [Life's challenges. Understanding the French differently]. Seuil.

Rouen Normandy Metropolis. (n.d.). *Et si on parlait de la forêt? (1/3)* [What if we talked about the forest? (1/3)]. https://jeparticipe.metropole-rouen-normandie.fr/questionnaire/et-si-parlait-de-la-foret-13

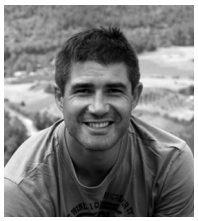
Rouen Normandy Metropolis. (2020, September 11). *La métropole Rouen Normandie, capitale du monde d'après* [Rouen Normandy Metropolis, capital of the World After] [Press release]. https://www.metropole-rouen-normandie.fr/presse/2020/la-metropole-rouen-normandie-capitale-de-lapres-demain-se-construit-aujourdhui-9523

Sebbah, B., Loubère, L., Souillard, N., Thiong-Kay, L., & Smyrnaios, N. (2018). *Les Gilets jaunes se font une place dans les médias et l'agenda politique* [Yellow Vests make their way into the media and the political agenda] (Research Report). LERASS.

Spire, A. (2018). *Résistances à l'impôt, attachement à l'Etat* [Resistance to taxation, attachment to the state]. Seuil.

About the Authors

Charlotte Birks teaches at the University of Rouen Normandy. She has a PhD in sociology and her research fields are focused on public policy, nature, leisure, and sport activities.



Damien Féménias is a university professor and works on territorialisation (territorial mediations) produced by sports leisure activities.

Charly Machemehl is a lecturer at the University of Rouen Normandy and a member of CETAPS. His research focus is on the development of sport and sports leisure since the end of the 19th century in singular urban contexts.

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Article

Multifunctional Green Infrastructure in Shrinking Cities: How Does Urban Shrinkage Affect Green Space Planning?

Olivia Lewis *, Sílvia Sousa, and Paulo Pinho

CITTA Research Centre for Territory, Transports and Environment, University of Porto, Portugal

* Corresponding author (olivia.lewis@fe.up.pt)

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Abstract
Despite global urbanization, not all cities have increasing populations. While not homogenous, shrinking cities arguably have different opportunities and challenges for green space than growing cities. This article reports a structured content analysis to investigate how urban green space planning evolved in two case study cities: Buffalo (New York, US) and Porto (Portugal). These cities both underwent shrinkage and suburbanization but with very different green space planning histories. The concept of green infrastructure is used as a lens to analyze green space planning change, specifically focused on multifunctionality. The aim of investigating how objectives and priorities for planning green spaces change during a period of urban shrinkage, and particularly what functions these cities have assigned to green space, showed that, over time, green spaces were expected to produce more ecological functions in both cities, and, particularly in Buffalo, contribute to the economic and demographic outcomes of the city. Overall trends in green space planning appear to have played a role but we find shrinking cities may leverage green space to meet unique needs. These findings contribute to the literature by addressing how shrinkage affects not only vacant areas but also overall green space planning, as well as suggesting that general green space planning studies should consider demographic change as a relevant context factor.

Keywords
green infrastructure; multifunctionality; shrinking cities; spatial planning; urban green space

Issue
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1. Introduction

In the US, 80 cities were identified as shrinking from 1970 to 2010, while 129 of Europe’s cities were shrinking from 1990 or earlier to 2005 (Ganning & Tighe, 2018; Turok & Mykhnenko, 2007). Schilling and Logan (2008, p. 451) wrote that “shrinking cities provide fertile ground for neighborhood-scale and citywide greening strategies that can revitalize urban environments, empower community residents, and stabilize dysfunctional markets.” In recent decades, have shrinking cities focused on planning green space to achieve these ends? There are almost countless possible objectives for urban green space (UGS), many of which relate to shrinking. While often complementary, these objectives can also imply trade-offs. Has the context of shrinkage affected UGS planning in these cities, including or beyond goals for green space that are directly related to urban shrinkage? To answer these questions, this research looks at change over time in municipal planning objectives for UGS in shrinking cities, using a local lens to look at what functions planners expected from UGS in the context of demographic and economic change. By studying the recent past of shrinking cities as socio-ecological systems, our goal is to contribute towards a better understanding of how to reach sustainable future pathways.

1.1. Concepts

1.1.1. Urban Shrinkage

Many authors define shrinkage using population loss, often as the sole dimension. The timeframes used for defining shrinkage vary greatly, from a very short two years to 40 years (Hartt, 2021; Hollander & Németh, 2011; Schilling & Logan, 2008). In addition to population decline, many definitions refer to economic downturn, loss of investment, and structural crisis. Economic decline is thus a common but not ubiquitous dimension (for an example of an exception, see Hartt, 2019). The following definition is widely cited:

> A shrinking city is a densely populated urban area that has on the one hand faced a population loss in large parts of it (for at least 5 years, more than 0.15% annually), and is on the other hand undergoing economic transformation with some symptoms of a structural crisis. (Stryjakiewicz & Jaroszewska, 2016, p. 28)

The literature on shrinking broadly agrees that the context of shrinkage shapes planning responses; however, there are two divergent mechanisms proposed for how this occurs, summarized in Figure 1. Pallagst et al. (2017) posit that the strategies a city creates to cope with shrinkage are directly influenced by that city's perception of shrinkage; for example, a city that accepts shrinkage will adopt strategies such as reducing infrastructure, thus "planning for decline," while a city that aims to maintain its population is either ignoring shrinkage or observing it without acceptance. A different view is that planning strategies are not influenced by the perception of shrinkage in that city: "Each city employs a complicated mixing of a variety of different planning strategies, regardless of whether they have 'accepted' population loss or not" (Heim LaFrombois et al., 2019, p. 8). As is shown in Figure 1, this means perceptions of shrinkage, in terms of acceptance, may or may not be a mediating factor between the situation of urban shrinkage and a city's response strategies.

1.1.2. Green Infrastructure

Green infrastructure (GI) is a recent conceptualization of the role of UGS, defined by Benedict and McMahon (2002, p. 12) as "an interconnected network of green space that conserves natural ecosystem values and functions and provides associated benefits to human populations.'' The concept gained traction alongside the emergence of ecosystem services and socio-ecological thinking in the 1990s and 2000s (Duvall et al., 2018).

GI definitions vary, although with general consensus on the concepts of connectivity and multifunctionality (e.g., Duvall et al., 2018; Lennon & Scott, 2014; Pauleit et al., 2019). Authors disagree about whether GI refers only to publicly planned and/or managed green spaces (e.g., Gómez-Baggethun & Barton, 2013) or also private spaces (e.g., Cameron et al., 2012). In this study, UGS is considered as open, vegetated urban space (Hunter & Luck, 2015), while GI is understood as a particular planning approach to green space. This differentiation is summarized as follows:

> The term green spaces can be applied to existing or planned green elements and structures regardless of whether or not they take into account UGI [urban green infrastructure] principles, while UGI stands for a specific perspective on natural areas and other open spaces in urban and non-urban surroundings. (Davies et al., 2015, p. 12)

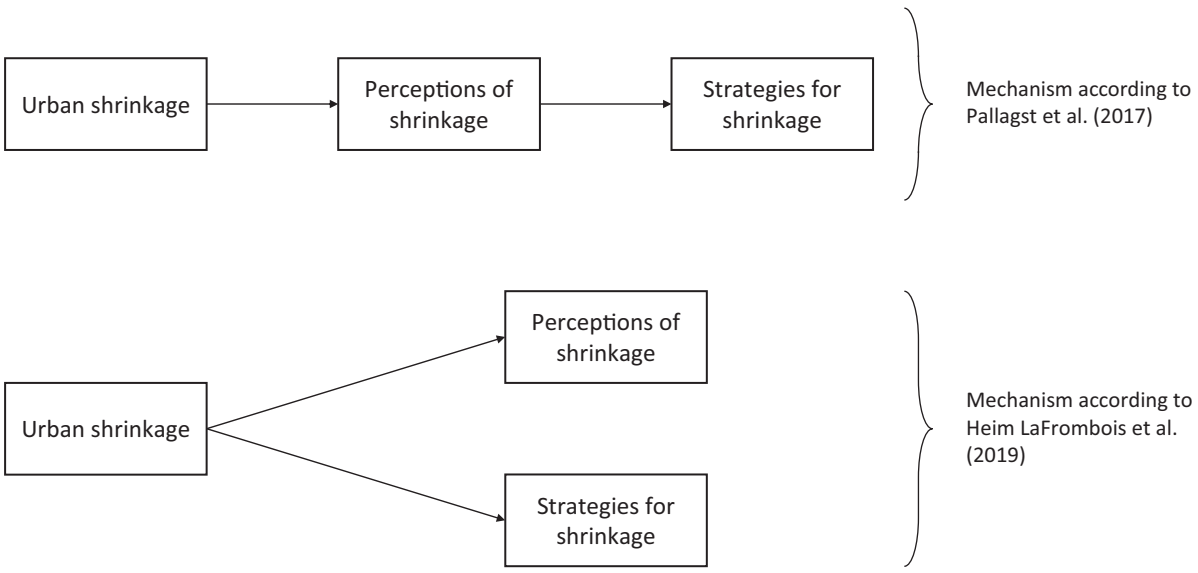

Figure 1. Schematic showing different proposed mechanisms for which the situation of urban shrinkage affects a city's strategies for responding to shrinkage.

The concept of multifunctionality used here is from Hansen and Pauleit (2014, p. 518): "Multifunctionality in GI planning means that multiple ecological, social, and also economic functions shall be explicitly considered…[it] aims at intertwining or combining different functions." Ecosystems are considered to provide functions that may then be considered services, that is, human-beneficial outcomes (Hansen & Pauleit, 2014).

1.2. Scope of the Article

This article sits at the intersection of the two research fields of shrinking cities and GI planning. Shrinking cities present a unique context for GI planning. James et al. (2009) presented five emergent themes for UGS research, namely physicality, experience, valuation, management, and governance. Structuring thinking around these themes reveals that green space in shrinking cities is considerably different than in growing cities (Lewis, in press). For example, shrinking cities often have patchwork landscapes of "occupied structures, abandoned structures, and vacant, formerly occupied land" (Nassauer & Raskin, 2014, p. 2), also conceptualized as "perforation" (Florentin, 2010). However, they do not necessarily have more large-sized green areas (>25 ha) than growing cities (Kabisch & Haase, 2013). Moreover, despite being "green," vacant spaces do not necessarily provide ecosystem services, as this depends on management regimes (Gardiner et al., 2014; Walker et al., 2017). From a resident's perspective, while a greener urban environment could present benefits, there may also be concerns about dangers—actual or perceived—from unmanaged spaces (Gulachenski et al., 2016; Nassauer & Raskin, 2014). Green spaces emerging during shrinkage may not meet the needs and preferences of urban residents (Colasanti et al., 2012; Schetke et al., 2010).

Furthermore, the situation for planning and management of green space is different in shrinking than growing cities. Shrinking cities often have more land to manage at the same time that population and tax base are decreasing. Finances have been identified as a challenge for planning and management of green space in this context (Florentin, 2010; Keeley et al., 2013). Different management strategies have been suggested, including bottom-up strategies such as community gardening on vacant lots (Lee & Sung, 2017) or participatory management of informal green spaces (Rupprecht, 2017), as well as top-down strategies like fencing and mowing (Morckel, 2017). Various authors have argued that traditional planning approaches are insufficient in shrinking cities (e.g., Galster, 2019; Heck & Will, 2007). However, alternative approaches may be complicated by the "stickiness" of existing institutional systems (Kirkpatrick, 2015, p. 261; Safransky, 2014; Sorensen, 2006). By applying the concept of GI to shrinking cities, we aim to think about the overall system of green space in a shrinking city, including, but not limited to, the topic of vacant land management.

Green space in shrinking cities can be planned and managed with a focus on a number of different ecosystem services and/or amenities (Herrmann et al., 2016). In this article, we focus on objectives for green space planning in terms of multifunctionality. We hypothesize that shrinkage is relevant through two mechanisms: (1) shrinkage motivates planners to produce a particular result (i.e., shrinkage as driver); and (2) shrinkage imposes limitations by reducing resources and increasing governmental responsibilities (i.e., shrinkage as context). This article employs a comparative, longitudinal case study approach. The longitudinal approach enables us to understand the development of these expectations within a city, while the comparative approach enables us to perceive whether these developments are common themes across shrinking cities and also the role of local context. Multifunctionality was investigated by considering the expected functions of green space, as well as how these objectives were related to one another, both in thematic terms and spatially, for example through different land-use types in the plan.

To address the aim of investigating change in green space planning in shrinking cities, with the lens of the multifunctionality concept, this article is based on a content analysis of planning documents from two cities, Buffalo (New York, US) and Porto (Portugal). The analysis is guided by two research questions: (1) What general approach to shrinking is visible in each document? and (2) How have expectations of green space multifunctionality—considering ecological, social/cultural, and economic functions—changed over time?

2. Methodology

2.1. Content Analysis

A directed content analysis of seven planning documents published between 1971 and 2020 was carried out. In the case of Buffalo, two sets of plans were analyzed, each comprising a comprehensive and a land-use plan; for Porto, the strategic reports of three municipal director plans were analyzed. Details of each document are shown in Table 1.

In Buffalo, the 2000s plans were written after a long period in which the city did not update its spatial plans despite much urban change. For Porto, the 2006 *Plano Diretor Municipal* (Municipal Director Plan [PDM]) has been considered "a clear departure from the preceding plans" (Madureira et al., 2011, p. 146). The 2006 and 2020 PDMs were also written after the municipal ecological structure (MES) concept was introduced by Portuguese Decree-Law No. 380/99 of September 22nd, giving a different national context to green space planning.

These types of strategic municipal plans can be viewed as "something more than a mere 'vision statement' but less than a rigid 'blueprint'" (Norton, 2008, p. 436) and are, therefore, a key point of analysis in

Table 1. Overview of the planning documents analyzed.

City	Year	Plan Type	Plan Title
Buffalo	1971	Comprehensive plan	*Buffalo Master Plan*
	1977	Land-use plan	*Buffalo City Plan*
	2006	Comprehensive plan	*The Queen City in the 21st Century: Buffalo's Comprehensive Plan*
	2016	Land-use plan	*Land Use Plan*
Porto	1993	Municipal director plan: Strategic section	*Porto Projecto Cidade Nova: Plano Director Municipal* (Project New City Porto: Municipal Director Plan)
	2006	Municipal director plan: Strategic document	*Plano Director Municipal do Porto—Relatório Setembro 2005* (Municipal Director Plan of Porto—Report September 2005)*
	2020	Municipal director plan: Strategic document	*Plano Diretor Municipal Relatório—Discussão Pública: Setembro 2020* (Municipal Director Plan Report—Public Discussion: September 2020)**

Notes: * Referred to as the 2006 plan, because it was ratified in 2006. ** The public discussion version of this document was analyzed because the final version had not yet been released at the time of analysis.

the overall planning process. The object of this research was the policy focus of the plans and not their quality (Norton, 2008). Various authors have chosen master plans as the object of content analysis; for example, Heim LaFrombois et al. (2019, p. 4) argue that these plans "represent the overall vision of the city and strategies for achieving that vision and incorporate the goals and strategies of other more specific plans," demonstrating their suitability for the questions posed here.

Existing research on urban shrinkage and GI has employed content analysis, including qualitative, context-oriented approaches (Grădinaru & Hersperger, 2019; Heim LaFrombois et al., 2019; Kim & Tran, 2018; Sousa, 2019), which were similarly applied here. Specifically, directed qualitative content analysis was used (Hsieh & Shannon, 2005). For the first research question, about the general approach to shrinkage in each document, plans were analyzed for content related to past shrinkage, population projections, and goals around shrinkage, as well as inductively for other relevant factors. For the second research question, the plans were analyzed for content relating ecological, cultural, social, and economic functions to green spaces. As Escobedo et al. (2019) highlight, the intended outcome of terms like GI and ecosystem services are more important than the terms themselves; we, therefore, chose to focus on what is conceptually covered by GI and multifunctionality and not only what was labeled as "green infrastructure," "ecological services," and so on.

2.2. Case Studies

A diverse case selection method was used to choose two case study cities of (currently) similar size and shrinkage pattern, with diverse UGS planning histories (Seawright & Gerring, 2008). Selecting a limited number of case studies is intended to meet calls for in-depth, comparative case study research in shrinking cities (e.g., Heim LaFrombois et al., 2019).

Buffalo, located in Western New York, next to Lake Erie, has a land area of approximately 104.6 km^2 (City of Buffalo & Office of Strategic Planning, 2016). Buffalo has been labeled a "quintessential rustbelt city" (Silverman et al., 2015, p. 4). From a peak population of 580,123 in 1950, Buffalo's population steadily declined to 261,310 residents in 2010 (Manson et al., 2021; Silverman et al., 2015). As shown in Figure 2, a slight resurgence in population was visible in the last decade, with the 2020 census reporting 278,349 residents (Manson et al., 2021).

The city was formed as a trading post on Buffalo Creek, on land traditionally of the Haudenosaunee Confederacy (Szczepaniec, 2018). It grew throughout the 19th century as a transit point and manufacturing center connecting the eastern seaboard and the grain-producing states of the Midwest (Kowsky & Olenick, 2013). The American park movement was born at the same time Buffalo was growing. This movement came to Buffalo around 1870, following a citizens' petition for a public, waterfront park; the noted landscape architect Frederick Law Olmsted visited Buffalo in 1868 and formed the basis of a three-part park scheme, connected by a number of parkways (Kowsky & Olenick, 2013). This "revolutionary" system of parks and parkways formed the basis for a Buffalo parks system that still exists today (Eisenman, 2013).

From 1950, population decline began in Buffalo, driven mainly by manufacturing jobs shifting out of the Rust Belt region and, later, suburbanization (Knight et al., 2018). Simultaneously, its share of regional population decreased, as did wealth: Median household income rose only 4% from 1950 to 2010, compared to 88% nationally (City of Buffalo & Office of Strategic Planning, 2016). A "rather broad neighborhood downgrading pattern" was observed from 1970 to 2010 (Delmelle, 2015, p. 5). Knight et al. (2018, p. 5) write that:

> Buffalo holds a reputation as a shrinking city that is characterized by issues of chronic vacancy,

> abandonment, and segregation. Yet, the success of its established neighborhoods and several revitalizing areas (notably downtown)…are giving rise to claims of a citywide resurgence.

In 2016, the city reported almost 12% of its land was vacant (City of Buffalo & Office of Strategic Planning, 2016).

Porto is an old port city in Northern Portugal, located where the Douro River meets the Atlantic Ocean. It covers 41.4 km^2. The city's peak population was 327,368 in 1981; this declined to 231,828 by 2021 (Statistics Portugal, 1984, 2021b). It is part of the Porto Metropolitan Area and can be considered a regional employment hub (Direção Municipal de Urbanismo et al., 2015). Some recent population growth is visible according to annual estimates but was not visible from the decennial censuses of 2011 and 2021 (see Figure 2).

Porto was identified as the most strongly shrinking city in Portugal from 1981–2011 (Alves et al., 2016). It was characterized as undergoing metropolitan shrinkage with urban sprawl (Sousa, 2010); from 1991 to 2011, the metropolitan area grew by 9% while the city proper shrank by around 21%, indicating a strong suburbanization process (Guimarães et al., 2016). Post-1981 population loss has been attributed to high housing prices and declining housing conditions and characterized by urban sprawl and city-center population loss (Alves et al.,

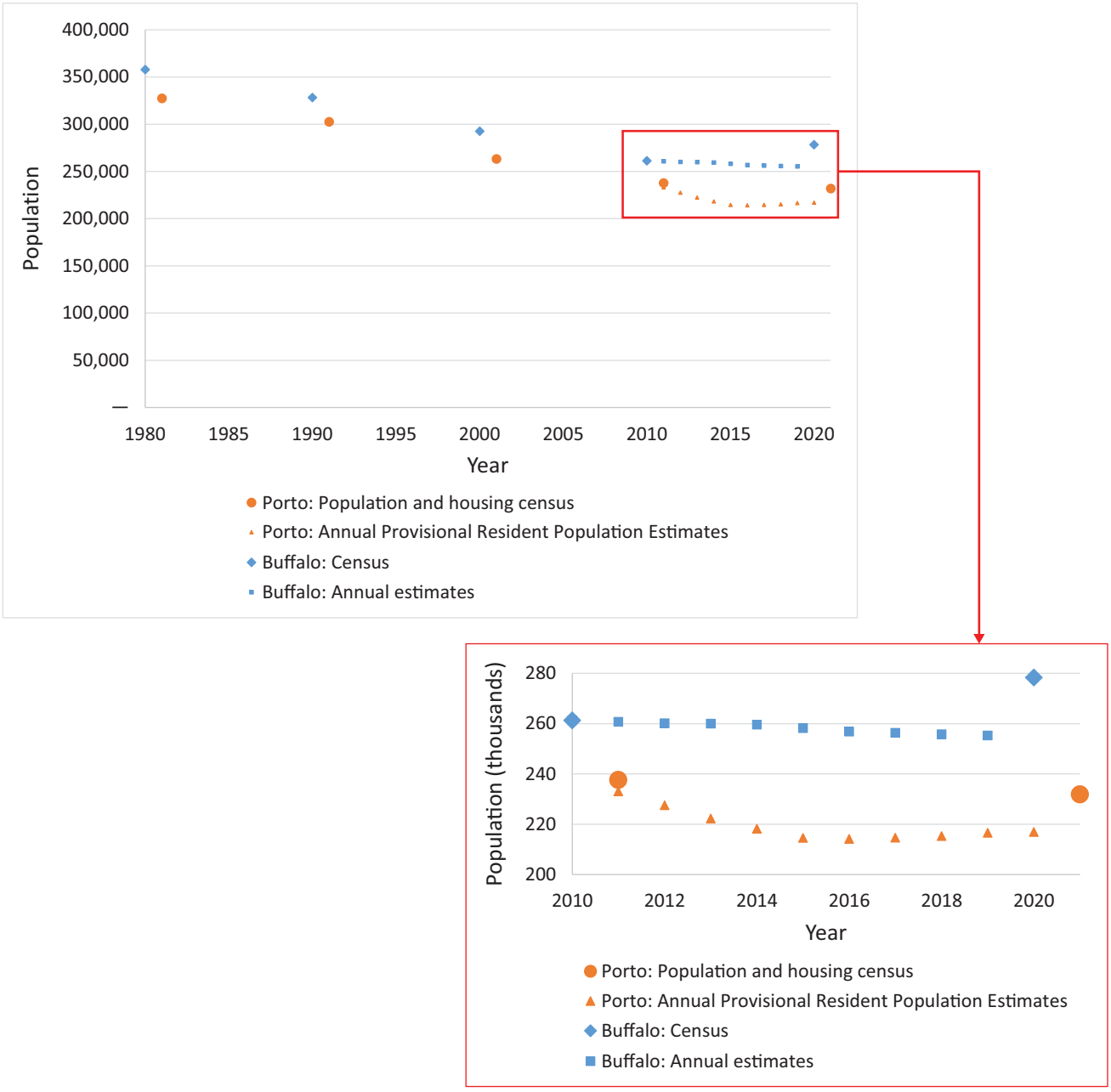

Figure 2. Population in Porto and Buffalo (main: 1980–2021; inset: 2010–2021). Source: Authors' figure based on data from Manson et al. (2021), Statistics Portugal (1984, 2007, 2021a, 2021b), and US Census Bureau (2020).

2016; Sousa, 2010). Further relevant factors, identified by local stakeholders, include suburban housing construction, location of jobs in the metropolitan area outside the city center, and car-friendly policies (Ferreira et al., 2020). Residential vacancy and unemployment exceed national averages but vary strongly across the city (Direção Municipal de Urbanismo et al., 2015).

Recently, new pressures, characterized as "tourist-driven functional gentrification," have become evident in Porto (Varady & Matos, 2020, p. 2). These include private building rehabilitation and housing pressures along with an influx of new businesses (Fernandes et al., 2018). Both tourism and student influx have led to a crisis of housing affordability, forcing lower-income families out of the city's historic core (Varady & Matos, 2020). Overall, an exceptionally fast, intense, internationally driven gentrification is described (Fernandes et al., 2018; Sousa & Rodriguez-Barcón, 2021; Varady & Matos, 2020).

Porto's green space cover varies strongly across its parishes, from 46.8% in the east (Campanhã), to only 26.05% in the central/eastern area (Historic Center and Bonfim; Graça et al., 2017). This, however, does not correspond to green space quality, with the western and southwestern parishes having higher quality green spaces (Graça et al., 2017). A comparative assessment of Porto's land cover from 1892 and 2000 concluded that "Porto did not follow the growing concern [visible in other European cities] for the preservation of its urban green structure as an integrated and coherent system" over the 20th century; in this time period, its green area dropped from over 75% to 30% (Madureira et al., 2011, p. 148).

As described, while Buffalo and Porto are both medium-size port cities that underwent suburbanization-driven shrinkage, they have very different structural and green space histories. Buffalo, although dense by US standards, has approximately 2,700 residents/km^2, while Porto is more than twice as dense, with around 5,600 residents/km^2. Buffalo's system of Olmsted parks and parkways structured the green space of the city, making it "the premier example" of parks and parkways planning (Kowsky & Olenick, 2013, p. 20), while Porto had a privately driven development (Oliveira & Pinho, 2008) that resulted in fragmentation of the city's green structure in the 1900s—according to Madureira et al. (2011), unusually so in the European context. The two cities can thus be considered interesting extremes from a green space perspective, while at the same time maintaining a size, geographic type, and shrinkage history that makes comparison possible.

3. Results

3.1. Approach to Shrinkage

The first research question asks what general approach to shrinking is visible in each document. As shown in Table 2, all four plans from Buffalo acknowledge ongoing population decline, and regrowth is clearly expected with concrete population predictions in the first three. Only the 2016 plan has a different outlook, presenting a general goal for regrowth but without a concrete prediction for future population; this plan is also unique in its broader focus on the drivers of shrinkage. The three more recent plans clearly show the assumption that the city's policies and plans can affect population outcomes, although the 2016 plan is less direct, focusing on creating "conditions" for growth rather than growth itself.

Table 2. Approaches to urban shrinkage as seen in municipal planning documents from Buffalo and Porto.

Plan Title	Framing of Past Situation	Population Projections/Expectations	Goals	Other Relevant Points
Buffalo Master Plan (1971)	Acknowledges population loss over past 25 years (City Planning Board & Division of Planning, 1971, pp. IV–12); economic shrinkage and shrinking tax base due to suburbanization (City Planning Board & Division of Planning, 1971, pp. I–6)	Regrowth expected by 1980; planning population figure set at 500,000 (City Planning Board & Division of Planning, 1971, pp. IV–12)	—	—
Buffalo City Plan (1977)	Acknowledges ongoing declining population	Population assumed to be close to 400,000 by 2000 (Division of Planning, 1977, Ch. III, p. 5)	—	Assumption that policies and planning will reverse trends in the city (Division of Planning, 1977, Ch. IV, p. 22)

Table 2. (Cont.) Approaches to urban shrinkage as seen in municipal planning documents from Buffalo and Porto.

Plan Title	Framing of Past Situation	Population Projections/Expectations	Goals	Other Relevant Points
The Queen City in the 21st Century: Buffalo's Comprehensive Plan (2006)	Acknowledgment of declining population	Assumption that population decline will stop by 2020 and regrowth will then occur (Office of Strategic Planning, 2006, p. 9); specifically, 0.5% annual growth from 2010 to 2015 and 1% from 2015 to 2030 (Office of Strategic Planning, 2006, p. 66)	—	Assumption that policies and planning will affect the population outcome (Office of Strategic Planning, 2006, p. 9)
Land Use Plan (2016; Buffalo)	Acknowledges population decline	—	General goal for regrowth: "Create the conditions for Buffalo to regrow again." (City of Buffalo & Office of Strategic Planning, 2016, p. 2)	Focuses not only on suburbanization as driver but also on broader changes (related to modes of transportation and national economy) that affected Buffalo (City of Buffalo & Office of Strategic Planning, 2016, p. 6)
Project New City Porto: Municipal Director Plan (1993)	—	—	—	Notes a lack of adequate demographic projections for planning at the Planning Unit (sub-municipal) level (Câmara Municipal do Porto, 1993, p. 33)
Municipal Director Plan of Porto—Report (2005)	Acknowledges population decline from 1981 to 2001 (Câmara Municipal do Porto, 2005, p. 19)	—	—	Mentions very high population density and historical overcrowding in the city center (Câmara Municipal do Porto, 2005, pp. 21, 121) as well as the importance of considering city use for employment and study as well as residence (Câmara Municipal do Porto, 2005, p. 215)

Table 2. (Cont.) Approaches to urban shrinkage as seen in municipal planning documents from Buffalo and Porto.

Plan Title	Framing of Past Situation	Population Projections/Expectations	Goals	Other Relevant Points
Municipal Director Plan Report—Public Discussion (2020)	Refers to a "slight recovery in the resident population…in recent years" (Câmara Municipal do Porto, 2020, p. 16)	—	A clear goal to reverse population loss: The first of its seven strategic objectives is to "promote conditions for living and well-being of the population, reinforcing residential activity and creating conditions for the demographic recuperation of the city" (Câmara Municipal do Porto, 2020, p. 37)	Questions whether slight ongoing population growth could continue without supporting policies and acknowledges increased housing costs and "socio-spatial segmentation" (Câmara Municipal do Porto, 2020, p. 16)

Porto's documents show a different approach; in the 1993 report, population loss is not acknowledged. The 2006 report acknowledges the city has gone through two decades of population loss (1981–2001); however, there is no clear demographic objective, and population loss is also framed in terms of historical overcrowding, as well as emphasizing city users beyond residents. The attitude of the 2006 PDM towards shrinkage was characterized as "indifferent" by Sousa (2019). The 2020 report does not set clear demographic objectives, but the first of its strategic objectives is "creating conditions for the demographic recuperation of the city" (Câmara Municipal do Porto, 2020, p. 37); similar to Buffalo, the role of the city is framed as creating conditions for population growth.

In no instance in either city is ongoing population decline or stabilization at a lower population level framed as a desirable objective.

3.2. Multifunctionality

3.2.1. Buffalo: 1970s

In Buffalo's 1970s plans, green space planning falls under Recreation and Open Spaces (City Planning Board & Division of Planning, 1971, p. 47; Division of Planning, 1977, Ch. V, p. 7). These plans listed few ecological functions. The 1971 plan describes that "programs to eliminate pollution and improve ecological relationships will be supported" (City Planning Board & Division of Planning, 1971, pp. III–4). The Tifft Farm Reservation also had the primary goal of wildlife preservation; it was planned to "contain a 75 acre wildlife sanctuary where no public access will exist" (Division of Planning, 1977, section V B–1.32), illustrating excluding humans from an environmental protection area. However, recreation and leisure were strong themes for UGS, demonstrating an emphasis on social function, as shown by the inclusion of green space in Recreation and Open Spaces. The 1977 plan details recreation functions, with local-use parks expected to provide passive uses and increasingly active recreation in larger parks (Division of Planning, 1977, Ch. 5, pp. 2–3).

Green spaces were also considered a means to attract or retain residents. Among 10 ways of attracting or retaining residents, Buffalo's 1971 plan lists two green space factors. The first is "the improvement of open spaces in the city," showing that open spaces, presumably including green spaces, are considered a desired feature for residents (City Planning Board & Division of Planning, 1971, pp. IV–11). The second describes people's "increasing desire for an urban environment for permanent residence and more distant open areas for recreation, instead of a suburban compromise" (City Planning Board & Division of Planning, 1971, pp. IV–11). This indicates a perceived separation between green space and urban environments. The plan also refers to green space providing relief from the urban environment (City Planning Board & Division of Planning, 1971, Ch. V, pp. 50, 65).

In economic function, a trade-off is framed as necessary between economic development goals and green space. In 1971, Buffalo had been losing population for approximately 20 years. However, the master plan does not show concern about excess green space, but rather how to deal with perceived inevitable development pressures on the small amount of open space available in a dense, developed city: "The temptation to use park land for expressway routes, school sites, and other public or private developments can be very great" (City Planning Board & Division of Planning, 1971, Ch. V, p. 44). Priority is given to planning foreseen expansion and expressways, with the policy that recreation areas should be sited where they are "not likely to hinder various expansion

programs, and not in the path of a foreseeable expressway" (City Planning Board & Division of Planning, 1971, Ch. V, p. 11). It is assumed that some existing sites will need to be replaced (City Planning Board & Division of Planning, 1971, Ch. V, pp. 44, 46). Green spaces are essentially framed as counter to development and must, at best, be involved in trade-offs.

In multifunctionality terms, these plans show an approach of different spaces for different uses: Parks, for example, are for social use, whereas the wildlife preserve is conceptualized as a sanctuary without public access. Green and grey infrastructure are not framed as compatible but rather as requiring trade-offs, and priority is given to siting green spaces away from areas potentially required by grey infrastructure. The desire to avoid a "suburban compromise" indicates that the city frames many of the functions of green space as deliverable outside the urban context, although it appears that the social functions delivered by parks of different scales are considered compatible with the urban environment.

3.2.2. Buffalo: 2000s

The 2006 plan defines GI comprehensively, dividing it into three "layers": formally protected, not formally protected, and potential GI (e.g., parks, transportation buffers, and vacant residential land, respectively; Office of Strategic Planning, 2006, pp. 49–50). The actual term "green infrastructure," however, is only briefly used, with seemingly different meanings, in these plans (see City of Buffalo & Office of Strategic Planning, 2016, pp. 2, 38; Office of Strategic Planning, 2006, p. 102). In these plans, many ecological functions are expected from UGS, including "providing wildlife corridors, urban habitat, support for biodiversity, and more" (Office of Strategic Planning, 2006, p. 49). Notions of ecological restoration and repair are visible; the 2016 plan has an objective to "repair the environment" and references "legacy environmental challenges" and "remediating prior environmental damage" (City of Buffalo & Office of Strategic Planning, 2016, pp. 36, 38). Providing access to protected areas is seen as a means of education and connection to nature, leading to a feedback loop that ensures the protection of natural sites (City of Buffalo & Office of Strategic Planning, 2016, p. 38). The 2006 plan includes different recreational functions as a main characteristic of parks. However, tension is noted between passive and active recreation uses (Office of Strategic Planning, 2006, p. 44). The plan also newly frames UGS as a cultural asset in the city. In 2006, Buffalo listed parks as a city asset in the historic architecture category (Office of Strategic Planning, 2006, p. 36). UGS is also considered a means of attracting people to the city. The plans directly link UGS to quality of life and amenity function (Office of Strategic Planning, 2006, p. 72). Open spaces are viewed as pull and retention factors, "important assets for any place seeking to attract and retain residents" (City of Buffalo & Office of Strategic Planning, 2016, p. 40). These resources are also expected to draw tourists (Office of Strategic Planning, 2006, p. 98). The document describes how a new park on the East Side "would also help attract visitors and new investment to this part of Buffalo" (Office of Strategic Planning, 2006, p. 92). However, UGS is also a means to serve existing residents. Regional assets, including waterfronts, parks, and parkways are seen to:

> Help create a quality of life for residents in the city and throughout the region that makes Buffalo a special place to live, work and play. They provide meaning and purpose to the daily lives of residents. They should not be understood only as economic assets. (Office of Strategic Planning, 2006, p. 16)

Compared to earlier separations of economic development and green space, the 2000s plans have a clearly different vision. UGS is framed as a competitive asset that can help drive the economic regeneration of Buffalo. The 2006 plan states that "great parks in good order will be a crucial element in any strategy to turn the city around" (Office of Strategic Planning, 2006, p. 44). Investment in parks is listed as one means of restoring population growth (Office of Strategic Planning, 2006, p. 9). UGS is considered a key factor in Buffalo's regeneration: "By building on our cultural assets, increasing the economic base…and enhancing the green environment, we are confident that we can reestablish Buffalo's position of greatness in the nation and the world" (Office of Strategic Planning, 2006, p. IV). The plan emphasizes the historic parks and parkways system as well as the waterfronts (Office of Strategic Planning, 2006, p. 15). It also frames UGS as important for companies, stating: "New and existing enterprises should respect and benefit from the green setting that a restored river and buffer zone will provide" (Office of Strategic Planning, 2006, p. 75). Importantly, all of these "assets" are seen as important in an urban competitiveness strategy (Office of Strategic Planning, 2006, pp. 21, 89). Economic function is also assigned to UGS by acknowledging that vacant lots can potentially add value to adjacent properties, with a range of uses that includes "community gardens to urban agriculture and forestry" (City of Buffalo & Office of Strategic Planning, 2016, p. 38).

In this set of plans, social multifunctionality reappears as a theme and tension is noted between different activities within parks. However, parks are also vested with additional functions; the Olmsted parks in particular are considered to have cultural and economic importance and be a means of drawing people and investment to the city. Earlier separation between wildlife preservation and social functions is replaced with a synergistic notion that protected areas can also serve to educate and connect residents with nature. The plans briefly describe that waterfronts, parks, and parkways are not "only" economic assets but also provide quality of life for residents; whether these two functions are considered synergistic or whether trade-offs are implied is not

fully clarified. The overall function of GI is now not limited to formal green spaces as in earlier plans. Vacant lots are also considered, primarily being mentioned here in terms of adding economic value to neighboring properties. To some extent, it appears that green spaces are expected to "do it all," simultaneously fulfilling the needs of existing residents, attracting new residents, attracting investment, and providing a host of ecological functions.

3.2.3. Porto: 2006

In Porto, no "GI" type concept is visible in the 1993 PDM and minimal discussion of expected functionality for UGS appears; hence, this analysis focuses on the 2006 and 2020 PDM reports.

The 2006 report includes the concept of MES, introduced by national Decree-Law No. 380/99 of September 22nd. The concept is explained as "an evolution of urbanistic thought increasingly concerned with questions of sustainability, protection of natural heritage, waterways, fragile ecosystems, risk areas, etc." (Câmara Municipal do Porto, 2005, p. 93), showing emphasis towards ecological benefits. Porto's 2006 report includes rehabilitating public space and the built environment as one of the five main strategic objectives of the plan, adopting a systemic (i.e., multifunctional) view of ecological and landscape resources (Oliveira & Pinho, 2008). Providing access to natural areas is seen as a means of education and connection to nature, leading to a feedback loop that ensures the protection of natural sites (Câmara Municipal do Porto, 2005, p. 230). The plan lists a variety of social functions such as civic activity, recreation, and social interaction. Sport and green space overlap as both are planned under "collective space types." UGS also begins to be seen as a cultural asset in the city: "Safeguarding and enhancing the natural and built heritage and the image of the city" is part of the objective of "enhancing the urban identity of Porto" (Câmara Municipal do Porto, 2005, p. 9). This plan does not list specific economic functions expected from the city's UGS, or frame UGS as an investment opportunity, but includes a green space type of mixed green areas centered on productive uses, namely agriculture and forestry, indicating some expectation for economically productive UGS. In contrast to Buffalo, the plan presents problems with the loss of UGS: A strongly expanding real estate market led to development pressures that caused the loss of existing UGS, especially private green space. "Land that [had] only recently been cultivated and [belonged] to old farms or groups of rural houses" was occupied in this way (Câmara Municipal do Porto, 2005, p. 98).

While social, cultural, economic, and ecological functions are all included to some degree as expectations of green space in the plan, the focus seems to be on ecological functions. This is also clear from the MES definition and even the framing of MES. Economic functions are the least emphasized; as in Buffalo, a seeming tension emerges between real estate pressure and green space. However, compared to Buffalo where the pressure was felt on city-owned and managed parkland, in Porto, it concerns the destiny of some small and scattered spots of former agricultural and quasi-rural private land still left within a densely occupied urban territory.

3.2.4. Porto: 2020

The MES appears in the 2020 report but is operationalized differently: It consists of four "components" rather than the seven land types used in the 2006 report (Câmara Municipal do Porto, 2020, pp. 67–68). The European-level concept of GI is specifically referenced in this report, representing the first clear introduction of "GI" into Porto's plans. The report states that the MES objective "is to promote the continuity of natural and cultural systems, the sustainability of the territory from a physical and ecological point of view, the growth of biodiversity and the protection of architectural and landscape heritage" (Câmara Municipal do Porto, 2020, p. 67), a broader definition than previously used.

The 2020 Porto report considers specific ecological issues, including soil permeability, air quality, heat island minimization, and nutrient circulation (Câmara Municipal do Porto, 2020, pp. 36, 64, 68–69, 76). The issue of soil sealing is raised, which is related in the plan to lack of vegetation and aquifer recharge problems (Câmara Municipal do Porto, 2020, p. 74). Like the 2006 report, social functions include recreation and social interaction. However, unlike in the 2006 report where both green space and sport areas are "collective space types," in the 2020 report they were separated: sport into the public facilities system and UGS into the environmental system. This may reflect a diminished importance given to some social functions of UGS compared to environmental outcomes. The productive-use mixed green area land type from the 2006 report does not reappear in the 2020 report.

This is the first analyzed document in which UGS is closely linked to of attractiveness in Porto. An overall objective of the plan is to "promote the living conditions and well-being of the population, reinforcing the residential attractiveness of Porto," with one indicator being "improved public space" (Câmara Municipal do Porto, 2020, p. 225). This shows the general framing of public space, including green space, as a contributor to quality of life and attractiveness. This report also describes how improving public spaces, and in one case specifically, green spaces, could be a means of reducing social (and spatial) exclusion in two areas that are still "stigmatized" (Corujeira and the Campanhã Railway Station area). These areas are both in the eastern part of the city, which is described as "still having stigmas associated with [it]" but having various attributes including landscape qualities that could make it an area that benefits from the "expansion of urban dynamics" (Câmara Municipal do Porto, 2020, pp. 28–29). On the other side of the city, improving the beach- and river-fronts is seen

as a means to redistribute tourism and leisure activities away from their concentration in the historic center (Câmara Municipal do Porto, 2020, p. 43). Green (and blue-green) spaces are also considered to maintain Porto's attractiveness on a larger scale: "Reinforcing the [city's] current attractiveness presupposes strengthening the factors that have contributed to position Porto among the most attractive cities in Southern Europe" (Câmara Municipal do Porto, 2020, p. 20); the city's natural and landscape "attributes" are listed among these features. This section seems particularly concerned with "qualified professionals," positioning the city as aiming for a specific type of attractiveness.

In this plan, the overall multifunctionality expectations of the green space system of the city appear to have shifted somewhat. While social functions were already expected from the city's green space in the 2006 report, in 2020 the MES definition is explained in broader terms, not only on protecting ecosystems but also referencing cultural systems and heritage. The economic expectations from green spaces appear to have shifted; instead of select sites having a productive land-use type, other sites are expected to help in territorial balancing by improving the image of some areas of the city. The overall blue-green system of the city is considered to be relevant for city competitiveness and attracting residents; this was already somewhat visible in 2006 via reference to urban image but is even more explicit here. It can therefore be argued that while there is not a dramatic shift from 2006, green space is given an increased role in overall territorial development, and ecological and attractiveness functions are also reinforced. The multifunctionality expectations of the overall network can thus be viewed as increased. Beyond formally created areas such as parks, natural areas such as the riverfront and beaches are clearly incorporated into this system.

4. Discussion and Conclusions

This study was built on the hypotheses that urban shrinkage affects green space planning: (1) directly (as a driver of UGS planning decisions); and (2) indirectly (as a context in which decisions are made). The results from the qualitative content analysis of planning documents in two shrinking cities provide evidence to support the first hypothesis: Urban shrinkage appears to be a driver of cities' expectations for UGS. In Buffalo, recent emphasis on the unique, historic character of the parks and parkways system and waterfront shows a revaluation of these heritage features and suggests the city has conceptually reframed these in response to shrinkage. In Porto, an aspect of green space contributing to urban competitiveness is also seen in the 2020 report. In the concept section of urban shrinkage, this article presented two theories from the literature about the mechanism by which urban shrinkage affects response strategies: with, or without, perceptions of shrinking serving as a mediating factor. Our results support the hypothesis that shrinkage has directly affected green space planning by creating goals for green space functions that are a direct response to issues created by shrinkage; however, it is unclear whether perceptions or attitudes towards shrinkage were a relevant mediating factor. Notably, although urban shrinkage was acknowledged to a greater or lesser degree, there was essentially a uniform focus on regrowth and no acknowledgment of potential desire to stabilize at lower populations or continue shrinking. Further research on the planning process could investigate this.

The specific outcomes expected for UGS in response to shrinkage may depend on the framing of shrinkage in each city: the way that "the conceptualization of shrinkage is dependent on a variety of frames that interpret the associated effects as crises of a specific nature" (Ivanov, 2021, p. 15). For example, in Buffalo, a narrative that problematizes depopulation and economic disinvestment leads to green space being a means to attract residents and companies. The literature often approaches the question of green space in shrinking cities from a perspective of managing an excess of (vacant) space, which can be considered adapting to shrinking (in the sense presented by Copus et al., 2021). However, the results found here show that green space responses in shrinking cities can also be framed around mitigating the issue of shrinkage by retaining and attracting residents (Copus et al., 2021).

As some parts of these plans focus on green space as an attractiveness factor for potential future residents, the question arises as to whether green space is planned and managed in a way that can draw new investment and residents and serve the local population, or whether trade-offs are being made. If so, questions are raised of what the underpinning logics of proposed greening are and who they are serving (Safransky, 2014; Walker, 2016). Clarifying this would require further research into the planning process and/or the outcomes of green space planning in these contexts.

Our results also suggest that while shrinkage is one factor driving expectations of UGS in city planning, it is not the only factor. Expectations of ecological functions developed significantly in both cities during the period studied. This mirrors broader trends in city planning: Nature in the city is no longer conceived of as a "refuge," but as a means of greening the city, with a more socio-ecological perspective and concerns for sustainability and wider environmental impact (Duvall et al., 2018). The idea that access to nature might increase environmental concern appears in the more recent plans, showing a changed perception of people's role in environmental protection. Around the time of Porto's 2006 report and Buffalo's later plans was also when concepts of ecosystem services and GI took off in the academic literature (Escobedo et al., 2019); this suggests that our findings align with broader shifts in green space planning trends. Other (non-shrinkage) factors also appear to be

at work in regards to social, cultural, and economic expectations. These include tourist demand in Porto; focus on using attractive landscapes to draw visitors away from the city center aligns with the strong impact of tourism described by Varady and Matos (2020).

The second hypothesis of this study was that shrinkage functions as a context in which UGS planning is conducted and thus indirectly affects UGS planning. Ecological concerns related to the cities' pasts appear to play a role in green space expectations and objectives: Where Buffalo is concerned with pollution from a long industrial history and many brownfield sites, Porto's documents show a higher concern with soil sealing, possibly due to green space loss over the 19th and 20th centuries (Madureira et al., 2011). Buffalo's more recent plans incorporate vacant land into the city's GI, suggesting that high vacancy as a result of shrinkage may affect the way in which GI is perceived and that vacant land is framed.

The introduction to this article shows that many of the concerns around green space in shrinking cities that are addressed in the literature are about vacant spaces and unmanaged land. However, the results show that most of the expectations of functions related to GI in shrinking cities are not related to these issues but rather to fulfilling objectives that would be relevant in any city, such as ecosystem services, or to resolving issues stemming from shrinkage such as attracting residents. This raises the question of whether vacant land is being fully integrated into the city's main green space planning, or if these issues still exist but are being dealt with in a different scope. As we see multifunctionality expectations for GI increasing over the years in shrinking cities, the integration of vacant land into the GI system could be a means of better meeting these expectations. However, as the introduction to the article notes, shrinking cities face challenges for planning and management that can sometimes lead to following traditional planning approaches. It seems this may be what is occurring regarding GI planning in these cities, even if the GI expectations are modified somewhat to meet specific challenges presented by shrinkage.

In this study, we investigated changing expectations for the multifunctionality of GI in shrinking cities. Future research could investigate other core GI principles, such as connectivity and equity, in a similar context. While we focused on overall UGS, research could also consider differentiated expectations by green space type, particularly vacant or abandoned space, which is a common research theme in shrinking cities. Likewise, while this study investigated planning approaches and intentions, a spatial analysis could inform us whether on-the-ground transitions towards GI occurred in these contexts.

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Conflict of Interests

The authors declare no conflict of interests.

References

Alves, D., Barreira, A. P., Guimarães, M. H., & Panagopoulos, T. (2016). Historical trajectories of currently shrinking Portuguese cities: A typology of urban shrinkage. *Cities*, *52*, 20–29. https://doi.org/10.1016/j.cities.2015.11.008

Benedict, M. A., & McMahon, E. T. (2002). Green infrastructure: Smart conservation for the 21st century. *Renewable Resources Journal*, *20*(3), 12–17.

Câmara Municipal do Porto. (1993). *Porto projecto cidade nova—Ratificação do plano director municipal (No. 67081/93)* [Porto new city project—Ratification of the municipal director plan (No. 67081/93)].

Câmara Municipal do Porto. (2005). *Plano director municipal do Porto—Relatório* [Municipal director plan of Porto—Report].

Câmara Municipal do Porto. (2020). *Plano diretor municipal relatório—Discussão pública* [Municipal director plan report—Public discussion].

Cameron, R. W. F., Blanuša, T., Taylor, J. E., Salisbury, A., Halstead, A. J., Henricot, B., & Thompson, K. (2012). The domestic garden—Its contribution to urban green infrastructure. *Urban Forestry & Urban Greening*, *11*(2), 129–137. https://doi.org/10.1016/j.ufug.2012.01.002

City of Buffalo, & Office of Strategic Planning. (2016). *Land use plan—City of Buffalo*.

City Planning Board, & Division of Planning. (1971). *Buffalo master plan*.

Colasanti, K. J. A., Hamm, M. W., & Litjens, C. M. (2012). The city as an "agricultural powerhouse"? Perspectives on expanding urban agriculture from Detroit, Michigan. *Urban Geography*, *33*(3), 348–369. https://doi.org/10.2747/0272-3638.33.3.348

Copus, A., Kahila, P., Dax, T., Kovács, K., Tagai, G., Weber, R., Grunfelder, J., Meredith, D., Ortega-Reig, M., Piras, S., Löfving, L., Moodie, J., Fritsch, M., & Martínez, A. F. (2021). European shrinking rural areas: Key messages for a refreshed long-term vision. *TERRA: Revista de Desarrollo Local*, *8*, 280–309. https://doi.org/10.7203/terra.8.20366

Davies, C., Hansen, R., Rall, E., Pauleit, S., Lafortezza, R., De Bellis, Y., Santos, A., & Tosics, I. (2015). *Green infrastructure planning and implementation—The status of European green space planning and implementation based on an analysis of selected European city-regions* (Report 5.1). Green Surge. http://dx.doi.org/10.13140/RG.2.1.1723.0888

Delmelle, E. C. (2015). Five decades of neighborhood clas-

sifications and their transitions: A comparison of four US cities, 1970–2010. *Applied Geography*, *57*, 1–11. https://doi.org/10.1016/j.apgeog.2014.12.002

Direção Municipal de Urbanismo, Departamento Municipal de Planeamento Urbano, & Divisão Municipal de Planeamento e Ordenamento do Território. (2015). *Relatório sobre o estado do ordenamento do território* [Report on the state of spatial planning]. Câmara Municipal do Porto.

Division of Planning. (1977). *Buffalo City plan*.

Duvall, P., Lennon, M., & Scott, M. (2018). The "natures" of planning: Evolving conceptualizations of nature as expressed in urban planning theory and practice. *European Planning Studies*, *26*(3), 480–501. https://doi.org/10.1080/09654313.2017.1404556

Eisenman, T. S. (2013). Frederick Law Olmsted, green infrastructure, and the evolving city. *Journal of Planning History*, *12*(4), 287–311. https://doi.org/10.1177/1538513212474227

Escobedo, F. J., Giannico, V., Jim, C. Y., Sanesi, G., & Lafortezza, R. (2019). Urban forests, ecosystem services, green infrastructure and nature-based solutions: Nexus or evolving metaphors? *Urban Forestry & Urban Greening*, *37*, 3–12. https://doi.org/10.1016/j.ufug.2018.02.011

Fernandes, J., Carvalho, L., Chamusca, P., & Pinto, J. (2018). Gentrification in Porto: Problems and opportunities in the past and in the future of an internationally open city. *GOT: Revista de Geografia e Ordenamento do Território*, *15*, 177–198. https://doi.org/10.17127/got/2018.15.008

Ferreira, A., Ribeiro-Santos, J., & Breda-Vázquez, I. (2020). Transcending dilemmas in urban policy-making: Envisioning versus adapting, growing versus stabilizing. *Planning Theory & Practice*, *21*(1), 76–93. https://doi.org/10.1080/14649357.2019.1703029

Florentin, D. (2010). The "perforated city:" Leipzig's model of urban shrinkage management. *Berkeley Planning Journal*, *23*(21), 83–101.

Galster, G. (2019). Why shrinking cities are not mirror images of growing cities: A research agenda of six testable propositions. *Urban Affairs Review*, *55*(1), 355–372. https://doi.org/10.1177/1078087417720543

Ganning, J. P., & Tighe, J. R. (2018). Moving toward a shared understanding of the U.S. shrinking city. *Journal of Planning Education and Research*, *41*(2), 188–201. https://doi.org/10.1177/0739456x18772074

Gardiner, M. M., Prajzner, S. P., Burkman, C. E., Albro, S., & Grewal, P. S. (2014). Vacant land conversion to community gardens: Influences on generalist arthropod predators and biocontrol services in urban greenspaces. *Urban Ecosystems*, *17*(1), 101–122. https://doi.org/10.1007/s11252-013-0303-6

Gómez-Baggethun, E., & Barton, D. N. (2013). Classifying and valuing ecosystem services for urban planning. *Ecological Economics*, *86*, 235–245. https://doi.org/10.1016/j.ecolecon.2012.08.019

Graça, M. S., Gonçalves, J. F., Alves, P. J. M., Nowak, D. J., Hoehn, R., Ellis, A., Farinha-Marques, P., & Cunha, M. (2017). Assessing mismatches in ecosystem services proficiency across the urban fabric of Porto (Portugal): The influence of structural and socioeconomic variables. *Ecosystem Services*, *23*, 82–93. https://doi.org/10.1016/j.ecoser.2016.11.015

Grădinaru, S. R., & Hersperger, A. M. (2019). Green infrastructure in strategic spatial plans: Evidence from European urban regions. *Urban Forestry & Urban Greening*, *40*, 17–28. https://doi.org/10.1016/j.ufug.2018.04.018

Guimarães, M. H., Barreira, A. P., & Panagopoulos, T. (2016). Shrinking cities in Portugal—Where and why. *Revista Portuguesa de Estudos Regionais*, *40*, 23–41.

Gulachenski, A., Ghersi, B., Lesen, A., & Blum, M. (2016). Abandonment, ecological assembly and public health risks in counter-urbanizing cities. *Sustainability*, *8*(5), Article 491. https://doi.org/10.3390/su8050491

Hansen, R., & Pauleit, S. (2014). From multifunctionality to multiple ecosystem services? A conceptual framework for multifunctionality in green infrastructure planning for urban areas. *AMBIO*, *43*(4), 516–529. https://doi.org/10.1007/s13280-014-0510-2

Hartt, M. (2019). The prevalence of prosperous shrinking cities. *Annals of the American Association of Geographers*, *109*(5), 1651–1670. https://doi.org/10.1080/24694452.2019.1580132

Hartt, M. (2021). The elasticity of shrinking cities: An analysis of indicators. *The Professional Geographer*, *73*(2), 230–239. https://doi.org/10.1080/00330124.2021.1871764

Heck, A., & Will, H. (2007). Interim use: Opportunity for new open-space quality in the inner city—The example of Leipzig. *German Journal of Urban Studies*, *46*(1).

Heim LaFrombois, M. E., Park, Y., & Yurcaba, D. (2019). How U.S. shrinking cities plan for change: Comparing population projections and planning strategies in depopulating U.S. cities. *Journal of Planning Education and Research*. Advance online publication. https://doi.org/10.1177/0739456X19854121

Herrmann, D. L., Schwarz, K., Shuster, W. D., Berland, A., Chaffin, B. C., Garmestani, A. S., & Hopton, M. E. (2016). Ecology for the shrinking city. *BioScience*, *66*(11), 965–973. https://doi.org/10.1093/biosci/biw062

Hollander, J. B., & Németh, J. (2011). The bounds of smart decline: A foundational theory for planning shrinking cities. *Housing Policy Debate*, *21*(3), 349–367. https://doi.org/10.1080/10511482.2011.585164

Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, *15*(9), 1277–1288. https://doi.org/10.1177/1049732305276687

Hunter, A. J., & Luck, G. W. (2015). Defining and measuring the social-ecological quality of urban greenspace:

A semi-systematic review. *Urban Ecosystems*, *18*(4), 1139–1163.

Ivanov, B. (2021). Narratives of crisis: How framing urban shrinkage and depopulation shapes policy and planning responses in Spain, Germany and the Netherlands. *Sustainability*, *13*(19), Article 11045. https://doi.org/10.3390/su131911045

James, P., Tzoulas, K., Adams, M. D., Barber, A., Box, J., Breuste, J., Elmqvist, T., Frith, M., Gordon, C., Greening, K. L., Handley, J., Haworth, S., Kazmierczak, A. E., Johnston, M., Korpela, K., Moretti, M., Niemelä, J., Pauleit, S., Roe, M. H., & Sadler, J. P. (2009). Towards an integrated understanding of green space in the European built environment. *Urban Forestry & Urban Greening*, *8*(2), 65–75. https://doi.org/10.1016/j.ufug.2009.02.001

Kabisch, N., & Haase, D. (2013). Green spaces of European cities revisited for 1990–2006. *Landscape and Urban Planning*, *110*, 113–122. https://doi.org/10.1016/j.landurbplan.2012.10.017

Keeley, M., Koburger, A., Dolowitz, D. P., Medearis, D., Nickel, D., & Shuster, W. (2013). Perspectives on the use of green infrastructure for stormwater management in Cleveland and Milwaukee. *Environmental Management*, *51*(6), 1093–1108. https://doi.org/10.1007/s00267-013-0032-x

Kim, H. W., & Tran, T. (2018). An evaluation of local comprehensive plans toward sustainable green infrastructure in US. *Sustainability*, *10*(11), Article 4143. https://doi.org/10.3390/su10114143

Kirkpatrick, L. O. (2015). Urban triage, city systems, and the remnants of community: Some "sticky" complications in the greening of Detroit. *Journal of Urban History*, *41*(2), 261–278. https://doi.org/10.1177/0096144214563503

Knight, J., Weaver, R., & Jones, P. (2018). Walkable and resurgent for whom? The uneven geographies of walkability in Buffalo, NY. *Applied Geography*, *92*, 1–11. https://doi.org/10.1016/j.apgeog.2018.01.008

Kowsky, F. R., & Olenick, A. (2013). *The best planned city in the world: Olmsted, Vaux, and the Buffalo park system*. University of Massachusetts Press.

Lee, J.-W., & Sung, J.-S. (2017). Conflicts of interest and change in original intent: A case study of vacant and abandoned homes repurposed as community gardens in a shrinking city, Daegu, South Korea. *Sustainability*, *9*(11), Article 2140. https://doi.org/10.3390/su9112140

Lennon, M., & Scott, M. (2014). Delivering ecosystems services via spatial planning: Reviewing the possibilities and implications of a green infrastructure approach. *Town Planning Review*, *85*(5), 563–587. https://doi.org/10.3828/tpr.2014.35

Lewis, O. (in press). A growing field in shrinking cities: A literature review on shrinkage and urban green space. In K. Pallagst, M. Bontje, E. Cunningham-Sabot, & R. Fleschurz (Eds.), *Handbook on shrinking cities*. Edward Elgar Publishing.

Madureira, H., Andresen, T., & Monteiro, A. (2011). Green structure and planning evolution in Porto. *Urban Forestry & Urban Greening*, *10*(2), 141–149. https://doi.org/10.1016/j.ufug.2010.12.004

Manson, S., Schroeder, J., Van Riper, D., Kugler, T., & Ruggles, S. (2021). *IPUMS National Historical Geographic Information System: Version 16.0* [Data set]. IPUMS. http://doi.org/10.18128/D050.V16.0

Morckel, V. (2017). Using suitability analysis to select and prioritize naturalization efforts in legacy cities: An example from Flint, Michigan. *Urban Forestry & Urban Greening*, *27*, 343–351. https://doi.org/10.1016/j.ufug.2017.09.006

Nassauer, J. I., & Raskin, J. (2014). Urban vacancy and land use legacies: A frontier for urban ecological research, design, and planning. *Landscape and Urban Planning*, *125*, 245–253. https://doi.org/10.1016/j.landurbplan.2013.10.008

Norton, R. K. (2008). Using content analysis to evaluate local master plans and zoning codes. *Land Use Policy*, *25*(3), 432–454. https://doi.org/10.1016/j.landusepol.2007.10.006

Office of Strategic Planning. (2006). *The queen city in the 21st century: Buffalo's comprehensive plan*.

Oliveira, V., & Pinho, P. (2008). Urban form and planning in Lisbon and Oporto. *Planning Perspectives*, *23*(1), 81–105. https://doi.org/10.1080/02665430701738081

Pallagst, K., Fleschurz, R., & Said, S. (2017). What drives planning in a shrinking city? Tales from two German and two American cases. *Town Planning Review*, *88*(1), 15–28.

Pauleit, S., Ambrose-Oji, B., Andersson, E., Anton, B., Buijs, A., Haase, D., Elands, B., Hansen, R., Kowarik, I., Kronenberg, J., Mattijssen, T., Stahl Olafsson, A., Rall, E., van der Jagt, A. P. N., & Konijnendijk van den Bosch, C. (2019). Advancing urban green infrastructure in Europe: Outcomes and reflections from the GREEN SURGE project. *Urban Forestry & Urban Greening*, *40*, 4–16. https://doi.org/10.1016/j.ufug.2018.10.006

Rupprecht, C. (2017). Informal urban green space: Residents' perception, use, and management preferences across four major Japanese shrinking cities. *Land*, *6*(3), Article 59. https://doi.org/10.3390/land6030059

Safransky, S. (2014). Greening the urban frontier: Race, property, and resettlement in Detroit. *Geoforum*, *56*, 237–248. https://doi.org/10.1016/j.geoforum.2014.06.003

Schetke, S., Haase, D., & Breuste, J. (2010). Green space functionality under conditions of uneven urban land use development. *Journal of Land Use Science*, *5*(2), 143–158.

Schilling, J., & Logan, J. (2008). Greening the Rust Belt: A green infrastructure model for right sizing America's shrinking cities. *Journal of the American Plan-*

ning Association, *74*(4), 451–466. https://doi.org/10.1080/01944360802354956

Seawright, J., & Gerring, J. (2008). Case selection techniques in case study research: A menu of qualitative and quantitative options. *Political Research Quarterly*, *61*(2), 294–308. https://doi.org/10.1177/1065912907313077

Silverman, R. M., Yin, L., & Patterson, K. L. (2015). Municipal property acquisition patterns in a shrinking city: Evidence for the persistence of an urban growth paradigm in Buffalo, NY. *Cogent Social Sciences*, *1*(1), Article 1012973. https://doi.org/10.1080/23311886.2015.1012973

Sorensen, A. (2006). Liveable cities in Japan: Population ageing and decline as vectors of change. *International Planning Studies*, *11*(3/4), 225–242. https://doi.org/10.1080/13563470701231703

Sousa, S. (2010). *Planning for shrinking cities in Portugal* [Doctoral dissertation, University of Porto]. Repositório Aberto. https://repositorio-aberto.up.pt/handle/10216/59821

Sousa, S. (2019). Local planning attitudes: Comparative content analysis of municipal director plans of shrinking Portuguese cities. *Bulletin of Geography. Socio-Economic Series*, *44*(44), 81–91. https://doi.org/10.2478/bog-2019-0017

Sousa, S., & Rodriguez-Barcón, A. (2021). Narrative around tourism gentrification and urban shrinkage: A qualitative approach to the case of Porto. *Finisterra*, *56*(116), 115–136. https://doi.org/10.18055/Finis19829

Statistics Portugal. (1984). *XII recenseamento geral da população. II recenseamento geral da habitação. Resultados definitivos: 1981* [XII population census. II housing census. Final results: 1981]. https://www.ine.pt/xurl/pub/65587858

Statistics Portugal. (2007). *Resident population (No.) by place of residence (at the date of Census 2001); Decennial*. https://www.ine.pt/bddXplorer/htdocs/minfo.jsp?var_cd=0000972&lingua=EN

Statistics Portugal. (2021a). *Resident population (No.) by place of residence (NUTS—2013), sex and age group; Annual*. https://www.ine.pt/bddXplorer/htdocs/minfo.jsp?var_cd=0008273&lingua=EN

Statistics Portugal. (2021b). *Resident population (No.) by place of residence, sex and age group; Decennial*. https://www.ine.pt/bddXplorer/htdocs/minfo.jsp?var_cd=0011166&lingua=EN

Stryjakiewicz, T., & Jaroszewska, E. (2016). The process of shrinkage as a challenge to urban governance. *Quaestiones Geographicae*, *35*(2), 27–37. https://doi.org/10.1515/quageo-2016-0013

Szczepaniec, K. (2018). *Fact sheet—Indigenous people of Western New York: Time immemorial to 2018*. Partnership for the Public Good. https://ppgbuffalo.org/files/documents/data-demographics-history/indigenous_people_in_wny_final.pdf

Turok, I., & Mykhnenko, V. (2007). The trajectories of European cities, 1960–2005. *Cities*, *24*(3), 165–182. https://doi.org/10.1016/j.cities.2007.01.007

US Census Bureau. (2020). *Annual estimates of the resident population for incorporated places in New York: April 1, 2010 to July 1, 2019 (SUB-IP-EST2019-ANNRES-36)*. https://www.census.gov/data/datasets/time-series/demo/popest/2010s-total-cities-and-towns.html

Varady, D. P., & Matos, F. L. (2020). *Urban revitalization and housing affordability: A case study of Porto* (Working Paper No. 978–989-8969-50–7). Faculdade de Letras da Universidade do Porto; Centro de Estudos de Geografia e Ordenamento do Território.

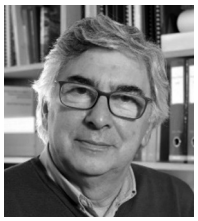
Walker, C. M., Colton Flynn, K., Ovando-Montejo, G. A., Ellis, E. A., & Frazier, A. E. (2017). Does demolition improve biodiversity? Linking urban green space and socioeconomic characteristics to avian richness in a shrinking city. *Urban Ecosystems*, *20*(6), 1191–1202. https://doi.org/10.1007/s11252-017-0671-4

Walker, S. (2016). Urban agriculture and the sustainability fix in Vancouver and Detroit. *Urban Geography*, *37*(2), 163–182. https://doi.org/10.1080/02723638.2015.1056606

About the Author

Olivia Lewis holds an MSc in environmental science, policy, and management from the MESPOM program. At the time of publication, she was working towards a PhD in spatial planning at the University of Porto under the RE-CITY ITN program. Moving to an urban planning lens from previous research on urban gardens and gardening, she is interested in better understanding how and why people shape the natural environment around them and vice versa.

Sílvia Sousa is an urban planner and a senior researcher at CITTA—Research Centre for Territory, Transports and Environment, in the Department of Civil Engineering of the Faculty of Engineering of the University of Porto. She has been actively involved in national and international research projects with a special focus on historic centre management, shrinking cities, urban resilience, and public value capture. ORCID: https://orcid.org/0000-0002-3825-5389



Paulo Pinho is full professor and chair of spatial and environmental planning at the Faculty of Engineering of the University of Porto. He was the founder and has been the director of CITTA—Research Centre for Territory, Transports and Environment for the last 15 years. From 2015 to 2019, he was the secretary general of AESOP. His recent research focuses on urban metabolism and low carbon cities, urban morphology and metropolitan dynamics, shrinking cities, and new forms of urban space production.

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Article

Making Green Work: Implementation Strategies in a New Generation of Urban Forests

Víctor Muñoz Sanz [1,*], Sara Romero Muñoz [2], Teresa Sánchez Chaparro [2], Lorena Bello Gómez [3], and Tanja Herdt [1]

[1] Department of Urbanism, Delft University of Technology, The Netherlands
[2] Innovation and Technology for Human Development Centre, Universidad Politécnica de Madrid, Spain
[3] Graduate School of Design, Harvard University, USA

* Corresponding author (v.munozsanz@tudelft.nl)

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Abstract
The concept of "urban forest" (UF) is gaining momentum in urban planning in the context of climate adaptation. Principles from the field of urban forestry are mainstreamed into urban planning, but little is known about effective tools for the successful implementation of new UFs. This article presents explorative research comparing how three cities (Almere, Madrid, and Boston) are dealing with the planning of a UF project, and their alignment with distinct organisational and typological interpretations of a UF. We employed a mixed-methods approach to gain insights into the main goals of the project, their organisational structure, and the employed planning process through the analysis of project documents and expert interviews. Our results point to an effective mainstreaming of environmental questions among stakeholders, but also indicate a poor development of objective criteria for the success of a UF. We note that municipal planners circumvented current internal rigidities and barriers by relying on intermediaries and local academia as providers of external knowledge, or by facilitating experiments. Finally, our results show that there may not be just one UF type to achieve the desired environmental and social goals and overcome implementation barriers. Conversely, each of the governance and organisational models behind the implementation of each type present collaborative and mainstreaming challenges. Therefore, we see an opportunity in further research examining processes and institutions towards the collaborative building of UFs that could bridge gaps between top-down and bottom-up approaches and activate different types of agencies.

Keywords
climate adaptation; mainstreaming; planning process; urban forestry; urban greening

Issue
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1. Introduction

Greening is a mainstream strategy in urban climate policies, and planting trees is particularly popular: Trees capture carbon dioxide, mitigate the urban heat island, and improve liveability and public health. Specifically, the concept of "urban forest" (UF) is gaining momentum in urban planning as a way to protect and expand the urban tree canopy in the context of urban climate adaptation. Additionally, there is growing political demand to implement tree-planting projects that deploy social and economic co-benefits. Amidst the Covid-19 pandemic, urban greening has been proposed by the US and the European Commission to push economic recovery (European Commission, 2020; The White House, 2021). In this regard, the European Green Deal asks European cities with over 20,000 inhabitants to develop "urban greening plans" by 2030.

Cities in Europe and the US are developing comprehensive plans for tree planting. However, little is known about effective approaches to successfully implement new UFs. Despite growing interest and advice to mainstream climate mitigation/adaptation—that is, to make it central to urban policies and programmes—greening is not integral to urban development administrations yet. Principles from the field of urban forestry are adapted to urban planning, yet they do not seem to match current processes of implementation (Ottisch & Krott, 2005). Furthermore, the decision-making of municipal managers is poorly understood by urban forestry (Ordóñez et al., 2019; Young, 2013). This article addresses those gaps by presenting exploratory research on different implementation strategies for UFs. Specifically, it compares how three cities are dealing with the planning of a UF, and how this aligns with distinct organisational models and typological interpretations of a forest.

Our research has three objectives concerning the main goals of the projects, the nature of their planning processes, and the organisational structures and implementation strategies being taken into consideration. Firstly, understanding how the case for green is made by different stakeholders and their definition of the task of creating a UF. Secondly, examining how municipal planning actors organise and seek support towards overcoming barriers for implementation. Third, ascertaining how and why an implementation strategy, governance, and organisational model is favoured, and the resulting type of UF. To do so, we compare three very different projects under development in three planning systems, belonging to a new generation of UFs: Utopiaeiland in Almere (the Netherlands), the Metropolitan Forest of Madrid (Spain), and the Urban Forest Plan of the City of Boston (US). Our study is explorative and descriptive. We followed a multiple-case study approach with multiple sources of information, combining expert interviews with a study of literature on UFs and mainstreaming, and desk research of planning and project documents accessed through project stakeholders. In opting for a sample of three polar types, we aimed to explore the diversity of approaches to UF at play in cities today.

The article is structured as follows. We begin by positioning the research in the urban planning–UFs nexus in the key urban forestry literature, framing it within the problematics of mainstreaming. Then we explain our methodology and describe the three case studies. Subsequently, we proceed to our analysis of the empirical materials along six dimensions related to our research aims: goals and ambitions, criteria for success, perceived challenges, leverages, implementation strategies, and organisational form. Our results suggest an effective mainstreaming of environmental questions among stakeholders yet indicate a poor development of objective criteria for the success of a UF. We note that municipal planners circumvented current internal rigidities and barriers by relying on intermediaries and local academia as providers of external knowledge, or by facilitating innovations in management or procurement. We conclude that there is not just one UF type to achieve the desired environmental and social goals and overcome implementation barriers. Conversely, each of the governance and organisational models behind the implementation of each UF presents collaborative and mainstreaming challenges. In this sense, we see an opportunity in further research examining processes and institutions towards the collaborative building of UFs that could bridge gaps between top-down and bottom-up approaches and activate different types of agencies. The relevance of our contribution is twofold: From a theoretical perspective, it identifies key cultural and organisational elements impacting the process of designing and implementing a UF. From the perspective of planning practice, our research defines possible approaches that cities could adopt to move forward their greening plans.

2. Mainstreaming Urban Forests Into Urban Planning

As media theorist Marshall McLuhan reportedly noted, in joining two antagonistic concepts, the term UF radically questions the historic relation between nature and humans (Dean, 2009). In research and policy, a UF is generally considered as the system encompassing all trees within an urban area, and urban forestry as the discipline that deals with their cultivation and management (Carreiro, 2007; Food and Agriculture Organization of the United Nations, 2016; Konijnendijk et al., 2006; Randrup et al., 2005). Although this definition is subject to national and typological interpretations, at its core, a UF has as much to do with forestry as with the urban condition (Randrup et al., 2005).

Therefore, it is mainly municipal urban planning that faces dilemmas and struggles when adjusting processes and strategies to mandates towards mainstreaming tree planting and urban greening (1t.org, 2020; European Commission, 2021). This is clear, for example, in how responsibilities for urban greening are laid in the Biodiversity Strategy of the European Green Deal, specifically at the municipal level (European Commission, 2020). Thus, in this section, we provide an overview from key literature on urban forestry of how the nexus between urban planning and UFs has been addressed, framing it within known challenges of mainstreaming climate change and environmental concerns.

Mainstreaming is a concept created by development agencies to describe a strategy that makes a theme central in the design, implementation, monitoring, and evaluation of policies and programmes of development aid (Gupta, 2010; OECD, 2014). Mainstreaming was first used for gender equality, but eventually reached governance, human rights, disability, and, more recently, climate adaptation and environmental concerns. In this regard, mainstreaming climate change and environmental questions aims to avoid climate policy disintegration across sectoral programmes and projects through multi-actor decision-making processes.

Consequently, this approach requires profound structural and behavioural change within governance structures (Gupta, 2010; Scott, 2019). Gupta (2010) argued the strength of mainstreaming is that it implies redesigning policies and planning processes, as well as fostering innovation in multi-stakeholder settings. Others criticise mainstreaming tendency to become a top-down, unidirectional process, dismissive of the rationales of other domains, and highly driven by leadership. Critically, such governance spaces are already cluttered with competing norms and interests (Karlsson-Vinkhuyzen et al., 2014; Karlsson-Vinkhuyzen & Kok, 2011).

Literature on UFs has focused overwhelmingly on operational aspects and on the multiple values of trees, but little on how the implementation of UFs fits within urban planning processes. Elaborations on the multi-functionality of UFs and their benefits have expanded to address the functions, services, disservices, and benefits of green (Cariñanos et al., 2017; McBride, 2017; Pearlmutter et al., 2017; Tyrväinen et al., 2005). Studies have argued that massive urban reforestation could impact global climate adaptation, and advance sustainable development goals (de la Sota et al., 2019; Endreny, 2018; Food and Agriculture Organization of the United Nations, 2016; Teo et al., 2021). Furthermore, efforts have been made to quantify the economic value of urban trees (Antonenko et al., 2020; Rogers et al., 2015, 2017). Advocates of urban forestry have proposed additional planning principles and methods for mainstreaming UFs into urban planning (Cities4Forests, 2019; Davies et al., 2017; Food and Agriculture Organization of the United Nations, 2016; Schwab, 2019). Specifically, emphasis across this literature is given to six aspects: (1) address the UF in urban plans through measures to protect and manage trees; (2) consider the long-term maintenance of the UF; (3) ensure interdisciplinarity and coherence across plans and departments; (4) form multi-stakeholder collaborations; (5) create feedback mechanisms to monitor tree data; and (6) shift into an adaptive management approach.

Despite this, urban planning and urban forestry have apparently not been successfully aligned. While the latter has emphasised technical matters, municipal actors value public functions and human well-being more (Barron et al., 2016). Ottisch and Krott (2005, p. 141) concluded that "urban planning as a whole is a very weak partner for urban forestry," given financial restrictions and powerful interests in urban development. Ordóñez et al. (2019) and Young (2013), conversely, disclosed how the decision-making of municipal managers is poorly understood by urban forestry experts. In particular, how those municipal employees find support to implement their decisions through new governance arrangements. These processes would benefit from stronger coordination models and a better understanding of how competing problems are prioritised (Ordóñez et al., 2020).

Therefore, despite growing appeals to support mainstreaming concerning climate mitigation/adaptation, a gap in project implementation persists within municipal practices. Conflicting interests and the lack of information, guidance, funding, and coordination between municipal departments are the most prominent barriers identified (Mogelgaard et al., 2018; Runhaar et al., 2018; Zuniga-Teran et al., 2020). The risks of such a gap in daily urban management tasks are that mainstreaming may turn out to be ceremonial, or that the new focus undermines other agendas, creating winners and losers (Bulkeley, 2013; Gupta, 2010; Karlsson-Vinkhuyzen & Kok, 2011).

Literature suggests that there is a need for empirical information on the frictions between strategies for mainstreaming UFs in urban planning and the messy reality of urban governance. It is still unclear what purpose a UF serves for different urban stakeholders; how barriers, leverages to implementation, and the embeddedness in a specific urban planning and urban forestry culture condition the planning process and the type of UF which is chosen; and how models of UF governance position within the classic top-down vs. bottom-up dichotomy (Ferguson & Gupta, 2002; Smith, 2014), and the nature of the collaborative challenges that emerge in each organisational approach. Understanding implementation processes and related organisational models is relevant to both urban planning and urban forestry. Firstly, as Förster (2014) noted, the results of planning methods and their contribution to the success of a planning process are rarely observed. This is critical as planning principles and methods are often decoupled from planning practice (Carlsson-Kanyama et al., 2008; Janssen et al., 2006; Nye & Rydin, 2008; Vervoort et al., 2010; Walker et al., 2008). Second, it emphasises UF as an oxymoron and contributes to advancing its understanding as a political arena in need of reconceptualization to better fit in the urban (Macnaghten, 2003; Perkins, 2014; Purdon, 2003; Sandberg et al., 2014).

To fill this gap, we adopted a multiple-case study approach to conduct exploratory research and compare three UF plans from three different cities and planning systems. These cases typify distinct approaches to implementation of an UF, and thus can be considered as extreme or polar types—cases of particular research interest in which the phenomenon under study is transparently observable (Pettigrew, 1990). This research has both theoretical and practical implications. From a theoretical point of view, it identifies key elements related to the process of designing and implementing a UF. From a practical point of view, our research can offer an overview of potential paths forward that could be used by municipalities willing to implement future plans.

3. Methodology and Case Studies

3.1. Methodology

This research follows a multiple-case study methodology, based on the analysis of a variety of data sources that

offer rich empirical descriptions of specific instances of a contemporary phenomenon, "the case" (Yin, 1981). Case studies enable insights into complex relationships that can provide useful pointers for addressing major substantive themes in a field (Yin, 1992) and are also useful for theory building (Eisenhardt, 1989). Over the last decades, case studies have been used extensively in multiple fields, including organisational theory (Galunic & Eisenhardt, 2001), strategy and decision science (Zelikow & Allison, 1999), and, most importantly for this work, sustainability (Assefa & Frostell, 2007; Dwyer et al., 2009; Moreno-Serna et al., 2020). In particular, case studies have been used in works that explore different aspects of urban transformation around sustainability (Ernst et al., 2016; Hölscher et al., 2019).

Our sources of information for the description and analysis of the case studies were planning and project documents, and expert interviews with urban stakeholders with essential roles in the projects investigated. Project documents of each case were used to get an idea about the official project goals, its size, and general aspects of its organisation. The documents were accessed through the interviewed stakeholders and project-related websites. These included tendering documents, zoning plans, project presentations, and news items, among others. The analysis focused in each case on understanding the use of the UF as an instrument for a particular purpose; the planning process, project set-up, and actors; the quality of the development and implementation process; the quality of the project's organisational structure (namely the functions of actors involved and their impact in the implementation process); and the embeddedness of the UF in a specific urban planning and urban forestry culture.

Expert interviews were central to our project analysis. By experts, we mean persons possessing institutionalised authority and knowledge with the potential of conditioning the actions of others in a meaningful way (Meuser & Nagel, 2009). Therefore, expert interviews facilitate gaining insights and context knowledge central to the research question that cannot be deduced from the literature (Mieg & Näf, 2006). Our sample consisted of municipal managers, academic partners, designers, and representatives of the third sector (i.e., NGOs) with long-term experience in each project identified during our preliminary research. We conducted semi-structured interviews with three experts within each project, always including a municipal manager. We relied on a fixed questionnaire for each interview, allowing comparison and maintaining data quality. The questions touched upon six dimensions: goals and ambitions, criteria for success, perceived challenges, leverages, implementation strategies, and organisational form. A qualitative analysis of the transcripts was conducted, allowing us to identify meaningful themes and sub-themes within each dimension, contributing to a better understanding of each case and the gaps, organisational hurdles, and leverages concerning the mainstreaming of urban forestry into urban planning. The results of the analysis are presented for every dimension, including an elaboration on the themes and subthemes, with figures and illustrative examples.

3.2. Case Studies

Our target population was cities engaged in the development of UFs at the time of writing. The analysed sample consisted of three cases and constitutes a "theoretical sample" (Eisenhardt, 1989) including a diversity of elements related to the framework of analysis. In particular, we selected the cases considering different governance models, namely Madrid (top-down initiative both in conception and in implementation); Boston (intermediate: initiative and concept by the top but with a need to collaborate with actors at the bottom); and Almere (bottom-up initiative in conception and in implementation). Furthermore, we included three additional criteria. First, we chose projects in the process of planning or early implementation. With that, we aimed to emphasise a new generation of UFs, born in a different context to that of the emergence of urban forestry in the 1960s. Despite their portrayal as "forests," each of the projects highlights a distinct UF typology, scale, and planning approach. Second, in each context, the discipline of urban forestry has a different status. Third, they are embedded in three different planning systems, yet municipalities are ultimately responsible for the implementation, management, and maintenance of urban green. With that, we want to emphasise the key role of municipalities in assuming the implementation of UFs and address possible gaps in municipal capacity weakening policies.

3.2.1. Urban Planning System and Presence of Urban Forestry in the National Context of the Case Studies

The case studies belong to different planning systems. Spanish planning can be characterised as hierarchical. Three levels of government are involved in the design and implementation of urban policies, under the principle of subsidiarity. There are no regional urban development plans, therefore municipalities are responsible for urban planning. In the Dutch case, the project is embedded in a decentralised and plan-led system. Due to the lack of funding, the Dutch government depends on lower levels of government and high levels of policy coordination for the implementation of planning policies. Finally, the American planning system is decentralised and fiscally driven. Municipalities need to be economically autonomous. This promotes the use of property tax by land use, favouring economic development.

The consideration of urban forestry in urban planning is uneven across the case studies. Urban forestry reached the Netherlands early, with researchers promoting the concept in 1984 (Randrup et al., 2005). Dutch urban forestry builds on a tradition exemplified by the Amsterdamse Bos, a UF considering open-ended

successional processes (Berrizbeitia, 2007). Several cities in Spain have developed projects of green infrastructure (de las Rivas Sanz & Fernández-Maroto, 2019), but, generally, the focus on urban trees has centred on their ornamental value. In fact, the first Spanish master's programme in urban forestry began only in 2019. With a 200-year long history of management of urban trees, the US is the birthplace of urban forestry, even before its "invention" (Jones, 2017; Konijnendijk et al., 2006).

3.2.2. Utopiaeiland Food-Forest, Almere

Utopiaeiland is an agroforestry project (1.4 ha) located on municipal land adjacent to the horticultural exhibition Floriade 2022. Initially, the municipality assigned the forested island to several entrepreneurs as an incubator of green start-ups with poor results. Instead, the Weerwoud Foundation was granted permission to transform the existing forest into a pilot of agroforestry systems with perennials, including horticulture, strip cultivation, and livestock with trees. Additionally, the project involved measures of ecosystem restoration, as well as areas for leisure and education.

The project involves multi-stakeholder cooperation. Weerwoud manages the land under a maintenance contract with the municipality until the end of Floriade, with a possible extension until 2032. The foundation manages volunteers that support maintenance. The project received funds from the national government, Floriade, and Flevocampus—an educational initiative—as it addresses key national environmental concerns around food systems. Local universities of applied sciences use Utopiaeiland for studies and internships. Wageningen University contributes with research to assess the project. Several NGOs are also involved, and entrepreneurs are exploring the commercialisation of locally grown products.

3.2.3. Metropolitan Forest of Madrid

The Metropolitan Forest of Madrid is a planned 75-kilometre-long forest belt, promoted by the Madrid City Council. Its total area will be 32.035 ha, of which 81% are existing natural spaces. Two million trees are projected to be planted in the coming 10 years in 2.300 ha of residual peripheral land, 50% of it in private ownership. It aims to mitigate the urban heat island, improve air quality, prevent desertification, support biodiversity, promote social cohesion, and increase the quality of life. The project is embedded in the municipal plan "Madrid 360," intended for meeting emission limits imposed by the European Commission. It is important to pinpoint that Madrid developed a roadmap for decarbonisation in 2050, a long-term strategy aimed at making climate adaptation initiatives more resilient to changes in political will. Another strategy in that same direction has been to adhere to Climate-KIC´s Deep Demonstration of Healthy and Clean Cities initiative and to CitiES2030, a network of four Spanish cities to accelerate action towards climate neutrality.

For contracting the design and production information development phase of the UF, Madrid City Council prepared a public tender, distributing the forest in five lots. To broaden the diversity of agents involved in the planning project, the City Council team and its academic partner (Universidad Politécnica de Madrid) concurred with experimenting with public procurement. The outcome was a series of participatory sessions, involving more than 800 people from municipal bodies, citizen groups, private companies, NGOs, and academia. This process delivered criteria for the five temporary consortiums of companies that won the tender, based on an extended meaning of what kind of forest Madrid wanted.

3.2.4. Urban Forest Plan of Boston

The Urban Forest Plan of Boston is an initiative of the city's Parks and Recreation Department. As a result of a public tender, Stoss Landscape Urbanism and Urban Canopy Works act as its lead consulting firms. The plan understands the UF as a generator of resilience and equity for all citizens. Through increasing street trees in the lowest-income neighbourhoods, Boston intends to address the unequal relationship between income and tree canopy, ameliorate the heat island effect, and improve air quality for its neediest citizens first.

The plan is strategic given that Boston has little land for tree planting besides its streets. The citywide and regional park system developed by Frederick Law Olmsted and Charles Eliot provides the starting point for the UF. Additionally, low-density neighbourhoods and universities with many privately-owned trees and wide streets are operationalized for conserving tree canopy. The goal is for the plan to be based on science, data-driven, and defined by the needs and desires of the community. It emphasises maintenance and public engagement, as the city wants to ensure better management today and 20 years from now.

4. Results

4.1. Goals and Ambitions

The most important arguments cited as goals and ambitions for the UFs by all actors were related to environmental, social, and economic sustainability. These revolved around three dimensions: First, to develop environmental awareness and engagement, exploring forms of participatory design and management. Particularly interesting were ambitions concerning environmental and community education specifically dealing with training communities to maintain and expand the UF in both Almere and Boston, or be more engaged in food production, in Almere. Second, the provision of environmental benefits to address relevant urgencies in each context (ecosystem restoration, water management). Third, to

increase the environmental qualities of the surrounding areas, having an impact on communities and their health and access to urban green (specifically climate justice in the Boston case). Innovation in both management and maintenance was mentioned mainly by municipal actors in the three cases: on the one hand, concerning elaborating legal frameworks to guarantee consistent management in the long term; on the other, connected to developing evidence-based approaches to maintenance that could inform or transform current municipal practises.

4.2. Criteria for Success

Criteria for success stated during the interviews were qualitative, not attached to specific benchmarks. For all municipal actors, their project would be successful if it was able to generate science-backed insights or mechanisms on how to combine environment criteria with social needs and landscape quality with economic viability for ongoing maintenance. Thus, success for this group is mainly related to having enough monetary resources or finding the right framework to implement their measures. In particular, it was considered a measure of success if a project was able to develop clear, innovative, and easily enforceable policies and ordinances to bring on board the private sector and other municipal departments in the implementation of a UF vision. Representatives of the third sector and knowledge institutions emphasised having an impact on increased environmental awareness and education as the desired accomplishment of the project. Common ground between both criteria is found in seeing success if the projects activate local communities for co-management and upscaling.

4.3. Perceived Challenges

How the internal coordination, frictions, and interests within municipal departments may affect the development and management of the UF projects is a critical barrier to implementation. This is a shared concern among stakeholders, including those working in municipal departments. Specific problems are: differences in approach between departments on urban green management (tree ordinances tend to focus on technical and operational aspects and not on ecological ones); existing institutional inertias, with innovation hindered by business as usual; lack of consistency and continuity of municipal actors and budget through political cycles (with funding focusing on capital and tree planting, and not in long-term maintenance); problems with staff resources (understaffing, lack of qualified personnel, or dependence on volunteers); and political overemphasis on quick impact through tree planting.

This suggests that a lack of strong vision and leadership is highly detrimental to successful implementation. However, representatives of the third sector and knowledge institutions indicated an excessive dependence on personal leadership as a barrier, as it risks damaging long-term prospects of continuity. For municipal actors, another important challenge was dealing with private property in the domain of their project. Negotiating transfers of land or co-management responsibilities were noted as complicated in the face of interests in urban development.

4.4. Leverages: How Municipal Actors Find Support

Municipal actors involved in the UFs of study search for support and legitimation mainly in knowledge external to their organisation. First, by involving knowledge institutions as stakeholders. These were considered of interest as they can contribute to the scientific validation of innovative management and maintenance strategies, increasing environmental awareness through educational activities and facilitating boundary-spanning collaborations, continuity, and trust-building in complex multi-actor settings. Second, by operationalizing knowledge from recognized best practices in climate mitigation. Third, by seeking innovative approaches in the design, management, and maintenance of UFs from other parties, namely citizens, NGOs, or consulting design firms. Cities also find support in national and international agendas. In the case of Madrid, being one of the 15 European cities part of the EIT Climate-KIC Deep Demonstration programme has enabled the continuity of the multi-actor collaboration despite the political change in the city council government.

The development of pilots or demonstration projects, as in the case of Almere, is a related strategy mentioned by municipal actors for gaining knowledge and support. Pilots would allow for experimentation with limited risks. Finally, growing social and political concerns on climate change are considered leverage to enact action. However, all actors interviewed affirmed that more environmental awareness is needed, hence the importance of involving knowledge institutions and academia in the projects.

4.5. Governance and Implementation Strategy and Typology of Urban Forest

Despite the common ground across cases in terms of goals, criteria for success, barriers, and leverages, we observed distinct approaches in how and why a specific governance and implementation strategy and type of UF is favoured (Figure 1). In Almere, the project was initiated from the bottom by an NGO and includes a volunteer training programme. This UF was conceived as a spatially defined, small-scale demonstration landscape. It is aligned with national concerns on sustainable food production, research agendas, and steered by strong personal leadership. The declared perceived role of the municipal actor was simply to facilitate a legal framework, via a maintenance contract. They favoured this UF type as a pilot towards scaling-up innovative urban

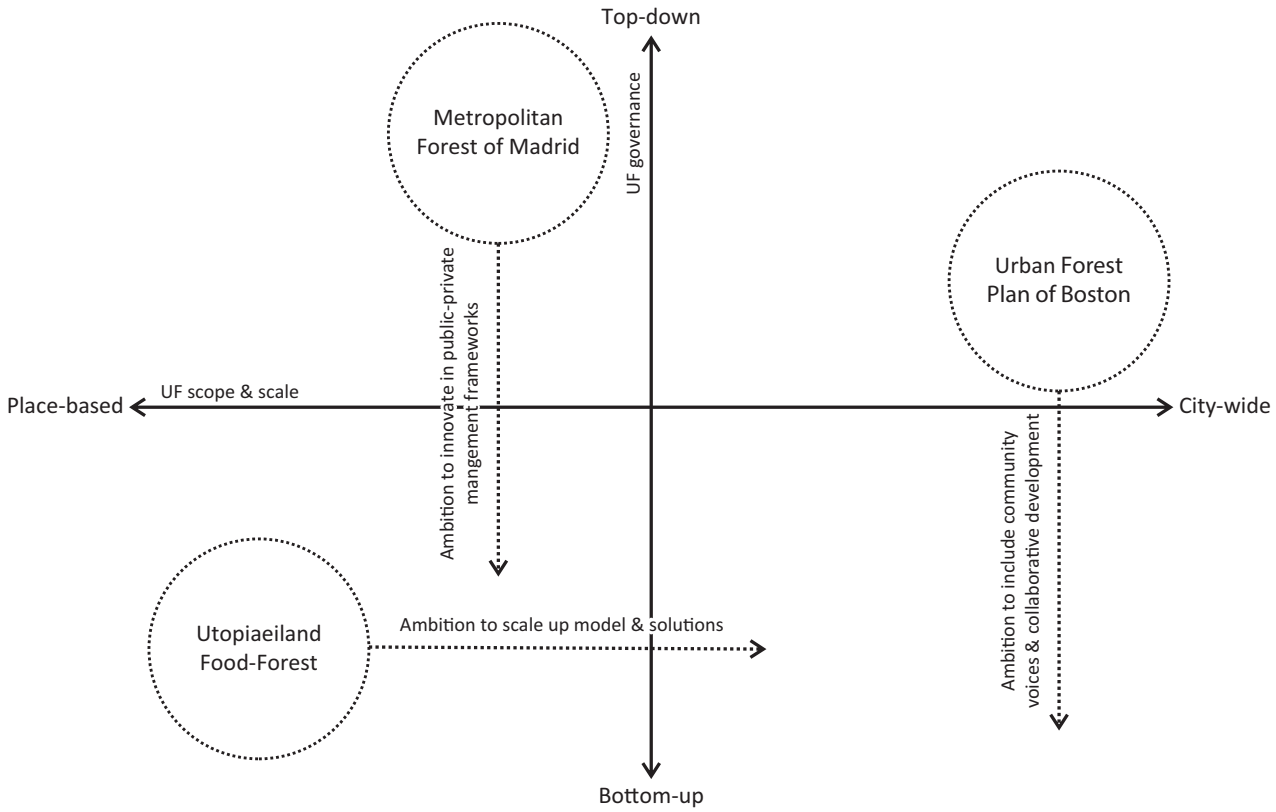

Figure 1. Position and ambition of the case studies within the top-down/bottom-up spectrum and range of scope and scale of the UF project.

green management and maintenance and replacing current municipal practices.

In Madrid, the project is managed by the Directorate-General for Strategic Planning, part of the Urban Development Government Area of the Madrid City Council. The typology of the UF as a municipally funded place-bound strategic project was chosen over a plan of urban forestry encompassing the whole city. The planning figure of a master plan was indicated as the preferred one. A new legal figure of land custody was mentioned to reach agreements with private owners for co-management. In implementing a master plan, municipal planners stated a desire to set a long-term legal framework for the UF, and to organise its maintenance differently than in other green areas of the city. Legitimation for this top-down approach was addressed through a collaborative, university-led multi-stakeholder process aimed at informing a process of public tendering, and through the adherence to (inter)national programmes.

In Boston, providing equal access to tree canopy coverage and related environmental benefits and qualities was declared as pivotal in the choice of the UF project. To maximise impact, this project follows the canonical definition of UF as a municipally led strategy dealing with all trees within the city. Given its wide scope, coordination and collaboration with multiple urban stakeholders to ensure legitimacy and sustainability are considered of critical importance in the interviews. Specifically, the municipal informant mentioned the goal of involving local communities in the planning process and future management of the UF, including plans for a workforce training programme. It is also desired that guidelines for city and private landowners can be easily followed and enforced.

4.6. Organisational Form of the Case Studies: Characterization and Gaps

Figure 2 presents a characterization of the organisational form of the case studies, showing how each case stands with regard to the project governance (top-down vs. bottom-up) and the distribution of agency (coherent vs. diverse). In the horizontal axis of the diagram, we use "diverse" to characterize actors that are in fact coalitions of agents, each one with a different interest and level of agency; these may be organisations with a horizontal structure, or groups of entities within one same category that do not constitute an organisation per se (businesses, local communities). With "coherent" we refer to actors in which agency is consolidated in one or a few organisational units (e.g., municipal departments). This characterization allows pointing out gaps in the structure of each project. In turn, these gaps direct at possible organisational hurdles impacting both the attainment of declared goals and ambitions and, more generally, the successful mainstreaming of urban forestry in the planning process. Utopiaeiland is a bottom-up project, organised around a wide array of actors. However, its

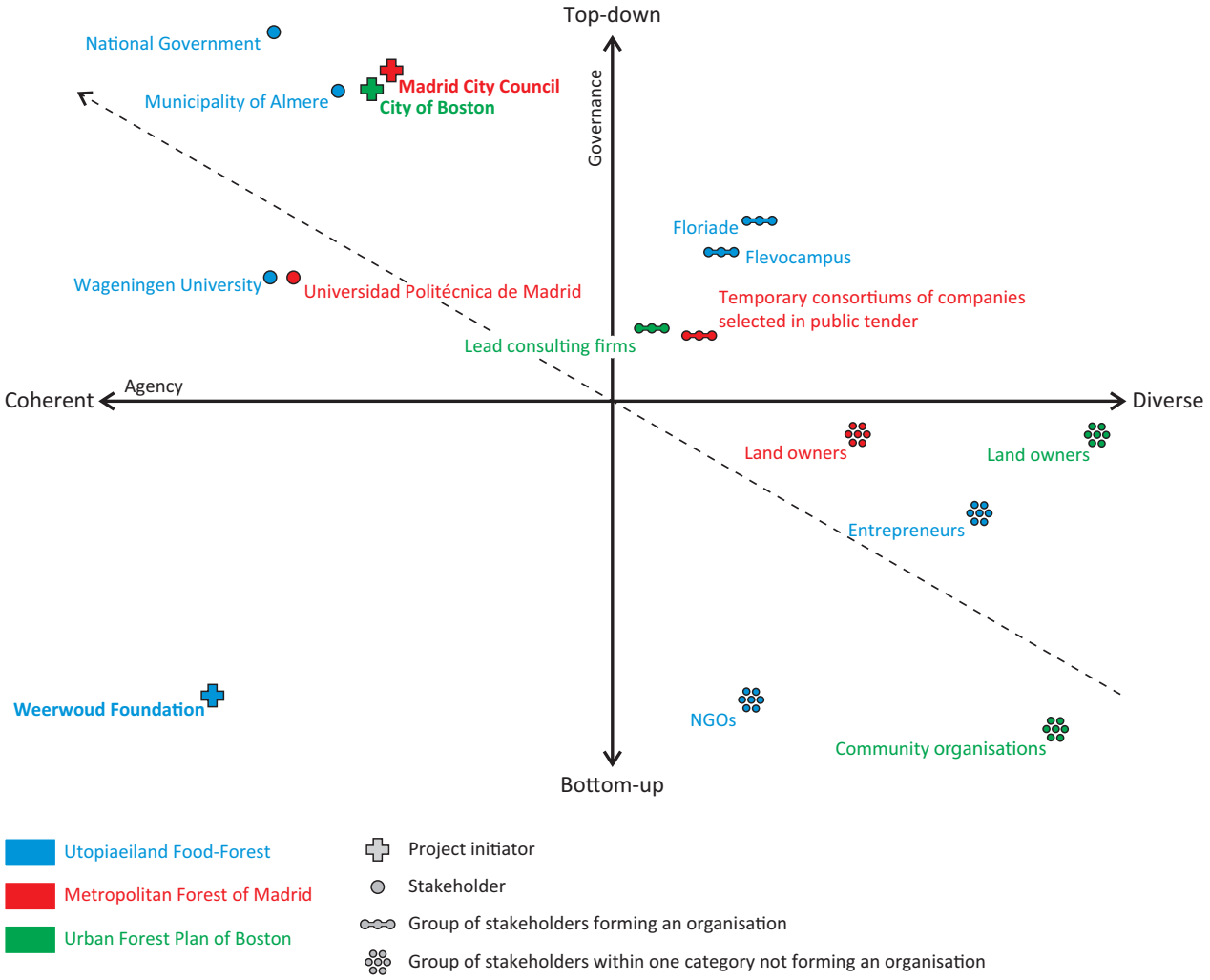

Figure 2. Characterization of the organisational form of the case studies.

implementation is characterized by its dependency on single, coherent, bottom-up leadership, and low levels of involvement of actors at the top. Therefore, such a governance model highlights possible collaborative and continuity challenges, which may affect the mainstreaming and scaling-up of the model. The Metropolitan Forest of Madrid can be characterized not just as top-down, but also as a project mostly organised around a set of very coherent actors with regard to their agency. Such an approach signals a gap in how to address more strongly the involvement of local communities and actors to achieve its goal towards participatory management. The Urban Forest Plan of Boston can be described also as top-down, yet it highlights an intermediate approach, as it gathers diverse actors in a balanced manner. Therefore, such a model places a higher emphasis on setting collaborative structures and routines and responds to a long tradition in urban forestry management.

5. Discussion and Conclusion

The results of this study have helped us answer our exploration of the nature of planning processes and implementation strategies being taken into consideration by municipal planners in UF projects. Concerning our first research aim, the results provide insights in understanding how the need for a UF is justified by different stakeholders, and what their definition of success in the task of creating a UF is. These results confirm studies signalling high levels of concern among urban stakeholders for environmental questions, such as ecosystem services (Young, 2013), pointing at an effective mainstreaming of such concepts. However, our results also indicate a poor development of objective criteria for the success of a UF, validating an identified gap in the literature (Ordóñez et al., 2019). A deeper exploration of benchmarks for UF plans could help sharpen municipal strategies and support adaptive management of such projects. The risk here is to focus only on quantitative assessments of tree performance (Mattern, 2021). For that, parameters ought to be holistic, place-specific, and include qualitative dimensions.

Concerning our second research aim, in our case studies, we identified how municipal planners are attempting to circumvent current rigidities and barriers to implementation. Our results indicate that the

main perceived barriers to UF are not precisely those linked to pressures of urban transformation, but to the lack of information, guidance, funding, continuity, and coordination between municipal departments, confirming insights from environmental mainstreaming literature (Mogelgaard et al., 2018; Runhaar et al., 2018; Zuniga-Teran et al., 2020). These barriers particularly impact long-term management and maintenance. Municipal actors seek support mainly from intermediaries, local academia, and (inter)national agendas to legitimise strategies, receive external knowledge, or coordinate experiments in governance, management, and maintenance.

Finally, and linked to our third research aim, understanding how and why a certain implementation strategy and type of UF is chosen questions the need to follow the usual definition of UF to introduce this concept into our cities. The urban forestry-centred definition of a UF strategy as that dealing with all trees within a city (Konijnendijk et al., 2006; Randrup et al., 2005) demands high levels of coordination and resources. Not all cities count with the technical capacities and planning heritage to immerse in such an endeavour. We note that, despite the importance of multi-stakeholder partnerships, ultimately, with such an approach, most of the responsibilities fall on the shoulders of municipalities. The strength of our results is that they show that considering the spectrum of possible top-down/bottom-up approaches and diversity of contextual conditions reveals that there is not just one UF type to opt for to achieve the desired environmental and social goals and overcome implementation barriers. In this sense, we see an opportunity in further examining processes towards the collaborative building of a context-specific idea of a forest.

There seems to be a dynamic quality in the development of a UF in relation to the top-down/bottom-up and scale and scope dimensions (with Almere wanting to scale up and Madrid and Boston aspiring to activate bottom-up actions). With top-down projects tending to have a wider ambition in terms of their spatial scope, further research is needed on the setting up of collaborative structures that might bridge the top-down/bottom-up gap and activate underutilized agencies among urban stakeholders towards sustainable city-wide urban greening. The Madrid Metropolitan Forest is not relying on, for example, local businesses; yet, it may need their involvement for future management and maintenance to be organised locally. While cases like Boston and Almere showcase interesting approaches for collaboration among diverse actors, our results point out gaps and challenges in terms of organisation that may impact success. In that regard, it would be important to corroborate our findings at a later stage of the development of the projects.

All in all, for a better implementation of UFs there is a need to further dive into strategies to strengthen current planning structures and processes or to conceptualise entirely new planning institutions and experimental forms of climate governance (Bulkeley, 2013). The results call for the urgent development of "urban transformative capacities" (Wolfram et al., 2019) towards reinventing urban planning and overcoming existing lock-ins in its processes. There are two major limitations in this study that could be addressed also through future research. First, we focused only on cities in Europe and North America, while including perspectives from other geographies could provide insights on alternative approaches to urban greening. Second, being this an exploratory, qualitative study, we are unable to fully generalise the research findings. Accordingly, a larger sample of case studies and a quantitative approach could provide a richer overview of the ways cities face the challenge of greening.

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Conflict of Interests

The authors declare no conflict of interests.

References

1t.org. (2020). *A platform for the trillion tree community*. https://www.1t.org

Antonenko, M., Dushkova, D., & Krasovskaya, T. (2020). Urban forests in megacities from the perspective of ecosystem services using the Timiryazevsky Forest Park, Moscow, as a case study. In J. Breuste, M. Artmann, C. Ioja, & S. Qureshi (Eds.), *Making green cities: Concepts, challenges and practice* (pp. 180–193). Springer Nature.

Assefa, G., & Frostell, B. (2007). Social sustainability and social acceptance in technology assessment: A case study of energy technologies. *Technology in Society*, *29*(1), 63–78.

Barron, S., Sheppard, S. R., & Condon, P. M. (2016). Urban forest indicators for planning and designing future forests. *Forests*, *7*(9), Article 208.

Berrizbeitia, A. (2007). Re-placing process. In J. Czerniak, G. Hargreaves, & J. Beardsley (Eds.), *Large parks* (pp. 175–197). Princeton Architectural Press.

Bulkeley, H. (2013). Climate change and urban governance: A new politics? In S. Lockie, D. A. Sonnenfeld, & D. R. Fisher (Eds.), *Routledge international handbook of social and environmental change* (pp. 173–185). Routledge.

Cariñanos, P., Calaza-Martínez, P., O'Brien, L., & Calfapietra, C. (2017). The cost of greening: Disservices of urban trees. In D. Pearlmutter, C. Calfapietra, R. Samson, L. O'Brien, S. Krajter Ostoić, G. Sanesi, & R. Alonso del Amo (Eds.), *The urban forest: Cultivating green infrastructure for people and the environment* (pp. 79–87). Springer International Publishing.

Carlsson-Kanyama, A., Dreborg, K. H., Moll, H. C., &

Padovan, D. (2008). Participative backcasting: A tool for involving stakeholders in local sustainability planning. *Futures*, *40*(1), 34–46.

Carreiro, M. M. (2007). Introduction: The growth of cities and urban forestry. In M. M. Carreiro, Y. C. Song, & J. Wu (Eds.), *Ecology, planning, and management of urban forests: International perspective* (pp. 3–9). Springer.

Cities4Forests. (2019). *Urban forests for healthier cities: Policy, planning, and institutional arrangements*. https://cities4forests.com/wp-content/uploads/2020/06/C4F-Urban-Forests-for-Healthier-Cities.pdf

Davies, C., Andreucci, M. B., Zurcher, N., De Vreese, R., Verlič, A., Sanesi, G., Bernasconi, A., & Calfapietra, C. (2017). *Guidelines for urban forestry as critical green infrastructure in European urban areas*. European Cooperation in Science and Technology (COST). https://www.panbern.ch/download/pictures/d4/18crwqzie49ruweikloq3qmpkiz7hk/davies_et_al._2017_guideline.pdf

de la Sota, C., Ruffato-Ferreira, V. J., Ruiz-García, L., & Alvarez, S. (2019). Urban green infrastructure as a strategy of climate change mitigation. A case study in northern Spain. *Urban Forestry & Urban Greening*, *40*, 145–151.

de las Rivas Sanz, J. L., & Fernández-Maroto, M. (2019). Planning strategies for a resilient urban fringe in three medium-sized Spanish cities. *Planning Perspectives*, *34*(4), 725–735.

Dean J. (2009). Seeing trees, thinking forests: Urban forestry at the University of Toronto in the 1960s. In A. Mac Eachern & W. Turkel (Eds.), *Method and meaning in Canadian environmental history* (pp. 236–253). Nelson Education.

Dwyer, R., Lamond, D., & Lee, K.-H. (2009). Why and how to adopt green management into business organizations? *Management Decision*, *47*(7), 1101–1121.

Eisenhardt, K. M. (1989). Building theories from case study research. *The Academy of Management Review*, *14*(4), 532–550.

Endreny, T. A. (2018). Strategically growing the urban forest will improve our world. *Nature Communications*, *9*(1), Article 1160.

Ernst, L., de Graaf-Van Dinther, R. E., Peek, G. J., & Loorbach, D. A. (2016). Sustainable urban transformation and sustainability transitions; conceptual framework and case study. *Journal of Cleaner Production*, *112*(Part 4), 2988–2999.

European Commission. (2020). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. EU Biodiversity Strategy for 2030: Bringing nature back into our lives*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0380

European Commission. (2021). *3 billion trees pledge*. https://ec.europa.eu/environment/3-billion-trees_en

Ferguson, J., & Gupta, A. (2002). Spatializing states: Toward an ethnography of neoliberal governmentality. *American Ethnologist*, *29*(4), 981–1002.

Food and Agriculture Organization of the United Nations. (2016). *Guidelines on urban and peri-urban forestry* (FAO Forestry Papers No. 178). https://www.fao.org/policy-support/tools-and-publications/resources-details/es/c/1155338

Förster, A. (2014). *Enhancing the effectiveness of spatial planning processes. Impacts, basic building blocks and critical variables of communicative planning methods* [Doctoral dissertation, TU Munich]. mediaTUM. https://mediatum.ub.tum.de/1210593

Galunic, D. C., & Eisenhardt, K. M. (2001). Architectural innovation and modular corporate forms. *Academy of Management Journal*, *44*(6), 1229–1249.

Gupta, J. (2010). Mainstreaming climate change: A theoretical exploration. In N. van der Grijp & J. Gupta (Eds.), *Mainstreaming climate change in development cooperation: Theory, practice and implications for the European Union* (pp. 67–96). Cambridge University Press.

Hölscher, K., Frantzeskaki, N., McPhearson, T., & Loorbach, D. (2019). Tales of transforming cities: Transformative climate governance capacities in New York City, US and Rotterdam, Netherlands. *Journal of Environmental Management*, *231*, 843–857.

Janssen, M. A., Goosen, H., & Omtzigt, N. (2006). A simple mediation and negotiation support tool for water management in the Netherlands. *Landscape and Urban Planning*, *78*(1), 71–84.

Jones, J. (2017). *Urban forests: A natural history of trees and people in the American cityscape*. Penguin Books.

Karlsson-Vinkhuyzen, S. I. S. E., Boelee, E., Cools, J., Visseren-Hamakers, I. J., van Hoof, L. J. W., Hospes, O., Kok, M., Peerlings, J. H. M., Podvin, K. J., van Tatenhove, J. P. M., & Termeer, C. J. A. M. (2014). *Mainstreaming biodiversity where it matters most*. Public Administration and Policy Group; Wageningen University; PBL Netherlands Environmental Assessment Agency. https://edepot.wur.nl/335490

Karlsson-Vinkhuyzen, S. I. S. E., & Kok, M. T. J. (2011). Interplay management in the climate, energy, and development nexus. In S. Oberthür & O. Schram Stokke (Eds.), *Managing institutional complexity: Regime interplay and global environmental change* (pp. 285–312). MIT Press.

Konijnendijk, C. C., Ricard, R. M., Kenney, A., & Randrup, T. B. (2006). Defining urban forestry: A comparative perspective of North America and Europe. *Urban Forestry & Urban Greening*, *4*(3/4), 93–103.

Macnaghten, P. (2003). Embodying the environment in everyday life practices. *The Sociological Review*, *51*(1), 63–84.

Mattern, S. (2021). Tree thinking. *Places Journal*. https://doi.org/10.22269/210921

McBride, J. R. (2017). *The world's urban forests: His-*

tory, composition, design, function and management. Springer International Publishing.

Meuser, M., & Nagel, U. (2009). The expert interview and changes in knowledge production. In A. Bogner, B. Littig, & W. Menz (Eds.), *Interviewing experts* (pp. 17–42). Palgrave Macmillan.

Mieg, H. A., & Näf, M. (2006). *Experteninterviews in den Umwelt—und Planungswissenschaften: Eine Einführung und Anleitung* [Expert interviews in the environmental and planning sciences: An introduction and guide]. Pabst Science Publishers.

Mogelgaard, K., Dinshaw, A., Ginoya, N., Gutiérrez, M., Preethan, P., & Waslander, J. (2018). *From planning to action: Mainstreaming climate change adaptation into development*. World Resources Institute. https://www.wri.org/research/planning-action-mainstreaming-climate-change-adaptation-development

Moreno-Serna, J., Sánchez-Chaparro, T., Mazorra, J., Arzamendi, A., Stott, L., & Mataix, C. (2020). Transformational collaboration for the SDGs: The Alianza Shire's work to provide energy access in refugee camps and host communities. *Sustainability*, *12*(2), Article 539.

Nye, M., & Rydin, Y. (2008). The contribution of ecological footprinting to planning policy development: Using REAP to evaluate policies for sustainable housing construction. *Environment and Planning B: Planning and Design*, *35*(2), 227–247.

OECD. (2014). *Mainstreaming cross-cutting issues: Seven lessons from DAC peer reviews*. https://www.oecd.org/dac/mainstreaming-cross-cutting-issues-9789264205147-en.htm

Ordóñez, C., Threlfall, C. G., Kendal, D., Hochuli, D. F., Davern, M., Fuller, R. A., van der Ree, R., & Livesley, S. J. (2019). Urban forest governance and decision-making: A systematic review and synthesis of the perspectives of municipal managers. *Landscape and Urban Planning*, *189*, 166–180.

Ordóñez, C., Threlfall, C. G., Livesley, S. J., Kendal, D., Fuller, R. A., Davern, M., van der Ree, R., & Hochuli, D. F. (2020). Decision-making of municipal urban forest managers through the lens of governance. *Environmental Science & Policy*, *104*, 136–147.

Ottisch, A., & Krott, M. (2005). Urban forest policy and planning. In C. Konijnendijk, K. Nilsson, T. Randrup, & J. Schipperijn (Eds.), *Urban forests and trees: A reference book* (pp. 117–148). Springer.

Pearlmutter, D., Calfapietra, C., Samson, R., O'Brien, L., Ostoić, S. K., Sanesi, G., & del Amo, R. A. (Eds.). (2017). *The urban forest: Cultivating green infrastructure for people and the environment*. Springer International Publishing.

Perkins, H. (2014). Urban forests are social natures: Markets, race, class, and gender in relation to (un)just urban environments. In L. A. Sandberg, A. Bardekjian, & S. Butt (Eds.), *Urban forests, trees, and greenspace* (pp. 19–34). Routledge.

Pettigrew, A. M. (1990). Longitudinal field research on change: Theory and practice. *Organization Science*, *1*(3), 267–292.

Purdon, M. (2003). The nature of ecosystem management: Postmodernism and plurality in the sustainable management of the boreal forest. *Environmental Science & Policy*, *6*(4), 377–388.

Randrup, T. B., Konijnendijk, C., Dobbertin, M. K., & Prüller, R. (2005). The concept of urban forestry in Europe. In C. Konijnendijk, K. Nilsson, T. Randrup, & J. Schipperijn (Eds.), *Urban forests and trees: A reference book* (pp. 9–21). Springer.

Rogers, K., Andreucci, M.-B., Jones, N., Japelj, A., & Vranic, P. (2017). The value of valuing: Recognising the benefits of the urban forest. In D. Pearlmutter, C. Calfapietra, R. Samson, L. O'Brien, S. Krajter Ostoić, G. Sanesi, & R. A. del Amo (Eds.), *The urban forest: Cultivating green infrastructure for people and the environment* (pp. 283–299). Springer International Publishing.

Rogers, K., Sarcre, K., Goodenough, J., & Doick, K. (2015). *Valuing London's urban forest: Results of the London i-Tree Eco Project*. Treeconomics London.

Runhaar, H., Wilk, B., Persson, Å., Uittenbroek, C., & Wamsler, C. (2018). Mainstreaming climate adaptation: Taking stock about "what works" from empirical research worldwide. *Regional Environmental Change*, *18*(4), 1201–1210.

Sandberg, L. A., Bardekjian, A., & Butt, S. (2014). Introduction. In L. A. Sandberg, A. Bardekjian, & S. Butt (Eds.), *Urban forests, trees, and greenspace* (pp. 1–16). Routledge.

Schwab, J. (Ed.). (2019). *Planning the urban forest*. American Planning Association. https://www.planning.org/publications/report/9026879

Scott, A. (2019). Mainstreaming the environment in planning policy and decision making. In S. Davoudi, R. Cowell, I. White, & H. Blanco (Eds.), *The Routledge companion to environmental planning* (pp. 420–433). Routledge.

Smith, N. R. (2014). Beyond top-down/bottom-up: Village transformation on China's urban edge. *Cities*, *41*, 209–220.

Teo, H. C., Zeng, Y., Sarira, T. V., Fung, T. K., Zheng, Q., Song, X. P., Chong, K. Y., & Koh, L. P. (2021). Global urban reforestation can be an important natural climate solution. *Environmental Research Letters*, *16*(3), Article 034059.

The White House. (2021, March 31). *Fact sheet: The American Jobs Plan* [Press release]. https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan

Tyrväinen, L., Pauleit, S., Seeland, K., & de Vries, S. (2005). Benefits and uses of urban forests and trees. In C. Konijnendijk, K. Nilsson, T. Randrup, & J. Schipperijn (Eds.), *Urban forests and trees: A reference book* (pp. 81–114). Springer.

Vervoort, M., Flap, H., & Dagevos, J. (2010). The ethnic composition of the neighbourhood and ethnic minorities' social contacts: Three unresolved issues. *European Sociological Review*, *27*(5), 586–605.

Walker, D. H. T., Bourne, L. M., & Shelley, A. (2008). Influence, stakeholder mapping and visualization. *Construction Management and Economics*, *26*(6), 645–658.

Wolfram, M., Borgström, S., & Farrelly, M. (2019). Urban transformative capacity: From concept to practice. *Ambio*, *48*(5), 437–448.

Yin, R. K. (1981). The case study as a serious research strategy. *Knowledge*, *3*(1), 97–114.

Yin, R. K. (1992). The case study method as a tool for doing evaluation. *Current Sociology*, *40*(1), 121–137.

Young, R. F. (2013). Mainstreaming urban ecosystem services: A national survey of municipal foresters. *Urban Ecosystems*, *16*, 703–722.

Zelikow, P., & Allison, G. (1999). *Essence of decision: Explaining the Cuban Missile Crisis*. Longman.

Zuniga-Teran, A. A., Staddon, C., de Vito, L., Gerlak, A. K., Ward, S., Schoeman, Y., Hart, A., & Booth, G. (2020). Challenges of mainstreaming green infrastructure in built environment professions. *Journal of Environmental Planning and Management*, *63*(4), 710–732.

About the Authors

Víctor Muñoz Sanz is an assistant professor of urban design at TU Delft, currently leading research on productive cities and landscapes. Prior to this, he was a postdoctoral researcher at TU Delft, coordinator of the Jaap Bakema Study Centre, and co-principal researcher of "Automated Landscapes" at Het Nieuwe Instituut. Víctor holds the degree of architect from Escuela Técnica Superior de Arquitectura de Madrid, a master's in architecture in urban design from Harvard University, and a PhD cum laude in architecture from Universidad Politécnica de Madrid.

Sara Romero Muñoz is a PhD student at the Universidad Politécnica de Madrid (UPM) researching human behaviour and perceptions on climate change. At the Innovation and Technology for Development Centre (itdUPM), she coordinates projects towards sustainable and equitable urban transformations in multi-actor settings. Sara holds several academic degrees: graduate in social and cultural anthropology, graduate in business sciences, graduate in communication and public relationships, and a master's degree in technology for human development.

Teresa Sánchez Chaparro is a faculty member at the Department of Industrial Engineering at the Universidad Politécnica de Madrid (UPM). She is academic director at the Innovation and Technology for Development Centre (itdUPM) and member of the Sustainable Organizations research group. Before joining UPM, she held various positions in organisms linked to quality assurance in higher education. Her current research interests are sustainable organisation strategies, sustainable businesses and fourth sector, social marketing, and quality assurance in higher education.

Lorena Bello Gómez is currently a design critic at the Harvard Graduate School of Design (GSD), following her lectureship at MIT from 2013 to 2021. Her current work seeks to connect design and political will to positively impact climatic adaptation. She started examining this topic in her dissertation *Hybrid Networks* and has applied some of its lessons when working with environmentally vulnerable communities engulfed in climatic risks with her practice TERRALAB. Lorena holds an architecture and urbanism PhD from Barcelona UPC, and a master's in architecture in urban design from GSD.

Tanja Herdt is an associate professor of theory and methods of urban design at TU Delft. She is an academic and a practicing urban designer with an emphasis on urban transformation, methods of urban analysis, and history and theory of the city. Tanja received her doctorate from the Department of Architecture at ETH Zurich, where she also was head of research at ETH-CASE. Her book on Cedric Price entitled *The City and the Architecture of Change* was published by Park Books.

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