UTD5

EMBRACING THE FUTURE
FOR AND WITH URBAN FORESTS
AND TREES

INTERNATIONAL URBAN
TREE DIVERSITY CONFERENCE

BOOK OF ABSTRACTS

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UTD5

INTERNATIONAL URBAN TREE DIVERSITY CONFERENCE

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Spanish National Heritage is the public body responsible for the assets owned by the State that have come from the legacy of the Spanish Crown.

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INTRODUCTION

As our cities face the pressing challenges of climate change, extreme weather events, increasing population growth, and urban densification, the role of urban forestry becomes increasingly vital. The 5th Urban Tree Diversity Conference (UTD5) aimed to help craft a vision for the future of urban forests by sharing innovations from a spectrum of scientific disciplines that seek to secure the health and resilience of our urban trees.

UTD5, building on the legacy from conferences in Alnarp/Malmo (Sweden), Melbourne (Australia), Vancouver (Canada), and St Petersburg (Florida, USA), offered an invaluable opportunity for urban forestry and arboriculture practitioners, researchers, policymakers, and stakeholders to come together and explore the future challenges and opportunities for our urban trees. By embracing emerging technologies, harnessing open data, and fostering citizen engagement, all in support of enhancing tree diversity, we can pave the way for greener and more resilient cities.

UTD5 was held in October 2024 in Madrid, Spain, where we welcomed 150 participants from 26 countries around the world to help craft a vision for the future of urban forests by sharing innovations from a spectrum of scientific disciplines that seek to secure the health and resilience of our urban trees. The program included 8 keynote speakers, 44 oral communications, 1 round table, 16 poster presentations, and 3 technical visits. Presentations were related to the following four different topics:

1) Using tree diversity to mitigate risks from a changing climate

The impact of climate change on urban areas calls for the transformation of our future cities. Urban forests constitute a unique nature-based solution by providing adaptive strategies for climate change mitigation and risk management. By exploring innovative approaches, such as tree species diversification and green infrastructure development, urban foresters and other tree professionals can enhance the resilience and livability of urban areas in the face of rising temperatures and extreme weather events.

2) Novel approaches to urban tree selection

This topic included case studies of innovative strategies for selecting trees that thrive in urban environments, from utilizing advanced data analytics and predictive modeling to incorporating principles of biodiversity and climate resilience into tree selection processes. By embracing novel approaches, we can enhance the health, beauty, and sustainability of our urban forests, ensuring they continue to enrich our communities for generations to come transforming the way we choose and cultivate urban trees.

3) Emerging technologies and their role in urban forest management

Incorporating emerging technologies into urban forestry practices can revolutionize the way we manage and monitor our urban forests. From advanced remote sensing techniques to drone technology and data analytics, these tools enable precise monitoring of tree health, early detection of diseases, and efficient resource allocation. Communications at UTD5 delved into the latest technological advancements and their application in urban tree species selection, highlighting their potential for enhancing the sustainability and effectiveness of urban forest management.

4) Harnessing open data and citizen engagement to support urban forestry

Effective management of urban forests requires collaboration with, and engagement from citizens and stakeholders. Open data platforms provide opportunities for transparent information sharing, enabling citizens to actively participate in decision-making processes. By fostering citizen engagement, urban foresters can tap into the collective knowledge and expertise of the community. Presentations on this topic included strategies for leveraging open data, citizen engagement, and effective communication to create a sense of ownership and promote diverse urban trees and forests.

We truly think that UTD5 provided a valuable platform for sharing knowledge, exchanging ideas, and shaping the future of urban forests and trees to benefit our cities and our communities. We are confident that this vital work will continue at UTD6, and we look forward to meeting you all there again!

The Organizing Committee

KEYNOTES

Fostering biocultural diversity of cities through urban forestry and the 3+30+300 rule

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The 3+30+300 rule (or principle) sets evidence-based guidelines for visible green (seeing at least 3 larger trees from every home, place of work, and school), surrounding green (no less than 30% tree canopy cover in every neighbourhood), and recreational green (at most 300 metres to the nearest, high-quality public green space). Since its launch in early 2021 by the presenter, in the midst of the Covid19-pandemic when the importance of visible and nearby nature became very clear, the rule has been adopted by municipalities, regional and national governments, and international organisations across the world.

This talk will focus on the diversity aspect of 3+30+300, as the rule could in in principle be implemented without due care for diversity concerns, especially when it comes to the 3 and 30 components. What can be done to promote local biodiversity through the rule? What are some of the principles to work with so that a healthy and vital urban forest is created? But also, how does implementation of the rule consider 'tree equity' and the diverse demands for, and perceptions of urban nature held by different socio-cultural groups?

The talk presents and discusses international experiences with linking 3+30+300 with diversity aspects. It shows how the concept of biocultural diversity, which recognizes that biodiversity and people/cultural diversity are closely entwined, can provide a useful lens for this. Future perspectives and recommendations for using 3+30+300 jointly with other principles and frames that specifically focus on enhanced biocultural diversity will be presented.

Sensing a Mixture of Reasons for Tree Diversity

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The application of tree diversity principles increases the odds of resilience against pests, climate extremes, and other factors affecting tree survival and growth. This is where the conversation often stops with tree diversity. But the odds of better spaces and places to live also increases with tree diversity. Cues from landscape design demonstrate how people like patterns, but they prefer seeing differences in textures, colors, and forms. A diverse landscape palette also brings increased positive response to see and hear through our for our auditory and olfactory senses. Heck, diversity also brings greater odds to place our bets of something to taste or touch in the urban forest. Day One of UTD5 presented us many ways to measure, plan, and manage the urban forest. This talk will illustrate the why, it's all about people, as we continue our fifth conference on the tree diversity topic.

Ten principles to help maximise ecosystem services from urban trees

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Towns and cities are complex, constrained environments that are challenging for trees to establish and thrive within. Therefore, policy makers and those engaged with the management of green infrastructure need to ensure that the ecosystem services, promised by advocates of the urban forest, are realised in practice.

This presentation provides a straight-forward framework of ten principles that will help funders, stakeholders, policy makers, managers and practitioners ensure that they are maximising the impact of trees in their urban environment.

The ten principles are:

1) Promote health and vitality in existing tree stock
2) Make provision for large trees
3) Establish ecosystem service priorities
4) Minimise disservices
5) Select trees to thrive, not just survive
6) Diversify strategically
7) Actively manage risks
8) Foster tree supply chains
9) Focus on equity of greenspace provision
10) Focus on establishment, not planting

Each of these principles will require subordinate strategies to aid delivery, but their inclusion in urban forest policies will greatly enhance the quality, impact and resilience of the urban forest for generations to come.

An ethical approach to tree management to meet new challenges

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Abstract

Human's relationship to nature has changed in the short turn of a few thousand years. In the past, direct dependence on the environment, whether more or less "wild" (hunting/harvesting) or "domesticated" (breeding/agriculture), required knowledge based on the understanding of rules and needs which govern the life of both plants and animals. Of this today very little remains; deprived of daily relevance, such knowledge and skills are now lost or relegated to a residual folkloric marginality. From a cultural point of view, however, it is a process dominated by anthropocentrism. For centuries man has placed himself at the centre of creation; the animal and plant worlds, considered intrinsically "inferior" were therefore subservient to the well-being of humanity.

More recently, tree conservation is justified because of their ecosystem services. These services, however, are translated into a universal language through their monetisation; the maintenance and protection of the tree are justified only to the extent that they allow a direct or indirect "gain" for the human community. In an industry in which the technical knowledge necessary for the good management of trees is now available, it is important to take an ethical step: to give dignity to the trees and to ensure compliance with and respect for them, regardless of their relationship with humans.

The ethical attitude applied to trees implies the recognition of their "otherness", that is the acceptance of their peculiar relationship with space and time. Trees - modular, resilient and self-cycling living beings - can aspire to a condition of ideal immortality, or an extremely extended longevity compared to our animal experience. Longevity, when associated with its being sedentary, makes us realise that the tree is no longer a simple organism, but is a 'place', hence an ecosystem. An ecosystem whose richness is directly proportional to the degree of ontogenetic evolution of the tree itself.

At the same time, when linked to cohabitation with human beings, longevity becomes *transgenerationality*, understood as the tree's capacity to acquire a cultural and identity value, expressible as a narrative witnessing capacity of human events.

In recent years, in Italy, attempts have been made to restore an equal relationship between trees, others living creatures (animals, plants, fungi, bacteria and viruses) and humans in anthropized contexts, based on the adoption of decalogues for the protection of trees both as ecosystems and as cultural milestones, inspired by the principle of contracting: tree specimens are welcomed in cities because of the ecological, environmental, aesthetic, compositional and cultural benefits that they ensure. In return, they are guaranteed inalienable rights. One of the most effective applications of this approach allows limits, opportunities and exceptions to be established during tree risk assessment campaigns by educating citizens to live together with what we call "acceptable minimum risk."

Reporter: a mobile app for citizens' monitoring of urban tree health

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Citizen science is defined as the voluntary involvement of people in scientific research, monitoring and management, which has been gaining prominence in urban forestry, with more citizens increasingly engaging in data collection for urban tree inventories and tree health monitoring. In particular, the widespread use of smartphones has offered new opportunities in the field of citizen science, contributing observations in real time and improving the connection of the reporters with urban trees and relevant living environments. A mobile app (i.e., Recorder) is designed for the Sino-European CLEARING HOUSE project. In a trial across three key cities in China (including Beijing, Shanghai and Guangzhou), citizens are invited to report their observations about urban tree health and their preferences for trees' benefits. This presentation will synthesize results of this trial focusing on the quality of data collected and the motivation of participants, and distill recommendations for further mobilizing this app to enhance public participation in urban tree management.

Urban Forest Policy and its Role in Limiting Urban Tree Diversity

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Urban tree supply chains are complex, involving growers, designers, landscapers, developers, and urban foresters, all of whom shape the species available on the market. As urban foresters, it can be tempting to blame other industries for the market's continued reliance on a limited palette of commonly planted species. While decisions made in nurseries or design studios do impact urban tree diversity, ignoring the role urban foresters and urban forest policymakers play in this issue hinders potential improvements and removes agency from urban tree managers. In this presentation, we will draw on focus group results from three different studies to identify common policies and practices that urban foresters can change to increase species diversity. Furthermore, we will recommend actionable steps toward creating a more resilient urban forest.

Tree Nurseries: The missing link in achieving diversity

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Abstract

It is now widely accepted that tree diversity in urban tree populations is essential if those populations are to be resilient to the challenges of the future which include climate change and the increased movement of pest and disease across continents.

Those planting trees are increasingly looking for a wider palette of species to choose from to achieve that diversity while under increasing pressure to plant greater and greater numbers of trees.

This presentation will challenge the 'numbers game' and suggest that numbers alone will not achieve the desired resilience and diversity. It will question the lack of long term strategic planning for urban tree populations and then look at the implications for the tree nursery industry having to meet the demand for a greater number of species to be available against a policy framework which is invariably short term.

The presentation will look at the challenges for the nursery industry in terms of what to grow, how to grow it and in what numbers with reference to particular species. It will also suggest that there is a 'chicken and egg' situation in what comes first, should the nursery lead and gamble in producing new and different species or should the lead come from consumers requesting new species. The presentation will also explore and suggest that there needs to be a long term collaboration between the two if a satisfactory outcome is to be achieved.

Charting the Future of Urban Tree Management: Lessons from Diversity and Technology

Johan Östberg Nature Based Solution Institute/The Tree Office. johan@tradkontoret.se

Building on the insights and innovations shared in previous Urban Tree Diversity Conferences, this keynote presentation will chart a course for the future of urban tree management. As urban areas face intensifying climate challenges and rapid population growth, the role of comprehensive and dynamic urban tree inventories is more vital than ever. By leveraging cutting-edge technologies such as remote sensing, data analytics, and GIS mapping, we can significantly enhance the accuracy and effectiveness of urban tree management practices. This presentation will also underscore the importance of integrating tree species diversity within inventories to mitigate climate risks and support resilient urban ecosystems. Reflecting on the progress made in past conferences, this session will explore the next steps in urban forestry, offering a forward-looking perspective on how to transform urban tree inventories into powerful tools for securing the health and sustainability of our urban forests.

TOPICS

TOPIC 1

USING TREE DIVERSITY TO MITIGATE RISKS FROM A CHANGING CLIMATE

Can physiological traits of juvenile trees really indicate stress tolerance in mature urban trees?

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It is widely agreed that tree diversity promotes resilience of urban forests under a changing climate. However, selecting a range of species that can tolerate stresses of future urban climates is challenging. Current approaches often use functional traits and provenance variation to screen and select suitable tree species. These studies are often made on young trees, assuming that they can represent the stress tolerance of mature trees. Whether the traits measured for young trees are good predictors of the traits and tolerances of mature trees is a key question to urban foresters and tree nursery industry.

This research provides fundamental information to support urban tree selection and resilience to future climates, by investigating whether the functional traits associated with drought tolerance are the same for mature urban trees and for seedlings grown from seeds collected from these trees. In total, 29 common urban tree species (from 12 genera, 6 families) are included in this study of Melbourne street trees. The mature trees were approximately 12-14 years old and the seedlings were 15 months old at the time of trait measurement. Six functional traits were measured, including leaf osmotic potential, degree of leaf succulence, specific leaf area, leaf dry matter content, stomatal density and leaf minimum conductance (g_{min}). This g_{min} trait is leaf water conductance when all stomata are closed or partially closed. Trees with lower g_{min} values generally retain water better under stress, thus surviving longer under prolonged drought.

Some traits varied greatly amongst species and between seedlings and mature trees (e.g. g_{min}), whereas other traits varied little (e.g. degree of leaf succulence). Mean g_{min} was 2.84 (mmol m^{-2} s^{-1}) in seedlings of *Eucalyptus melliodora* but increased up to 13.48 (mmol m^{-2} s^{-1}) for mature *E. melliodora*. This change suggests E. *melliodora* is less drought tolerant as a mature tree. In contrast, a few tree species (e.g. *Lophostemon confertus* and *Melia azedarach*) demonstrated lower g_{min} in mature trees as compared to seedlings, suggesting they become more drought tolerant in maturity.

Data analysis on results reveals ontogeny (age) has significant impact on certain functional traits related to environmental stress tolerance of studied tree species. This is valuable information for future species selection for urban forests aiming for diversity and resilience under climate change.

Growing a Diverse Resilient Urban Forest - Minneapolis Tree Planting Guidelines

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The loss of ash trees (*Fraxinus*) to Emerald Ash Borer was a major opportunity to establish a more diverse and resilient urban forest. This generational opportunity was not squandered. Learn how Minneapolis used thoughtful, deliberate, multi-scaled tree selection guidelines to select a diverse mix of trees, even with considerations for future forest pests and a changing climate.

This session will cover the specific planting guidelines that have and continue to be used to shape the Minneapolis Urban Forest. It includes a discussion of the goals used to shape the guidelines and how the guidelines have evolved over time. The session outlines how the guidelines are being applied across various urban forest tree populations (street trees, parkland trees, and woodland trees). These guidelines are applied by referencing tree inventory data at multiple scales (city, neighborhood, block segment, and park). Species selection is essentially limited based on the existing Genera level diversity that exists in each area. As Minneapolis has been recovering from losing ash trees in the face of Emerald Ash Borer, this replanting strategy has been successfully establishing a rich level of diversity in a relative short amount of time. This establishing forest is more resilient to future conditions and impacts.

Participants will understand how increasing urban forest diversity improves urban forest resilience. Learners will be able to analyze populations to assess guideline development needs. Resource managers will be able to apply diversity guidelines at multiple spatial scales to achieve the benefits of resilience as broadly and specifically as possible.

Growing Resilient Trees and Urban Forests Through Standards of Care

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Abstract

Should you or Shall you do something? Terms have meanings and Standards with actions lead to positive tree outcomes. Shall suggests something you must do. While should suggests a recommendation that while not mandatory is really something you should have a good reason to explain why you did not take action. This talk will delve into standards of care with trees throughout the world and their importance to promote resilient urban forests. Many standards exit with a basic premise to best grow and care for tree populations throughout the world's urban forests. These standards vary from their use to promote safety for tree care practitioners, to standards that promote the development of trees used to plant urban green spaces, while other standards promote the care of existing tree populations. And frankly proper arboriculture is a basis for healthy and resilient urban forests. In particular, this talk will focus on the process used to develop and promote the American National Standards Institute (ANSI) A300 Tree Care Standards. We will first identify a brief history of these standards and how they evolved over the past 30 years. Then the presentation will address the commonality of incorporation by municipalities with their integration into their tree care operations. We will address further how a specification creates a detailed plan of action that helps promote safe and healthy and ultimately resilient tree populations. Finally, we will focus on how and why a voluntary tree care standard has become common in the development of tree care specifications within the United States and other locations. To close, the presentation will suggest policy ways to better take a tree care standard to promote it's practice and regularity with use.

Impact of Monoculture on City of Johannesburg Urban Forest and the use of indigenous trees to mitigate climate change

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Abstract

The City of Johannesburg has claimed to be one of the largest man-made urban forest in the world, with between six and ten million trees, and estimated 3 million trees are in open public space. City of Johannesburg was a savannah grassland and, after years of planting the n orthern suburbs of the city resemble that of the rain forest. Due to increasing temperatures, pests and diseases have increased in CoJ and threatens the urban forest. One of the major pest *Euwallacea fornicatus* PSHB was first reported in the City of Johannesburg in 2018. It was discovered that trees in the old Northern suburbs of Johannesburg were highly affected by the PSHB and other tree diseases. One of the objectives of the study was to map tree species affected by PSHB and this led to identification of monoculture practices in CoJ.

5793 trees were counted and mapped in old suburbs of Johannesburg, and it was found that there is limited species diversity planted on open public spaces. If was found that exotic species make up to 98% of the tree species. *Platanus* spp has the highest number of trees (52.4%), followed by *Jacaranda mimosifoila* (30.2%), *Quercus* spp (8.7%) and *Acer negundo* (4.6%) respectively. Other various tree species were (4,1%). In greening of Soweto, 200 000 trees were planted and tree withdrawals were analysed it was noted that 93% of the trees planted were four (4) main species, which is *Combretum erythrophyllum* (31%), *Celtis* africana (30%), *Olea africana* (16%) and *Searsia lancea* (16%) and 7% was represented by other species. This presented a risk on urban forest being wiped out in case of severe pest outbreak such as PSHB. *Platanus* spp, *Quercus* spp, *Combretum* spp and *Acer* spp are reproductive host of PSHB, and most of these species are dead and some severely dying back. High temperatures, drought and severe weather conditions have accelerated the tree decline, thus altering landscape of urban forest, especially large exotic trees (Oak trees, Maple trees and London planes).

The findings has led City of Johannesburg to revise list of trees that must be planted in CoJ, which is 80% indigenous trees. initiatives of tree planting with communities have been promoted to redesign the urban forest, especially on previously disadvantaged areas. CoJ between 2016 and 2023 has planted 73153 ornamental trees and distributed 12339 fruit trees. CoJ has prioritized trees that are hardy and can be able to survive harsh conditions. Furthermore, CoJ is promoting fruit tree planting as part of the campaign to mitigate the risks of climate change and build resilient urban forests and food security.

Adapting to change in urban forestry: A comparative assessment of growth dynamics and physiological responses to drought in *Quercus robur* and *Acer pseudoplatanus* from different Italian provenances

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Abstract

Although the selection and use of different provenances within a single tree species is an established practice in forestry, the same cannot be said for urban forestry. Therefore, the purpose of this work, through the setting of two experimental trials, was to i) assess the growth, physiology and phenology, during the entire vegetative season, of northern, central and southern Italian provenances of two species widely used in urban contexts across Europe, *Quercus robur* (five provenances [Lombardy, Piedmont, Tuscany, Umbria and Campania]) and *Acer pseudoplatanus* (four provenances [Lombardy, Piedmont, Campania and Calabria]); ii) test if the provenance influences the species physiological response to drought stress and subsequent rewatering.

In our study, we observed a significant impact of provenance on phenology, and on the final height and biomass, encompassing both root and aerial components, particularly evident in the *A. pseudoplatanus* species. With regard to *A. pseudoplatanus*, plants from the Lombardy site showed better tolerance to drought stress and recovery than other provenances. For the *Q. robur*, plants from the Umbria site tolerated drought stress better than other provenances. This research contributes to informed decision-making, policy development, and landscape planning efforts aimed at enhancing the resilience and ecological functionality of urban green spaces by elucidating the mechanisms underlying the performance of different tree provenances.

Rethinking Urban Tree Diversity: Beyond Santamour's 10-20-30 Rule. A case study from Camden, London

Kenton Rogers Treeconomics

In the realm of urban forestry, the significance of a diverse tree-scape cannot be overstated. Amidst the well-known Santamour's 10-20-30 rule, which advocates for specific percentages of species, genus, and family in municipal forests, a critical gap persists—particularly in understanding the nuanced dynamics of dominance diversity.

This presentation takes a transformative approach by placing a spotlight on Hubbell's Dominance Diversity Curves, providing a fresh perspective on urban tree diversity for effective climate change adaptation and risk management.

While Santamour's rule has undoubtedly contributed to enhancing urban forest diversity, there exists a dearth of empirical evidence evaluating its efficacy on a global scale across varied climates and land uses. Amidst this gap, we redirect the spotlight to Hubbell's Dominance Diversity Curves, questioning whether this alternative methodology could offer a more comprehensive understanding of urban tree diversity.

Acknowledging the limitations of traditional metrics based on sheer numbers, our exploration extends beyond Santamour's numerical guidelines. Instead, we delve into the nuanced realms of leaf area and basal area, redefining how we measure and interpret urban tree diversity.

Central to our discussion is the evaluation of various methodologies for assessing tree diversity, with a keen emphasis on Hubbell's Dominance Diversity Curves. By leveraging The London Borough of Camden's tree stock as a case study, we unravel the intricacies of this approach. Our presentation serves not only as an exposé of alternative metrics but as a practical guide for applying Hubbell's Dominance Diversity Curves in benchmarking tree diversity.

Accessible to all equipped with a tree inventory system and spreadsheet software, these methodologies transcend proprietary constraints. Join us in this exploration to magnify the role of Hubbell's Dominance Diversity Curves in reshaping our understanding of urban tree diversity.

Discover how this approach contributes not only to effective risk management but also to fostering resilient urban forests in the face of climate change challenges.

Urban Tree Risk Assessment for Landscape Trees in Urban Estates of Hong Kong

Allen Zhang Technological and Higher Education Institute of Hong Kong

Detail tree species, key structural and physiological defects, tree dimensions, growing habitats and planting site conditions in selected sampled public housing estates (PHEs) in Hong Kong were assessed. The results showed diverse planting of 202 species from 56 families, with most species beset by multiple defects. The health and structure of two dominant tree species, *Acacia confusa* and *Ficus microcarpa*, were respectively influenced by inadequacies and stresses in planting environments, such as inclined surface of disturbed slopes, small pits and planters with poor soil quality, and soil not shielded by groundcover vegetation. Some tree defects of twigs, branches and trunks were associated with tree dimensions, especially tree height and its unnaturally high ratio to crown width and DBH. The findings verified the importance of a species-specific analysis to optimize urban-tree management and maximize benefits to the society.

How Climate Crisis affects trees in Historic Gardens: The case of National Garden in Athens Greece

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Abstract

The National Garden, one of the first public gardens of modern Athens, is located in the heart of Athens' city center. Its planting began in 1839 and it covered until 1852 a total surface area of 15,4 hectares. The National Garden constitutes a great example of the 19th-century landscape architecture (in the English style), with meandering paths and views open to the surrounding landscape and antiquities. Many indigenous tree species were initially planted, transferred from different parts of Greece, such as *Quercus ilex, Cupressus sempervirens, Ulmus campestris, Platanus orientalis,* but also a great number of exotic plants were introduced in the Garden, eg *Washingtonias, Livistonia chinensis* and other ornamentals like *Melia azedarach, Koerleuteria paniculata, Schinusmollis*.

The historic plantings of the National Garden are those made during the first decades of its creation and form the backbone of the Garden, giving great ecological value, enhanced biodiversity characteristics and a special bond between the Garden and Athen's present and future.

During the last few decades there has been extensive drought, longer summer heat waves, more extreme and frequent snow, wind and rain and longer vegetation periods in the entire region of Attica. All the above, form a new and altered environment that affects, among all living creatures, the tree populations both in natural and urban environments.

The impact of the climate crisis to heritage gardens, is exceptionally significant. The potential risk of accidents is higher, the stress on heritage trees is very high and, in many cases, it results in loses of important historic trees.Diseases and pest attacks have also increased (the global commerce and commuting also plays an important role), a higher cost of maintenance is demanded and loss of income has been noted as gardens have to be kept closed due to safety reasons for many days per year.

To adapt to the effects of climate crisis and in order to offer adequate time to the historic tree population of the National Garden to adjust to this new norm, numerous actions need to be taken at all levels:

- documentation regarding the biodiversity within the National Garden and how it influences its functions,
- professional tree inspection and maintenance, especially for individual heritage trees and/or damaged trees, due to extreme weather phenomena,
- implementation of a replanting program, that takes into consideration both the original design and the tree shape that need to be protected, but also the new environmental conditions,
- implementation of soil improvement activities and disease and pest management programs, to enhance and improve tree health in all their population,
- use of new technologies (drones, geodata, and others),
- staff training,
- an increase of funding and public awareness regarding the importance of the tree population in the National Garden and all its current challenges.

Many of the above actions have already been started and are funded in various ways: donations, green funds, the Garden's own resources. The effort needs to be continued to ensure the resilience of the National Garden and ultimately preserve its original architectural concept and preserve it for the future through a changing and unstable environment.

TOPIC 2

NOVEL APPROACHES TO URBAN TREE SELECTION

Visual assessments of street tree vitality contradict vulnerability estimates based on climate envelope analysis

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Tree species selection for future urban climates is currently often based on past tree performance, climate envelope modelling or plant traits for stress tolerance. The use of arborist tree vitality (health) assessments for cities that represent future climate analogues has been proposed but not well investigated. In this study we use street tree composition in four cities: Manningham and Bendigo in Victoria; Wagga Wagga and Parkes in New South Wales. These four cities represent a 700 km aridity gradient along which we are able to compare predicted tree health from climate envelope modelling with the observed tree vitality from arborist visual assessments.

Street tree species diversity decreased along this aridity gradient and the proportion that exotic trees represented increased in more arid cities. As expected, trees that originate from warmer climates were planted in the more arid cities, but their climate safety margin also decreased. A tree with a small safety margin is at the edge of its known climate distribution and likely to be exhibiting signs of stress, poor growth or poor vitality. However, the tree vitality scores from arborist visual assessments were similar along this aridity gradient and counterintuitively the least healthy trees occurred in the least arid city. There were 18 tree species that occurred in all four cities and there was no significant difference in their vitality scores along this aridity gradient.

Our data suggest that visual assessments of urban street trees amongst climate analogue cities can provide a valuable tool for future tree species selection. Analysing tree vitality scores along climate gradients can directly assess tree performance under potential future climates. This has advantages over the more theoretical assessment of climate envelope modelling approaches, that may over-predict the climate vulnerability and vitality limits of urban tree species.

Why the need to diversify our urban forests? lessons from the natural forests

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There are more and more calls for diversifying our urban forests to make it more resilient to increasing disturbances to climate change and exotic pests and diseases. The scientific basis for this call for diversification is in fact well established from more than 30 years of research done in natural ecosystems. A new ecological field has actually emerged from this research: Biodiversity-Ecosystem Functioning or BEF for short. In this talk, I will review the history of BEF research from both grassland and forest ecosystems and point out the mechanisms and approaches that have been developed in natural ecosystems that are pertaining to urban trees and forests. How can mechanisms of facilitation and complementarity be used in urban forestry? How can the principle of the assurance hypothesis be useful to better plan for urban trees?

How can we use functional traits to make better decision on what tree species to plant? Being more cognizant of the many ecological mechanisms at play in a diversified urban forest will help researchers and practitioners develop new approaches and tools to make this diversification more efficient.

Criteria for the Selection of Urban Tree Species with Low Allergenicity

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Abstract

Traditionally, the criteria used for the selection of urban trees have considered climatic tolerance, adaptability to urban environmental conditions, water requirements, resistance to pests and diseases, and aesthetic value, among others. The provision of a wide range of ecosystem services has been another of the factors recently taken into account when incorporating species into urban green infrastructure elements. However, some important disservices associated with ecosystem functions have not had the same consideration. This is the case of allergenic pollen that many species emit during the flowering period. These allergenic substances can have an impact on the health of a high percentage of the urban population, with emissions from tree species that form urban forests being the main causes of this problem.

The extensive use of a low number of species in the different types of urban forests, the introduction of exotic specimens, the globalization of species, the limited supply of species in the nursery catalogues, the lack of knowledge of the reproductive biology of plants, the discrimination of fruit-producing female specimens and the obtaining of species resistant to pests and diseases and of great ecological breadth, which allow them to survive in very different bioclimatic conditions, have caused a uniformity in the so-called urban vegetation, and, in parallel, a rise in respiratory diseases associated with the presence of allergenic pollen in the air.

Given the new challenges that cities must face to minimize the impacts of climate change, increasing green areas and urban trees are identified as one of the most efficient measures. It is therefore time to incorporate the allergenicity criterion among the conditions to select new species for urban forests and other elements of green infrastructure. The alteration of current climatic conditions in many territories may represent an opportunity to include in new nursery catalogs tree species whose allergenicity in origin does not have an impact on the health of the local population, whose floral phenology is not altered by a change in climatic conditions and above all, an opportunity to increase the specific, morphological and functional diversity of urban trees as a measure to reduce the enormous sources of allergen emissions that currently exist.

SylvCiT: An urban forest diversification software to improve resilience to global change

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Abstract

The importance of urban tree diversity for improving resilience is increasingly understood by decision makers. Urban foresters want to prevent the overrepresentation of species on their streets and in their city, which could result in a significant loss of canopy cover in the event of a large-scale disturbance such as a drought or an exotic pest or disease. Although numerous software and tools exist to visualize tree inventories and plan tree maintenance work, only a few offer support for increasing tree diversity.

We present SylvCiT (sylvcit.ca), an open-source and decision-support software designed to analyse urban forest characteristics at multi-scales and recommend diverse tree species from different functional groups. These groups are composed of species with similar values of traits such as seed mass, specific leaf area, drought tolerance, flood tolerance. While the first interfaces of SylvCiT provide the user with a spatially explicit portrait of the urban forest (species richness, functional group diversity, structural diversity) and associated ecosystem benefits (stored carbon, ornamental value), the tool is designed to produce a list of functional groups and appropriate species to plant considering neighboring trees.

Based on optimization and machine learning algorithms, SylvCiT identifies the types of trees that are absent or less abundant to make recommendations that increase diversity to improve resilience to global change. SylvCiT is a multidisciplinary research project involving ecological sciences (ecophysiology, ecohydrology, soil biodiversity), climate sciences (urban heat islands) and computer science (artificial intelligence). For instance, we are currently testing different machine learning approaches to predict tree growth and integrate these predictions in SylvCiT to improve recommendations and estimate ecosystem benefits over time.

Eco-Efficiency of Urban Woody Species: CO_2 Assimilation, Sequestration, and Particulate Pollution Capture in European Cities

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Abstract

The research investigated the ecological contributions of several urban woody species in Rimini, Italy, and Krakow, Poland, focusing on their CO_2 assimilation, sequestration, storage, and particulate pollution capture capabilities. In Rimini and Krakow, 1712 trees of 15 species were studied for their CO_2 assimilation efficiency and PM accumulation across various crown sections and seasons. Findings reveal species variations in CO_2 assimilation and PM accumulation, with species like *Platanus x acerifolia* and *Quercus robur* exhibiting high CO_2 assimilation rates, and *Quercus ilex* and *Pinus nigra* showing notable PM accumulation capacities. While land use (park or street) did not consistently affect CO_2 assimilation, specific management practices could impact individual tree CO_2 assimilation. Moreover, PM accumulation trends varied between cities, influenced by rainfall and wind conditions. These insights offer valuable guidance for urban planners aiming to enhance air quality and sustainability through strategic tree selection and management practices.

Species-specific crown allometry for regulating growing space requirements in mixed species urban areas

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Promoting tree species diversity in urban areas and forests is considered one adaptive strategy for increasing their resilience in the face of climate change. Greater tree species diversity involves managing species mixtures and, therefore, requires suitable management tools that support decision-making by urban foresters. Tree crown size is an important tree trait in urban areas, as it is linked to the tree's growing space requirements and several functions and services, such as cooling effect by shading, carbon sequestration, or pollution mitigation. In this study, we analysed tree crown projection area- tree diameter allometry for several forest tree species commonly used in urban areas in Spain, as a first tool for selecting tree species and managing species mixtures. We used sample trees of selected species from the Spanish National Forest Inventory to explore their variability in tree crown allometry. By using quantile regression, we determined the upper (quantile 95%), middle (quantile 50%), and low (quantile 5%) allometric relationships, which are associated with tree growing under low, medium, and high tree density conditions. For each species, we provided the crown allometry plasticity by the ratio between the upper and lower quantile of the crown projection area for a reference tree diameter (25 cm). The upper allometric relationships may be a reference for urban trees growing isolated. The middle relationships may represent the reference allometric pattern for urban trees growing in groups or stands. Additionally, we introduced the growing space equivalence coefficients between species, which allow for consideration of species-specific growing space requirements when mixing species. These tools will facilitate the design and management of more diverse urban forests.

Surviving extreme meteorological events: The role of botanical collections in evaluating meteorological disruptions in urban forests: A case study from Montes Arboretum, Technical University of Madrid

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Abstract

Extreme meteorological events can significantly impact urban forests, particularly amidst the expected exacerbation of climate anomalies within current climate change scenarios. Here, we focus on assessing how such events affect urban forests in a university arboretum (*Arboreto de Montes*), emphasizing the crucial role of botanical collections in monitoring their effects.

A notable example under study occurred during the winter storm in Madrid in January 2021, which brought heavy snowfall followed by an extended period of intense cold (known as the 'Filomena' storm). These extreme conditions caused considerable damage to trees in urban areas of Madrid and other cities in central and eastern Spain. This fact underscored the need for effective strategies to assess and manage adverse effects.

Analyzing the data reveals a wide variety of affected taxa, including both common and rare species found in Madrid's urban forest. Damage included branch breakage, trunk bending, uprooting, and cold-related injuries. Notably, species like the stone pine (*Pinus pinea*) and Arizona cypress (*Cupressus arizonica*) experienced the most significant damage.

This study highlights the critical role of botanical collections in evaluating the effects of extreme meteorological events on urban forests, especially in monitoring rare species. Some of these species may have broader applications within the city in the context of climate change, as they adapt to warmer and drier conditions. By providing detailed data on the magnitude and nature of damage and recovery, these collections facilitate informed decision-making for the future management and conservation of urban forests.

Assessment of the ecological status of trees for controlling air pollution with particulate matter in the cities of Armenia

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Abstract

The services provided by the urban trees may decrease the climate-ecological, social, and health risks. In the urban environment, air pollution is regarded as the main environmental risk for human health and one of the air pollutants most harmful to human health and the environment is particulate matter (PM). Vegetation as a natural phytofilter means of removing environmental pollution and absorbing large quantities of toxic substances from the environment.
Ambient air pollution issues are actual in Armenia's cities. The current conditions of the green areas of the Armenian cities (Yerevan, Gyumri, and Vanadzorr) do not meet the expected requirements of the climatic-ecological development of urban areas: in almost all cities of Armenia, greening spaces were reduced as a result of the energetic default and economic blockade of the RA of the 1990s. The reduction of green spaces led to a drastic deterioration of the environment.

This article highlights some results of research on the study of urban parks and streets implemented during 2021-2024 in the cities of Yerevan, Gyumri, and Vanadzor, which have different climates and geographic conditions. The main research goal was a comparative study of the accumulation of particulate matter by urban greenery. For PM measure was selected the most widespread tree species in the studied cities in the summer: in Yerevan Platanus orientalis and *Quercus robur*; in Gyumri *Fraxinus excelsior* and *Tilia caucasica*; and in Vanadzor *Aesculus hippocastanum* and *Acer pseudoplatanus*. The ecological status of trees was assessed through visual observation. Significant accumulations of Particulate matter (PM) were found in the tree species of all the studied cities, but in the streets and parks, PM accumulated the most in the leaves of the *Quercus robur* tree species in Yerevan, which speaks of the high ecological burden of the capital and the resulting health risks of the national population. In these cities, PM levels were higher in street plantations than in parks. The natural-climatic and ecological conditions of the cities of Armenia were studied and the ecological status of trees was assessed by selecting a visual observation and leaves sampling of trees to measure PM capture of the cities of Armenia was carried out. All studied tree species have a high potential for PM absorption, demonstrating strong phytofilter properties. Therefore, they can be effectively used in their typical climatic zones and included in street plantings, gardens, and parks. It is necessary to reconsider the present types and add more sustainable, decorative types adapted to arid conditions, which follow the provisions of the Paris Agreement (for instance, the Cotinus, some types of the Sorbus, and the Elaeagnus, the Tamarix, such shrubs as the Sambucus). Obtained results can lead urban planners and policymakers to make intelligent decisions about urban greening initiatives to improve air quality and overall well-being.

Tree selection and urban biodiversity in urban forests

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Biodiversity protection is the basis for maintaining the health, stability and functional ecosystem. Whether the urbanization areas with frequent human activities need to protect and restore biodiversity, and whether the city can become an ecological home which are harmonious coexistence between man and nature (including some animals, birds, insects who are environmentally friendly, healthy and safe etc.).

What is the effect of urban biodiversity on regional biodiversity conservation and restoration and ecosystem health?

What specific measures should be taken from the perspective of urban forest ecosystem construction?

This paper introduces the main research and specific progress of urban biodiversity in Beijing, Shenzhen and other cities carried out by the Urban Forest Research Center , National Forestry and Grassland Administration in recent years, including: The variation of butterfly diversity in Beijing city park along with the urban gradient revealed the spatial variation of butterflies for 26 species, indicating that the urbanization gradient had negative effects on butterfly diversity, but good forest structure helped to reduce this effect.
The annual variation characteristics of bird community in Shenzhen urban forest were found to be related to forest species composition, vertical structure and canopy density. Shenzhen urban forest bryophyte diversity is relatively rich, 48 species of trees are attached to 29 species of trees, orchards can also provide a good habitat for moss.

Finally, from the perspective of maintaining the integrity and functionality of the urban ecosystem, the restoration strategy of the whole ecological chain of urban biodiversity based on understanding, establishing and maintaining the ecological relationship is discussed. Combined with urban forest construction, some strategies and suggestions were put forward, such as optimizing urban forest network, using native plants, retaining near-nature forests and wetlands with low human disturbance, maintaining biological corridors between adjacent large habitats, and strengthening the restoration of local biodiversity.

Towards More Uniform Reporting of Urban Tree Diversity in Urban Forest Management Plans: Introduction and Pilot Use of the Tree Diversity Reporting Index in Michigan, USA

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Abstract

In recent years, it has become a growing priority to establish and maintain resilient urban forests. This has been motivated, in part, by significant tree loss following varied pest and pathogen infestations, and in part, due to concerns regarding urban tree survival in changing climatic conditions. Plans for urban forest resilience are rooted in principles of urban forest biodiversity, begin with comprehensive inventories of urban tree cover, and are often laid out in urban forest management guidance documents. However, there are no universal standards with which this inventory data is presented in urban forest management plans (UFMPs), making it challenging to assess urban forest biodiversity and resilience within and among municipalities. We developed a new tool – the Tree Diversity Reporting Index (TDRI) to assess the comprehensiveness with which tree diversity is reported in UFMPs. TDRI values were quantified based on the presence or absence of 7 key tree diversity metrics in UFMPs, with values ranging from 0 to 7. We conducted content analysis of accessible municipal-scale UFMPs in Michigan, USA (n=37) to calculate their respective TDRI scores and determine the extent to which they reported tree diversity. TDRI scores ranged from 0 to 7 across the state ($\mu = 4.16$). Species composition, condition rating, and size were the most commonly reported metrics, while condition rating per size class was reported least frequently. There was significant variability in how species, size class, and condition rating were reported, the latter of which was often done so with the absence of clear definitions of each of the assigned classes. Findings are intended to promote adherence to a more standardized system for reporting tree diversity across UFMPs, so as to facilitate more scalable long-term assessments of progress in achieving tree diversity goals outlined in UFMPs, and to do so across jurisdictional boundaries.

TOPIC 3

EMERGING TECHNOLOGIES AND THEIR ROLE IN URBAN FOREST MANAGEMENT

Urban Forest Values: Integrating I-Tree Model and LiDAR Technology for comprehensive assessment of tree values in historic gardens

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Abstract

Recent advancements in forestry technologies, particularly the Handheld Mobile Laser Scanner (HMLS), have revolutionized urban forest planning by providing enhanced access to crucial tree structure features. LIDAR technology quickly captures detailed 3D models of trees, facilitating non-destructive biomass quantification in forestry, a feature highlighted by Pérez-Martín et al. (2021) in surveying monumental trees for green space inventories in preserving cultural landscapes. Urban forestry provides various benefits, contributing to the well-being of cities, their residents, and the environment. It plays a vital role in mitigating urban environmental challenges like high temperatures and CO_2 levels, providing shading and enhancing air quality, as emphasized by Xie et al. (2023), who highlight the need for detailed urban coverage, down to individual trees, for comprehensive quantification of urban forest functions. I-Tree software is widely used in urban planning for estimating the ecosystem services of trees. Technologies like LiDAR enable the creation of high-resolution, 3D maps of tree structures, allowing for precise data on canopy density, height, and biomass. Additional biometric information, such as land cover, total tree height, crown size and LAI further enhances the model's accuracy on I-tree software. Recent advancements in LiDAR technologies allow for better-informed decision-making in urban planning and landscape design, maximizing the ecological benefits of urban green spaces (Sharma et al., 2024).

Integrating technologies like LiDAR with ecosystem service assessment tools such as the i-Tree software allows for the evaluation and monetization of tree values. In this study, twelve monumental *Ficus macrophylla* subsp*. columnaris* trees were selected from various historical gardens in Palermo, Sicily. This tree characterized by expansive canopies and develops aerial prop roots from its branches, which thicken into additional trunks upon reaching the ground, providing extra support for canopy weight. Non-destructive field measurements with HMLS enabled detailed tree surveys.

The I-Tree software used in this case study evaluates these urban monumental trees, quantifying tree benefits and the value of trees in urban areas through suitable software tools. The methodology extrapolates information on tree shape and overall conditions, creating 3D tree models to compute tree metric variables such as diameter at breast height, total height, crown basal area and wood volume. These provided biometric data on above-ground tree parts for monitoring tree health, growth, biomass, and carbon sequestration. This research addresses a notable gap in existing studies by using LiDAR and the i-Tree model to offer insights into sustainable urban forest ecosystems, especially for monumental trees and this species. The study's insights into carbon dynamics for each Ficus tree have significantly impacted decision-making by providing a data-driven framework for management of historic urban gardens to Palermo. If local community has been involved in a future awareness-raising events, the process can lead to better decision-making by incorporating local knowledge into management preserving the benefits of historical landscapes. Engaging the community in decision-making can also foster a sense of ownership and responsibility, leading to more well-maintained tree resources (Kim *et al.,* 2024). Integrating LiDAR technology with ecosystem services assessment tools maximizes urban monumental trees' benefits, enhancing decision-making for urban planners and researchers.

Sonic tomography and chlorophyll fluorescence, the ability to test a tree's structural and physiological health relevant to biotic and abiotic stresses during practical tree care operations

Simon Stratford Stratford Tree Surgery LLC

Our climate is changing faster than our trees can keep up. As urban areas Chlorophyll Fluorescence determines the photosynthetic capacity of a tree by assessing its health and vitality. This technique is used to detect physiological damage caused by biotic or abiotic stress factors well before visible symptoms manifest themselves.

Sonic tomography uses sound wave technology to determine the structural compaction degrees of woody fibers through the cross-section of a tree. Early detection of the separation of these fibers will, depending on the position and degree of compromise give strong indications of canopy loading pressures on what may now be a weakened structure.

We use both tools in the everyday practical application of generalized tree care to help us better understand how invasive pathogen can move through woody fibers and present dramatically different results over a short period of time and or monitor a tree's ability to remain within a landscape. The analysis of this data invariably provides the primary steps before moving into the various skill sets demanded from trained pruning.

The presentation will include real time data/photographic evidence of repetitive time lapsed Sonic tomography scans and chlorophyll fluorescence data to help the audiences better visualize and understand how to utilize this technology in the urban environment and to better interact with a client base by explaining why and how the proposed work on targeted trees is required and what the longer-term consequences of these actions will contribute to overall health.

Different areas associated with the arboricultural industry have long sought a reliable, portable, and non-invasive method for detecting and measuring internal decay within living trees. Sonic tomography, as a tool for advanced technical tree safety inspection, realized its development potential in 1999 using sensors situated around a cross-sectional area of the tree where the starting and arrival times of sound waves passing through the wood could be detected.

The images provided by the sonic tomography testing area are created virtually from the speeds detected and measure the elasticity or not of the woody fibers using the path of least resistance between the sensor points as determined by the three principles ways in which wood is laid down namely, axially, radially, and transversely. The images do not directly correlate to density or any other material property of the wood within the deteriorated parts. The location of damage within the cross-section of the tree scanned is more important in terms of strength loss than the size alone. The earlier detection of ring-shake decay, "where early-wood of one or more rings is decayed causing separation of two late-wood zones by degrading the early zone between" (Rinn, 1999), provides a typical example of the necessity to correctly identify what the images provide in relation to this possible loss of strength. Here, the center part of the cross-section is separated from the outer part of the stem and is, therefore, unable to transmit stresses within that cross-section under differentials in loading regardless of the condition of the wood in the center. This is particularly important under exceptional wind-loading conditions. Unlike resistance drilling, sonic tomography became the only non-invasive method whereby this type of decay could be potentially identified. The development of Picus SoT and ERT have made it possible to more accurately determine whether the introduction of decay organisms is an active part of the structural changes of elasticity and density in the wood of the scanned cross-section. In addition to the Picus toolkit, we now utilize AdBian AI loading analysis with 3D scanning coupled to sonic tomography. This modeling allows the 3D scan to assess additional outer perimeter wood, including tree root flares, not captured during the sonic tomography scan. The AdBian software, by assuming decay of the nearest wood assessed by the scan, uses sectional modulus calculations to provide us with loading statistics throughout the tree's trunk stem from kilonewton pressure exerted by the canopy from different directions. In this way, we are better able to analyze what, if any, modifications are required to the canopy so that loading forces can be reduced at the critical points being assessed by both software suites. Before any work is undertaken, chlorophyll fluorescent testing is carried out on leaf samples to determine the physiological health of the tree. There is a two-fold purpose for this procedure, and that is to firstly determine the general physiological health of the tree prior to any reduction work and secondly, to "learn" the tree's ability to create additional trunk biomass so that the sectional modulus ratios can at least be maintained. Our monitoring of this is achieved with repeat scans through the same sensor points in twelve-month intervals, where the overlaying images give us an intuitive idea of the progression and direction of the decay initially detected.

i-Tree and STEW-MAP as tools for effective and participatory management of the urban forest: Case study from Medellín, Colombia

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Abstract

Knowledge of the structure and benefits of the urban forest is important for the formulation of management strategies for this resource in cities. Likewise, identifying the stakeholders involved in its care and protection is vital for successful management. The U.S. Forest Service (USFS) has developed two tools that facilitate the evaluation of these ecological and social factors.

One of the tools is i-Tree, a suite of computer programs that analyses the urban forest and estimates its current and future ecosystem services. It evaluates, among others, the health condition of the urban forest, quantifies carbon storage and sequestration, air pollutant removal and avoided runoff, as well as its monetary value. It also identifies tree species that optimize ecosystem services in time and space to enhance human health and well-being.

Another tool, Stewardship Mapping and Assessment (STEW-MAP), shows which organizations care for the environment, natural resources, and green spaces; and, where they work and how they interact with each other. STEW-MAP obtains information about community groups and organizations implementing environmental stewardship in their areas. It identifies which organizations are strong, and which require further support and opportunities to involve them in urban forest management and protection.

The presentation will focus on the use of these tools for strategic urban forest management, since it provides data for informed decision making that promotes optimal tree design and planting, and participatory management of urban forests. In this way, it seeks the improvement of the condition of the urban forest, the environment, and the quality of life of citizens, as well as valuing its importance and promoting its protection, conservation, and improvement by different stakeholders.

The IT system for managing the urban greenery resource in Wroclaw and delivering open data of urban trees to inhabitants

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Wrocław Municipal Greenery Authority (ZZM) in Poland launched IT system for managing urban greenery resource in the city recently as the effect of the co-funded by EU project called *Implementation of system for managing urban greenery resource in Wrocław: e-platform Greenery in Wrocław - stage 1*. ZZM is responsible for maintaining greenery in Wroclaw: parks, squares, municipal forests and green areas along streets – almost 2900 ha which covers 9,8% of the city area. There is also municipal agricultural land under ZZM management. The project aims to improve resource management and communication with citizens, contractors and other stakeholders by providing selected data on the geoportal and serving e-services.

Electronical services include:
- e-notification – anyone can send information about a problem in a green space,
- e-arrangement – via which ZZM gives directives on external investments in municipal green spaces,
- e-land lease – it enables reaching an agreement on leasing agricultural land plot,
- e-contract update,
- e-opinion – it gives community councils a possibility of giving an opinion on trees indicated for felling,
- e-survey – via which ZZM can collect opinions from inhabitants on various topics as part of consultation proces,
- e-route – it is a separate on-line map with propositions of walking, biking and running routes through green spaces of Wroclaw.

Open geoportal shows all the inventoried trees in areas under care of ZZM, with basic info about them, as well as all recreational and sport facilities available in these spaces. The system supports processes: greenery maintenance (including: caring for, felling and planting trees), recreational facilities' management, leases of agricultural land plots and external investments arrangements. Project included also purchasing equipment, dendrological inventory of over 40,000 trees and the information base of objects under care of ZZM. Goals of the project are:

1. Facilitating and improving residents' contact with local government unit;
2. Increasing safety in green areas by improved management of trees;
3. Green spaces promotion through interactive application and geoportal;
4. More efficient and pro-eco management of green areas through precise ordering and control of works;
5. Collecting and sharing open data.

Independently, the City Hall is the Partner of LifeCoolCity project co-financed by the EU within LIFE program. Its aim is to manage environmental problems through Blue Green Infrastructure and Nature Based Solutions. It will i.a. allow to manage the presence, quality and biodiversity of trees in the city. One of the outcomes will be open data of all trees in Wroclaw in form of the canopy map after the system based on machine learning will sort out any inaccuracies.

3-30-300 and the Metrics of Urban Forestry's Future

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Abstract

Our ability to measure urban tree canopy has evolved. New technologies have improved and expanded the insights provided by canopy assessments, such as higher frequency updates, faster analysis, and higher resolutions. The benchmarks we use to guide urban forest management must evolve too.

This presentation will review promising advancements in urban tree canopy data and the opportunities for new urban forest quality indicators. One such indicator is the 3-30-300 rule, which states that every citizen should be able to see at least three trees from their home, have 30 percent tree canopy cover in their neighborhood and not live more than 300 meters away from the nearest park or green space. The presentation will discuss how canopy data ties into new urban forest metrics, can be connected to social and health benefit goals, and provide a demo of how software can track and analyze how well a city meets the 3-30-300 rule to inform urban forest management.

Adapting Urban Canopies: Enhancing Tree Diversity Through Smarter Tree Inventories in a Changing Climate

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Our climate is changing faster than our trees can keep up. As urban areas continue to expand and climate change accelerates, the diversity of urban tree populations becomes crucial for ecological resilience and urban well-being. This study focuses on the pivotal role of tree inventories in promoting and maintaining tree diversity in dynamic urban environments. I will explain advanced tools and methods, such as remote sensing, i-Tree, and smart tree inventories, which enable precise monitoring and strategic management of urban forests.

Key topics will include:

- The application of smart tree inventories for identifying species diversity and performance, crucial for adapting to and mitigating the impacts of climate change.
- Proven strategies for increasing species diversity through informed selection and placement using i-Tree & urban tree canopy analysis to enhance ecological resilience against pests, diseases, and environmental stresses.
- Samples from recent case study cities that have leveraged these technologies to optimize their urban forestry efforts, illustrating the tanible benefits of increased tree diversity in urban landscapes.

We will demonstrate collaborative models involving government agencies, tech innovators, and community groups, showing how integrated efforts can lead to more robust and diverse urban forests. The output will be actionable insights on using the latest technologies to foster a resilient urban tree canopy that is better equipped to face the challenges of a rapidly changing climate.

Revolutionizing Urban Forest Management through Smart Tree Inventories and Artificial Intelligence

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As urban areas expand, the management of urban forests becomes crucial for environmental sustainability and public well-being. The integration of Smart Tree Inventories (STIs) and Artificial Intelligence (AI) presents a transformative opportunity for urban forestry. This study shows the advancements in STIs, which utilize geospatial technologies and remote sensing to accurately catalog and monitor urban trees. We have already rolled out this technology in 50+ cities worldwide, where these innovative inventories provide comprehensive data on tree species, health, tree structure, and environmental contributions. We are able to obtain a detailed overview, currently capturing 41 tree parameters (with more on the way) that traditional methods cannot match.

Furthermore, we will show how AI leverages this data to enhance decision-making processes. Through predictive analytics, AI can forecast potential disease outbreaks, assess risk from aging tree populations, and optimize planting and maintenance schedules. Case studies from different cities show how these technologies have been successfully implemented, showcasing significant improvements in efficiency and resource allocation.

In conclusion, the future trajectory of urban forest management will be linked to how smart technologies and AI not only streamline operational tasks, but also enhance the ecological integrity and resilience of urban landscapes. The implications for policy-making, urban planning, and community engagement will be discussed, emphasizing the need for a tech-driven approach in the stewardship of urban green spaces.

Urban Tree Health Monitoring through Satellite Imagery and Machine Learning: An Integrated Approach to Enhance Urban Forestry Management and Environmental Sustainability

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Abstract

This research introduces an innovative approach to urban tree health monitoring by leveraging high-resolution satellite imagery from ESA-Sentinel-2 and cutting-edge machine learning techniques. Urban trees play a pivotal role in enhancing the environmental quality and public health within city landscapes. Traditional methodologies for gauging tree health are typically laborious and constrained by limited spatial coverage. Addressing these challenges, our study devised a machine learning model grounded in the deepforest algorithm, adept at pinpointing urban trees and quantifying their canopy extents using Google Maps imagery. Through the acquisition of spectral band data (B3, B4, B8) from Sentinel-2, we determined the Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI) for each identified tree. These indices shed light on the photosynthetic activity and water availability of the trees, respectively. A temporal evaluation of these metrics enabled us to trace health trajectories and pinpoint distressed trees, facilitating focused management actions. Beyond surpassing the constraints of conventional assessment methods, our methodology offers enriched insights for urban planning and environmental management strategies. The study not only confirms the precision of satellite-derived assessments against terrestrial observations but also underscores the transformative potential of machine learning and remote sensing technologies in redefining urban forestry management. Significantly, this research has culminated in the creation of a complimentary service for citizens (MyTreeSOS), allowing them to monitor the health status of their trees. This development represents a substantial stride towards engaging the public in urban forestry conservation efforts, promoting a proactive stance in the maintenance of urban green spaces.

TOPIC 4

HARNESSING OPEN DATA AND CITIZEN ENGAGEMENT TO SUPPORT URBAN FOREST MANAGEMENT

A cultural-historical activity theory approach for multiple stakeholder engagement for urban tree planting in low-cost housing areas of South Africa

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Abstract

Low-cost housing areas (LCHAs) in South African urban areas typically face several barriers to the planting of trees, which are often exacerbated by the various institutional and systematic socio-economic, socio-cultural, and socio-political dynamics that shape everyday realities in these neighbourhoods. Beyond the institutional and technical governance measures that need to be implemented for the effective establishment and governance of urban forests, a myriad of ways to advance urban forestry goals, including community outreach and involvement exist. The aim of this study was to understand how, in the face of persistent barriers to urban tree planting in LCHAs, multiple stakeholders can contribute to improving the status quo of a lack of trees through the design of a participatory learning approach for tree planting.

Three case studies were conducted in three small towns in the Eastern Cape, South Africa. Using the cultural-historical activity theory (CHAT) as an analytical framework, focus group discussions with residents, local and provincial government officials, and non-governmental organizations were employed to elicit a more qualitative understanding of barriers to tree planting in LCHAs in the first stage of the inquiry. In the second stage, tree planting awareness events, and the generation of activity systems (AS) for all cases to identifying contradictions and tensions, representing opportunities for development and transformation for the design of a sustainable participatory learning process for tree planting in LCHAs, were conducted.

Key results indicate that food security is an important consideration for urban tree planting in LCHAs, and residents lament on their exclusion in the decision-making regarding tree planting. The AS for participatory urban tree planting in LCHAs have three emergent characteristics, namely, AS as a unit of analysis, multi-voicedness, and historicity of AS. Coupled with the dynamics of the daily realities prevalent in LCHAs, these themes account for why tree planting is more than digging holes and planting trees but requires certain levels of stakeholder engagement while navigating a system where tree planting is barely a priority.

The themes highlight the multi-voicedness, dynamism, agency, and historical legacy of LCHAs in relation to urban tree planting that has historically been perceived as a practice for the elite, and residents were able to exercise a certain level of agency and power by participating in decision-making for tree planting during tree planting and awareness activities.

The multi-voicedness may account for why some initiatives reached a certain degree of implementation while others did not. The analysis of surfacing contradictions revealed the value of designing context-specific interventions for urban tree planting in LCHAs and engendered a better understanding of the processes that may affect the success or failure of tree planting initiatives, including how stakeholders, their power, and actions affect such initiatives. Incorporating fruit and indigenous trees to food gardens can improve the prospects of tree planting in LCHAs, and strong collaborations between communities, and the departments and entities involved in the development of LCHAs can facilitate this.

Radical Arboreal Engagement: More-than-human community engagement in urban forest planning, design and management

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Everyone has a story to tell, and as Donna Haraway aptly puts it, it matters who tells the story. Most research on inclusive urban forests and urban green spaces focuses on how we can implement distributive justice and procedural justice for human citizens, i.e. ensuring the urban forest is physically accessible and that people can participate in the citizen participation processes of urban forest planning, design and management. However, we bestow urban trees and other more-than-human beings with very limited self-determination. What if we redefine urban trees as arboreal citizens rather than green assets – granting them a voice and a seat at the table? How can radical arboreal engagement foster more-than-human community engagement in urban forest planning, design and management?

This presentation builds on ongoing PhD research, exploring intersectional environmental belonging in urban forests. The intersectional environmental approach recognises that we are more than our age, ethnicity, health, or social background, and that we are part of nature. Collaborative place-based storytelling sessions help recover the interconnections between more-than-human beings, giving voice to historically marginalised perspectives, and exploring intersecting identities in and of the place itself.

In this interactive presentation, I will demonstrate how urban forest planning, design, management and governance can incorporate more-than-human agency. A range of case studies and examples is introduced based on Sherry Arnstein's 'Ladder of Citizen Participation' (1969), showcasing the potential of arboreal citizen participation to support fair, inclusive, healthy and resilient urban forest planning, design and management for all beings.

Empowering Urban Forest Management: Insights from Civic Engagement and Data-driven Strategies

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Abstract

Urban forest management poses a significant challenge, involving tree inventorying, care, and monitoring in city environments, necessitating substantial expertise. Nevertheless, urban trees provide immense ecosystem services to city dwellers. Environmental education programs play a vital role in fostering civic engagement, leading to active participation in essential stewardship activities for urban tree preservation. The Healthy Trees Healthy Cities (HTHC) initiative offers a robust framework for civic involvement, providing crucial insights into urban tree health through its mobile application and web-based dashboard. These insights empower urban forestry professionals to prioritize attention to trees most in need. Specifically tailored for non-experts, the HTHC app has proven its utility among municipalities and neighborhood groups across the United States.

In this presentation, we will share experiences from engaging high school students in Wisconsin, USA, and more recently, at the American International School of Barcelona, Spain. Drawing from literature in education, we emphasize the significance of robust training protocols, particularly in using rubrics for accurate assessment. Ensuring consistency among raters, akin to practices in evaluating student literacy, is paramount. We propose a comprehensive training protocol for raters, including project objective introduction, pre-training on tree health rating, guided discussions on observable factors, rubric introduction, collaborative scoring sessions for expectation normalization, blind scoring exercises, and error analysis discussions.

We will explore the practical usability of the collected data by urban forest management professionals, illustrating how it informs strategic decisions, enhancing urban tree resource stewardship. Our insights underscore the pivotal role of civic engagement and robust data analysis in ensuring urban forest vitality and sustainability.

Lastly, we will discuss how this tool addresses other Urban Tree Diversity Conference themes. We will explore its potential in selecting tree species to mitigate climate change risks, such as sea level rise and saltwater flooding in New York City. Additionally, we will consider its application in selecting tree species suitable for urban heat island areas. Moreover, we will discuss how the methodology supports emerging remote sensing technologies by providing calibration or validation data.

Forestami, a project of cultural dissemination in Milan metropolitan area

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Abstract

Forestami is a project born in 2018 by a research of the Polytechnic of Milan with the aim of planting together 3 million trees by 2030 in the Metropolitan City of Milan and increasing the tree canopy cover. At the same time, the quantitative objective is supported by social and cultural aims, such as nourishing a civic and cultural evolution on the crucial role of nature in the metropolitan territory, spreading and sharing commitment against global warming and involving citizens, communities, institutions, private companies in a collective project for a common objective.

Urban forestry, cultural dissemination and citizen engagement are the key points of the Forestami project.

Since the beginning, Forestami has drawn the attention of the 3 million inhabitants of the entire metropolitan area. Everyone can contribute to this collective challenge with different resources and actions: through donations for the project development and directly participating in the activities proposed by Forestami.

To trigger this physical, environmental, and cultural change, the project aims to imagine a new "ecological way" of thinking by reconsidering forests and nature as a fundamental element in people's minds and, from a spatial point of view, in the public and collective structure of our cities and landscape.

For this purpose, cultural dissemination aims to involve different targets and audiences, spread values, benefits, opportunities and perspectives of urban forestry to different levels of society and build networks and alliances.

Since 2018, 59 intervention sites have been created directly with Forestry funds, equal to 58.500 new trees and shrubs. From the design to the creation of the new urban woods, **social cooperatives and other territorial stakeholders** are involved, engaging different social and cultural situations through various initiatives: collective planting activities, *Scuola Forestami, Forestami Academy, and Custodiscimi*.

Scuola Forestami and Forestami Academy aims to integrate the Forestami project implementations with environmental education through activities involving schools, institutions, and public citizens with a participative approach and experiences on the field organized with different workshops.

Custodiscimi is one of the main projects that has collected up to now 5000 participants in two editions. This project involves citizens, public bodies, associations, and private companies to raise awareness and re-involve citizens in our green heritage's care, implementation, and maintenance, activating different levels of society and building collaboration networks.

To build the network of 'caretakers' that custody forest plants for about eight months, different hubs in the metropolitan territory were created to organize the plant delivery activities.

Plants were "lent" to citizens with the agreement of giving back healthy plants that afterwards became part of the Forestami project's intervention in the metropolitan complex and articulated forestry system. Citizen participation plays a crucial role in increasing biodiversity awareness and contributes to the broader vision of the sustainable development of the territory. The challenge is to disseminate the forest value, explaining to people the difference between planting a single tree and creating and designing a new forest.

These initiatives promote a network of active realities and players to stimulate volunteer and free cooperation among citizens, institutions, and public administrations. A common effort for a common purpose.

Engaging residents, community groups and smaller municipalities to help them green their open spaces and start to build better urban forestry programs from the ground up

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Abstract

Engaging residents within an urban forestry program should be a cornerstone of any program. However residents engagement varies across the world in terms of its success or even its existence.

In the UK Urban Forestry Programs engagement with residents is on the whole very poor and hollowing out of Local Government during the austerity years means many soft skills to engage with the public has been lost along with staff.

At the same time urban forestry professionals have often been sidelined from crucial decisions meaning in many cities residents have lost faith in their programs. The most prominent of these in recent years has been in Sheffield and also Plymouth where programs of tree removal have met with protest, municipal governments issuing injunctions against residents and even looking to send residents to jail for trying to protect their trees.

This presentation will look at work from a number of case studies from across the UK where residents and local groups have worked to try and plant trees in their neighborhoods. It will look at some of the challenges they have faced, from mind boggling "municipal processes" to a lack of trained staff within municipalities, and also skepticism around the need to engage or even that if trees planted will survive.

Eliciting Information from Diverse Citizens to Build a More Inclusive Urban Forest: What young adults preferences can teach us about tolerant greenspaces

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The voices of young adults (15–24) ring faintly in the conversation around urban forest preferences and citizen needs. This absence results in a lack of both procedural and distributive justice in the provision of urban forests. Urban forests shape young adults — including their connections with nature, engagement in pro-environmental behaviours, and social and psychological health — but the dramatic reshaping of urban areas via rapid growth, densification, and technological innovation means today's young adults have fewer opportunities to benefit from urban treed landscapes.

In a potentially vicious cycle, this shortfall can result in a weakened sense of connection with nature, leading to less time spent in natural environments and fewer sustainable behaviours. Achieving justice for young adults requires understanding their preferences, clarifying relationships between urban forest characteristics and use, and translating research into evidence-based design.

This presentation fills these gaps by summarising interdisciplinary knowledge regarding the impacts of contact with nature on the development and well-being of young adults; describing case studies conducted in formal parks located in Australia's largest cities of Sydney and Melbourne to clarify connections between our existing knowledge and the real-world provision of NBS; and applying these findings to develop an appraisal framework comprising three primary attributes — order, diversity, and seclusion and retreat — that supports the design and integration of urban greenspaces that uniquely benefit young adults' social development and mental health. Finally, we explore the framework's implementation, demonstrating its utility and flexibility for urban planners, municipal policymakers, and natural-resource managers seeking to advance intergenerational equity.

Community Outreach: The Heritage Oak Project

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Nicole Stuart, Duntemann Urban Forestry

A project to identify and map the large-diameter, pre-European settlement oaks that resided in one neighborhood of Oak Park, Illinois USA provided the foundation for conveying the importance of these heritage trees to the community. The oaks provided an opportunity to engage the residents of Oak Park to better understand species diversity and the community's role in providing stewardship for antiquity trees. The project was separated into four phases: Survey, Mapping, Analysis and Outreach.

Survey – A walking survey of the neighborhood containing all of the large-diameter (50 mm+) oaks was conducted. Approximately 180 trees were identified on both public lands and private residential properties.

Mapping – A letter was sent to all of the private property owners describing the project and seeking permission to access the property to map the trees and collect basic data (species, diameter, condition, etc.). Approximately thirty of the landowners gave permission. A team was deployed to GPS the trees on private and public lands. Seventy-eight trees were mapped.

Analysis – The mapped trees were compared against Federal land survey maps from the 1830's that delineated broad vegetation systems. All of the mapped oaks coincided with a *Quercus/Carya* woodland area identified in the 1831 map.

Outreach – A series of public events were presented to inform the property owners and residents on the significance of these remnant trees and the stewardship role they play in preserving these trees.

Native species were historically underused by the Village, however the last few decades as seen a marked increase in their use throughout the community. Their planting has increased species diversity in the community and have become a significant component of the landscape.

Growing the Stonehouse Community Arboretum

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The Stonehouse Community Arboretum is a long-term environmental and social project based in Stonehouse, Gloucestershire, in the UK.

It is not a conventional arboretum, but rather it includes all of the trees on public and private land in the urban and rural parts of Stonehouse. Its focus is not on tree planting, but tree establishment – and it puts the emphasis on the importance of preserving and enhancing our existing trees as well as planting new ones. Ultimately its aim is to create a diverse collection of trees, responsibly and sustainably planted and cared for, which will deliver a wide range of benefits to the Stonehouse community and encourage people to visit the town. The arboretum is there for everyone – for all parts of the community and for current and future generations.

The Stonehouse Community Arboretum has a management plan which has been featured in a number of best practice guidance documents, and is delivered by the Town Council and a dedicated community group – the Friends of Stonehouse Community Arboretum. In summer 2024 it was recognised with formal accreditation through the international ArbNet Arboretum Accreditation Programme (Level I).

In this talk, John Parker – Chief Executive Officer at the Arboricultural Association and the founder of the Stonehouse Community Arboretum – will present this case study of public and political engagement in tree care, one in which arboricultural professionals and volunteers work together to improve the lives of citizens through trees.

POSTERS

Food source trees provide adequate foods for birds in residential areas

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Abstract

Aims: Urban areas can provide important habitats for birds. Residential green spaces can play an important role in urban green spaces and may provide valuable resources for urban birds. Food diversity and quantity can be one of the factors that could be limiting bird survival. Therefore, by considering the food preferences of birds, this study aims to determine the relationship between birds and their food sources in Beijing residential areas. Furthermore, this study seeks to determine what factors may influence bird feeding behavior in residential areas.

Methods: Forty residential areas were selected as survey plots and surveyed monthly from June 2020 to May 2021. Shannon-Weiner diversity index was used for evaluating bird diversity, and the distribution was defined as the numbers of residential areas where birds fed. A generalized linear model was used to evaluate the influencing factors of bird feeding in residential areas, and linear regression was performed on the diversity index, abundance and the distribution of bird feeding sources.

Results: (1) The feeding behavior of 2,242 birds (35 species, 14 families) were recorded. We observed that bird richness was at its highest in spring, followed by autumn, winter and summer, then abundance was at its highest in spring, followed by winter, autumn and summer, and the Shannon-Wiener diversity index was at its highest in autumn, followed by spring, winter, summer. (2) A decrease in food sources was observed in the following: insects (33.87%), samara (18.33%), berries (9.77%), cones (8.16%) and grass seeds (5.17%). (3) The direct utilization of plants by birds was 60.4%, while the indirect utilization was 39.6%. The Shannon- Wiener diversity index of food source plants decreased in autumn (3.1612), winter (2.9651), spring (2.9203) and summer (2.1763). (4) The species of food source was the most critical environmental factor that determined birds feeding behavior in residential areas. Birds with more abundant food sources had larger populations and wider distribution ranges.

Conclusion: Plant species in residential areas can be highly diverse and can offer a wide range of food sources for multiple species of birds throughout their entire phenology between the early spring and autumn. It is necessary to plant more native tree species and fruiting plants, reduce hedgerows, and advocate near- natural management measures with low disturbance.

Sésame, a decision support tool for tree planting in urban areas

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In the face of climate change and ecological emergency, cities need to adapt and become greener in order to remain liveable for all.
What and where to plant? These questions are complex and there is no one-size-fits-all solution. Sésame (Services ÉcoSystémiques rendus par les Arbres, modulés selon l'essence - Ecosystem services provided by trees, modulated according to species) helps local authorities' technical departments make the right choices in terms of species and planting locations.
Used upstream or as a complement to project-based expertise, this tool aims to raise awareness of the importance of ecosystem services provided by plants in urban areas.

Initially developed by Cerema, the city of Metz and Metz Eurométropole, Sésame is based on a compilation of multiple data on services provided, environmental constraints and requirements of a large number of species, varieties and cultivars of trees, shrubs and climbing plants. So far, the database includes more than 500 plant species (mostly trees). This data is cross-referenced with field data and feedback from management departments, providing input to tackle landscape constraints and issues.

The tool takes the form of a web app. Firstly it is necessary to describe constraints and the specific conditions of the project. Ultimately, it suggests a range of appropriate species.

The process is built around an algorithm based on criteria that are clearly explained in a technical and scientific manual that comes with the tool. It is obviously not a magic formula but a source of inspiration, to be confronted with other points of view.

Besides helping in the choice of species, the tool offers advice on the organisation of planted elements in the urban area, on their layering and maintenance. Sésame also helps to strike the right balance between exotic and local species.

Sésame has been rolled out a dozen or so times throughout French cities and conurbations (Libourne, Angoulême, Paris, Angers, Bordeaux métropole, Grand Lyon métropole) and in more extensive urban areas (Seine-Saint-Denis and Bouches-du-Rhône). The tool is systematically adapted to the local climate and the specific issues of each local authority in partnership with all local stakeholders.

The website is progressively updated with variations of the Sésame tool:
https://sesame.cerema.fr

Enhancing Ecosystem Services and Urban Sustainability Through Tree Diversity in Malaysian Street Landscapes

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Street trees play a vital role in urban environments by providing essential ecosystem services such as improving air quality, reducing urban heat island effects, and managing stormwater, while also mitigating climate change through carbon sequestration. Malaysia's long history of urban greening, starting with the planting of *Pterocarpus indicus* in 1778, has led to significant progress, notably Kuala Lumpur City Hall's 1973 initiative, which rapidly transformed the city.

This paper presents a practical framework for selecting street trees in Malaysia, aligning with spatial, functional, and sustainability needs suitable for different urban hierarchies in Malaysia. Current guidelines, like the National Park Landscape Guideline are adapted to local conditions to ensure efficient use of urban spaces. Our study recommends adjustments to street tree assemblages to optimize the use of limited urban spaces and resources, promoting a sustainable and resilient urban forest.

A carbon evaluation of 50 native species, conducted with the LICOR 6400XT, revealed 16 trees with high photosynthetic rates, led by *Sterculia parviflora*, *Podocarpus polystachyus*, and *Cananga odorata*. Environmental factors like temperature, sunlight, CO2 availability, and soil water content influence photosynthetic efficiency, while tree size, growth rate, and leaf structure do not. These findings contribute to better-informed decisions for tree selection, promoting urban sustainability and enhancing environmental benefits.

Exploring the potential of new technologies for low cost inventory of urban trees

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Abstract

Trees and urban green areas are necessary components for delivering healthy, sustainable and liveable cities as they can improve the quality of life in urban areas by reducing temperatures in summer, removing pollutants from the air, reducing flooding and increasing biodiversity.

Urban planning and the managing of public street trees according to social, economic and impactful climate scenarios is challenging. Legislation on these topics stresses the need to conduct and update tree inventories in order to foster a city's sustainability. However, to support the management of trees and green infrastructures municipalities need data about composition, diversity, size, geolocation and tree status, and as such, trees need to be monitored regularly. Environmental benefits provided by urban trees have been quantified in recent years using software on empirical equations developed by experts based on data from information from inventories.

Recent Portuguese legislation (Republic Diary No. 59/2021) imposes that all municipalities prepare a complete inventory of the urban trees in both public and private domains of the municipality. Even so, several municipalities did not gather yet this information, which could lead to non-compliance with current legislation, mostly because these efforts are time-consuming and costly.

Previous work carried out about structure and diversity in urban areas of Lisbon, Cascais and Almada, showed the species richness and abundance in these areas and also that the leaf area is the key variable for estimating the environmental benefits of trees in the studied municipalities. Leaf area changes with season, with tree condition and with management. As such, a system that can combine, simple field work with LIDAR data that incorporates the contribution of leaves in the tree crowns, can respond to the various requirements to estimate most environmental benefits and to have updated tree structure information.

The goal of this study is to explore the potential of new technologies for low cost inventory of urban trees status in Lisbon old gardens in order to provide data to the municipalities about diversity and environmental benefits. This will support the management of their trees and green infrastructure in order to increase their resilience to climate change.

Sustainable Urban Forestry: Niterói's Success Strategies

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With more than 55,000 trees and approximately one tree for every 8.13 inhabitants, the Municipal Government of Niterói stands out in the Metropolitan Region of Rio de Janeiro as a local government that understands trees as fundamental elements for city planning. As a result of advancements in this field, in 2024 the municipality was recognized for the third consecutive year with the international Tree Cities of the World award, granted by FAO and Arbor Day Foundation.

Among the various initiatives developed regarding the management and planning of urban forests, two of them demonstrate great relevance: the Arboribus Project and the Notable Greens Project. Jointly, these projects are responsible for promoting healthier public spaces, mitigating climate change, and enriching local biodiversity by prioritizing nature-based solutions.

The Arboribus Project consists of a detailed mapping of Niterói's urban trees, where teams assess its dendrometric characteristics through a floristic census, which allows to percieve a general parameter of the city's tree canopy, both in terms of diversity and interaction with the environment in which they are inserted. After tabulating and analyzing the data, safety protocols are created, prioritizing the recovery or replacement of individuals that require specific management and/or pose risks.

In addition, the Notable Greens Project advocates for the strategic introduction of native species from the Atlantic Forest adapted to public streets, squares, and urban parks, aiming to mitigate potential future conflicts, correct historical planning deficiencies, and debunk the conception that trees and urban infrastructure are incompatible. Among the chosen species are those with characteristics compatible with the urban environment, such as Paubrasilia echinata (Lam.) Gagnon, H.C.Lima & G.P.Lewis and Poincianella pluviosa (DC.) L.P.Queiroz.

Over the years, the combined implementation of these tools has resulted in the planting of 752 seedlings per year and the replacement of 276 trees that posed conflicts and risks to the population. In this sense, it is fundamental to highlight the importance of the complementary and synergistic approach, responsible for strengthening the efficiency and impact of actions aimed at urban tree canopy in the municipality. Niterói witnesses a significant transformation in its public

Comparing the summer ultraviolet radiation characteristics in the shade of 3 urban forests based on human health effects

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Abstract

Ultraviolet (UV), primarily ultraviolet B(UV-B) radiation, has multiple biological effects on human health, and urban forests can provide residents with a moderate UV radiation environment.

In order to understand whether there are inter-species differences in UV radiation characteristics in canopy shade, diurnal spectral irradiance measurements in the open and below grove canopies of 3 native tree species in Beijing, Chinese scholartree (Sophora japonica, SJ), goldenrain tree (Koelreuteria paniculate, KP) and Shangtung maple (Acer truncatum, AT), had been taken in summer using a portable fiber spectrometer. The results showed that:
(1) the ratios of UV radiation in shade to which in the open (Shade Ratio, SR) were 0.03—0.1. There were significant differences in UV irradiance between different grove shade at the same time period. AT grove had the lowest shade ratio with a range of 0.03 to 0.05 compared to the range of 0.03—0.09 for KP grove, and 0.07—0.1 for SJ grove;
(2) significant consistency in shade ratios of the three groves were found at each wavelength. Shade ratios in UV-B band was not as low and stable as it was in the UV-A band, which indicated that the tree canopy had a stronger effect on UV-A radiation screening than UV-B. The proportion of UV-B radiation in total UV radiation(UV-B/UV) values in shade were generally higher than that in the open, with the highest in AT grove, followed by KP grove and the lowest in the SJ grove;
(3) the canopy significantly changed the spectral waveform of both daylight vitamin D production spectrum weighted UV irradiances (UVVD) and erythema action spectrum weighted UV irradiance (UVer), but the spectral curves in different grove shade were similar. In terms of intensity, the ratios of UVVD/UVer were 0.84—1.27.

The mean value of the ratios were 0.99 for SJ grove, 0.95 for KP grove, 0.98 for AT grove and 1 for which in the open, with no significant differences between 3 groves; (4) the diameter at breast height (DBH), diffuse non- interception (DIFN), mean tilt angle of the leaves (MTA), leaf area index (LAI), leaf transmission, and other features of tree species or structural characteristics of the canopy, could affect the intensity of UV radiation in grove shade. But the UV radiation spectral waveforms and the positions of the peaks and valleys within different groves were generally consistent, indicating that there were no significant inter-species differences in UV light quality between groves.

Methodology for optimal species selection in the urban forest

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The selection of the optimal species for each location of a city is a crucial task to ensure a resilient and quality Urban Forest that maximizes the Ecosystem Services it provides to citizens.

In this sense, we present a methodology for this selection of a basic management tool, adapted to the specific needs of each city and species based on five criteria:

• Climate, the different components of the climate condition the correct development of plant species.
• Potential Disorders or problems on infrastructures and people as allergies, dirt or interference, improving the efficiency of urban forest management.
• Availability in nearby tree nurseries. A tree that is already in similar growing conditions to the city where it will be located will have higher probability of success. This translates into cost and management savings.
• Environmental needs of the species. Evaluating its specific cultivation requirements in order to propose it in the best location and thus increase the quality of its development and the benefits of a healthy tree.
• Landscape. The trees improve the entire environment in which they are located, providing color, textures and aromas that enrich the landscape of the city, depending on the characteristics of each species.
• Ecosystem Services provided change depending on the species: the ability to absorb CO2 and other pollutants, water regulation, or improving the quality of life of citizens are some of these services available to citizens who enjoy the Urban Forest in their city.

This methodology, always supported by the latest scientific studies, strategic documents related to the innovative trends in Green Infrastructure Management and based on the best practices and existing guidelines on the subject, takes into account more than 60 characteristics, both quantitative and qualitative, in order to maximize the benefits provided.

In practice, the species selector allows to obtain a numerical score of the suitability of each selected species in relation to each future location of the specimen.

The query can be launched by choosing several factors such as the type of tree (coniferous or deciduous), width of the road, soil compactness and pollution tolerance. The manager will obtain a list of species not only according to the specific characteristics of the desired plantation, but also maximizing the benefits of the ecosystem services it can offer and minimizing future disservices.

Assessment of the health of urban trees based on aerial remote sensing

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Abstract

Tree condition maps were made in four Polish cities: Sopot, Złotów, Jasło and Rzeszów, using aerial remote sensing data. Tree health was modeled on hyperspectral and LiDAR data, with use of reference field measurements done by arborists, as training and validation datasets. Models were trained using machine learning methods and applied to the area of entire cities on the level of single tree crowns. The maps were used to analyze which tree taxa are, on average, in the worst health condition in each city individually and overall in the group of cities. Based on the results, it was indicated which tree taxa commonly found in Polish cities are not resistant to urban conditions in the era of climate change.

Equitable Canopy, Planting Priorities, and Technology

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Abstract

The equitable distribution of trees throughout cities ensures that all residents have access to the multitude of benefits created by urban forests. Tree canopy assessments allow cities to understand their canopy distribution and precisely identify areas with low tree canopy and high planting potential. As our ability to measure urban trees and canopy evolves, so too must the strategies and benchmarks we use to guide urban forest management.

This presentation will demonstrate how cities and nonprofits can apply canopy data to maximize ecosystem benefits where they are needed most, develop citywide benchmarks, monitor canopy trends, and inform management plans. Topics will include a review of modern canopy assessment technology and analysis tools and how those tools support inclusive urban forest management through plans, projects, and policies.

Integration of iNaturalist for enhanced urban forest management: an experience at the Montes Arboretum of a multifaceted approach to data collection and community engagement

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Abstract

iNaturalist - a nonprofit social network and database - has emerged as a powerful tool for documenting biodiversity and supporting informed decision-making. iNaturalist connects academics, naturalists, and researchers worldwide to document observations of the biological world. The integration of iNaturalist into urban forest management represents a comprehensive approach to data collection and community engagement, also offering a multifaceted approach for understanding and enhancing urban ecosystems. Originally conceived as a platform to foster community interaction, iNaturalist has evolved into a resource for monitoring various aspects of urban biodiversity. Here, we showcase the experience from the Arboreto de Montes, highlighting the practical application of iNaturalist in a real-world urban forest setting. Through iNaturalist, users can contribute valuable data on living organisms, ranging from tree development to the emergence of invasive species. By leveraging the platform's capabilities, managers can track the growth and phenology of trees over time, assess trends in biodiversity, and identify potential threats such as invasive species, fungi or plagues. The platform's user-friendly interface and extensive database make it an accessible and efficient tool for collecting and analyzing data relevant to urban forest management.

In addition to its role in data collection, iNaturalist fosters community engagement and participation in urban forest management. Through the platform, users are encouraged to explore and document their local environments, leading to insights into exploration patterns within urban areas. Furthermore, user observations provide valuable information on public preferences, rare species identification and ecological interactions, enriching our understanding of urban ecosystems.

Bioforest: A space for biodiversity and social participation in Villalbilla

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Abstract

The 'Villalbilla Bioforest' is a restoration and environmental dissemination project on a parcel owned by the Villalbilla Town Council (Community of Madrid). This land suffered from high degrees of abandonment, characteristics of the area included: poor soil with abundant construction waste; the flora was sparse and low in diversity; faunal diversity was very limited due to the absence of suitable ecological niches for development; minimal ecosystem services provided; negative social perception of the area, lacking attractiveness for social or educational use.

In response to these circumstances, the idea emerged to develop a restoration project aimed at enhancing biodiversity and adding value to the parcel at all levels. In 2022, the mentioned project was drafted with the following objectives: create a biodiverse urban forest for sustainability and resilience; achieve a healthy and attractive space for Villalbilla residents and promote awareness of the importance of biodiversity conservation in urban forests; enhance the generation of ecosystem services. To achieve the objectives, the following actions have been designed and implemented: To condition a wooded trail that connects the different areas, *Acer campestre* specimens are planted on both sides of the trail. Created Ecological niches:

1. Biodiversity shelters - Alongside a copse of hornbeams, nests for ladybugs and logs are integrated to encourage shelter creation by fauna;
2. Food forest - Simulates a small forest system that will provide various food resources. Some species incorporated: *Castanea sativa* and *Quercus ilex* (both inoculated with *Boletus edulis*);
3. Natural meadow composed of Mediterranean species (sustainable herbaceous ecosystem);
4. Cactaceae zone - Xerophytic species are incorporated to simulate an arid ecosystem;

5. Watercourse - Representation of a small river habitat that will enhance biodiversity;
6. Ornithological garden - Integrated by different shrub species that provide shelter and food for birds;
7. Butterfly oasis - Plantation with a diversity of host and nectar plants for butterflies;
8. Insect hotel - Wooden structure with different compartments that provide shelter and food for various beneficial insects.

Furthermore, participatory activities are being conducted with residents to engage them and ensure the success of the project, promoting the city's transformation towards sustainability and resilience.

Citizen participation process of the Santa Cruz de Tenerife's Green Infrastructure and Biodiversity Plan. Geolocalized social network data and design of public spaces open to citizens using Minecraft

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Abstract

Green Infrastructure Plans are understood as elements of great potential to identify and cohere green spaces and natural systems in the urban environment, planning them to achieve equitable distribution and environmental justice between the urban forest and the citizens. In this sense, the elements that constitute GI include, in addition to a wide range of overlapping and multi-scale assets, from street trees to urban parks, forested areas to playgrounds, as well as the social use and activities that are linked to them.

In order to promote a richer and more interconnected GI network, it is necessary to identify specific elements at the local scale, especially to address issues such as: the distances between green spaces and the population; their size and characteristics; the accessibility of residents to outdoor activity spaces and sports, or the location of surrounding facilities such as artistic, cultural or sports facilities. Precisely these aspects have proven to be decisive in citizen use of GI elements.

The elements of the GI not only refer to physical characteristics, but also to facilities, outdoor activities and user preferences that contribute to a comprehensive understanding of the network as a complex urban-scale network. It is for this reason that a diagnosis has been made based on social network data, considered as voluntary first-hand information about physical elements of the city and citizen preferences in relation to them.

Location-based social networks have been shown to be a valid resource for the analysis of issues related to the management and planning of the city's GI at different scales. In addition, social network data has been found to be a cost-effective source for rapidly measuring parameters and monitoring a wide range of phenomena compared to both traditional field techniques of data collection and official databases of government institutions. Data from 4 social network were analized, identifying on a city-scale map the spaces of citizen interest related to wellbeing, cultural, pets and leisure activities, more used routes of sports activities (running, cycling, walking), all of them of great relevance to detect people preferences and plan strategic actions in the GI of Santa Cruz de Tenerife.

On the other hand, the citizen participatory process has been completed, involving citizens in the design of public spaces through Minecraft. This is an exercise of "imagination" and the objective is to know in a very visual way the perspective and visions that citizens have about urban spaces and their expressions. In this way, the GIP will be able to adapt to the different visions and needs projected by the inhabitants of Santa Cruz through the imagination and creativity offered by Minecraft.

This citizen process was developed through youth and children's summer camps and face-to-face workshops (municipal technicians, cultural and senior centers, open to public stand at the city's May festivities), as well as a website open to citizens in order to collect the designs of real urban spaces of Santa Cruz. 350 citizen projects were collected in the form of designs of spaces freely chosen by each participant on the city map. The most significant were collected as concrete actions of the GI Plan. The people's preferences are framed in a great harmony with the goals and objectives of the GIP, mainly in terms of the naturalization of the city and the sports and leisure use of green spaces.

Spain's progress on SDGs 11 and 13

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Since the First Industrial Revolution, the increase in human activities based on the burning of fossil fuels and deforestation, coupled with the ever-accelerating growth of the world population, has triggered an unprecedented climate crisis. As is being proven, urban environments are the most vulnerable systems to the effects of this crisis, and therefore measures must be taken to mitigate them.

The Sustainable Development Goals consist of 17 strategies that governments must fulfill to minimize the critical issues human development faces. There are different SDGs that are primarily aimed at ensuring the habitability and sustainability of human settlements (SDG 11), and the consequences of the climate crisis (SDG 13).

There is an urgent need to develop strong regulations that protect and promote urban trees and the development of urban and peri-urban green spaces. These green areas, in addition to improving the quality of life in cities, provide essential ecosystem services that help mitigate the adverse effects of the climate crisis: they create carbon sinks, regulate temperature, generate barriers against air and noise pollution, and also reduce stress levels, creating lasting physical and mental well-being for urban inhabitants.

After an exhaustive analysis of different databases, the conclusions of this study are the following: In Spain, the concentration of urban pollutants and CO2 emissions per capita are being reduced, the surface area of green areas in cities is increasing. Progress is being made on SDGs 11 and 13. The main components that we must measure to monitor the SDGs studied consist of ozone concentration, CO2 emissions from the transport sector, PM10 type pollutants and the percentage of green area. In addition to the official SDG 11 and 13 indicators, it is necessary to study other values such as the percentage of the population with access to green surface, the quality of them and the urban NDVI index.

The Role of Universities in Urban Forestry Citizen Engagement: Insights from the European Treetag Campaign

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Abstract

This presentation delves into the essential role universities play in promoting citizen engagement and fostering urban forestry through research, education, and practical demonstration projects. The focus will be on the European Tree Tags campaign, an innovative initiative where universities collaborated with local communities to enhance public understanding of the ecological, social, and economic value of urban trees.

The campaign involved tagging trees with informational labels across various European cities, educating students, citizens on the importance of urban green infrastructure while encouraging their participation in tree monitoring and advocacy. Universities acted as key facilitators, not only by leading scientific research but also by engaging students and community members in hands-on activities, workshops, and data collection iniciatives.

Through the lessons learned from the European Tree Tags campaign, we examine how academic institutions can help build long-term community stewardship of urban forests, enhance environmental education, and drive policy changes that support resilient urban ecosystems.

Delivering thermal school oasis to climate change mitigation strategies by Nature Based Solutions

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Abstract

Cities need to address climate change mitigation through a diversity of multi-scale, multi-agent, and integrative strategies that embrace cities and their environments. This presents a significant opportunity to reimagine the structure of primary and secondary schools, colleges, and universities in urban areas as new contexts for creating cool spots within cities and enabling greenhouse gas mitigation through urban trees and Nature-Based Solutions (NbS).

This research presents a database of urban trees and NbS in school environments across various cities, facilitating decision-making for future replicability. It was found that in 90% of the cases, renaturalization is employed through the strategic incorporation of specific plant species, including trees, shrubs, and climbing plants. The selection of these green elements is based on multifunctional criteria, considering aspects such as their perennial or deciduous nature, their ability to provide edible fruits, emit distinctive aromas, and contribute diverse textures. These features have significant impacts on school environments, improving water management by 70%.
Renaturalization is highly effective as it aligns well with students' cognitive processes and learning in schoolyards. Additionally, water and soil management play a crucial role in revitalizing previously impermeable spaces, transforming them into complementary elements that support green areas.

While this study primarily analyzes school environments, it also considers the potential expansion to other educational contexts, such as colleges and universities. This is part of an ongoing research project that is still under development. The research includes the analysis of 18 case studies across Spain (Madrid and Barcelona) and France, where cataloging sheets were developed, and the effectiveness of these interventions was evaluated in terms of their potential to mitigate climate change. Consequently, this research underscores the opportunity, feasibility, and importance of this approach, aligning with SDG 3 'Health and Well-being', SDG 11 'Sustainable Cities and Communities', and SDG 13 'Climate Action'.

The urban green spaces in the city of Vila Real: street tree diversity and ecosystem services

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Urban trees are a significant part of the urban ecological framework, which contribute to a milder climate, reduce air pollution, provide aesthetic urban scenarios and increase biodiversity. Knowing the current abundance and diversity of urban tree species is crucial for proper urban forest planning, to maintain or improve environmental quality, human health and well-being in cities, particularly when is expected an increase in the global urban population and a need for climate change adaptation. Street trees are an important component of the urban spaces and managing its composition and structure (in terms of species, phenology and age) has significant effect on the provision of environmental benefits provided by these green structures. Vila Real is a city in the north of Portugal (450 m asl), with more than 700ys of existence. The city has several different types of urban areas: historic areas (S1), contemporary areas built up until the early 80s of the 20th century (S2) and major urban expansion after the 80s (S3). Planning and management of the public street trees in the city is challenging due to economic and social factors. The present study aims to characterise the public street trees in Vila Real using a sample of 2500 trees, representing the different typologies of street trees in the city, and estimating their ecosystem benefits. Street trees are comprised of 100 taxa, including genera and species. The most abundant species is *Quercus rubra*(12%), followed by *Liquidambar styraciflua* and *Tilia platyphyllos*. Around 44% of the trees are young, with diameters less than 15.2cm.

There is an asymmetry in terms of the values of richness, diversity and dominance between areas, with the lowest number of trees, lowest richness and diversity occurring in the older areas (S1) and the high diversity corresponding to the contemporary areas of the city (S2).

The street trees in older areas (S1, S2), contribute, in average, to higher levels of carbon storage and annual carbon sequestration. Street trees in contemporary areas (S2) have in average, higher canopy cover, thus contributing to higher average levels of pollution removal and avoided run-off. Information obtained in this study highlight the importance of the maintenance of the actual street trees in order to have bigger trees in near future. Moreover, it is important to increase the canopy cover with new plantations to enhance the environmental benefits to promote biodiversity and to provide urban comfort.

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