

**EFUF 2023**

# URBAN FORESTS AS NATURE-BASED SOLUTIONS

Krakow, 24–26 May 2023

## **URBAN FORESTS AS NATURE-BASED SOLUTIONS**

### **25<sup>th</sup> European Forum on Urban Forestry (EFUF2023)**

May 24–26, 2023, Krakow, Poland

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It is with great pleasure that I write this foreword to the 25<sup>th</sup> edition of the European Forum on Urban Forestry (EFUF), which is being held for the first time in Poland. It will be very interesting for delegates to discover the progress of urban forestry in Poland. There is no better place to start this voyage of discovery than in the City of Krakow.

This year the overall theme of the Forum is urban forests as nature-based solutions. In that theme, the role that trees and associated habitats contribute in terms of nature recovery, health and well-being, liveability and climate resilience is very significant. Speakers will be presenting on a range of topics related to this. It also comes at a time when the Sino-European CLEARING HOUSE project, which is investigating this topic, is preparing its conclusions. Hence we will learn about the work and findings of this project through a number of contributions.

This Forum coincides with a major achievement for EFUF, which has now been constituted as an international organisation. This has been done under the framework of Belgian law and provides a platform for further collaborations, funding applications and an extension of activities in the future. I would like to thank Rik de Vreese for his hard work in facilitating the legal incorporation in time for this year's Forum. This also opens the door for the EFUF membership scheme, which will be discussed in Krakow.

Each EFUF is the work of many organisations, and a great deal of hard work, most often undertaken on a voluntary basis. This year I offer my gratitude to the Forum organisers (the Sendzimir Foundation, European Forest Institute, Krakow Municipal Greenspace Authority) and the Forum Partners (CLEARING HOUSE, University of Agriculture in Krakow, Rector of the University of Lodz, International Union of Forest Research Organizations, Teraz Śródowno). I would also like to extend my appreciation to Agata Czaplarska for her hard work and dedication in the organisation of EFUF 2023.

Finally can I remind you that EFUF is active throughout the year and encourage you to visit the [EFUF website](#) and download the MyEFUF App to your smartphone.

**Clive Davies**  
Chairperson  
European Forum on Urban Forestry

# EFUF 2023

## Conference Organisers

European Forum on Urban Forestry | <http://www.efuf.org>

The Sendzimir Foundation | <http://www.sendzimir.org.pl>

Krakow Municipal Greenspace Authority (ZZM) | <http://zzm.krakow.pl>

European Forest Institute | <http://www.efi.int>

## Conference Partners

CLEARING HOUSE | <http://www.clearinghouseproject.eu>

IUFRO | <https://www.iufro.org>

## Programme and scientific committee

**Agata Czaplarska** | The Sendzimir Foundation, Poland

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**Łukasz Mielczarek** | Krakow Municipal Greenspace Authority, Poland

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**Karolina Maliszewska** | The Sendzimir Foundation, Poland

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## DAY 0 | Tuesday 23<sup>rd</sup> MAY 2023

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18.00–20.00 EFUF ICEBREAKER, Welcome cocktail and buffet, early registration

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## DAY 1 | Wednesday 24<sup>th</sup> MAY 2023

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08.30–09.30 Registration of participants, coffee

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09.30–11.10 **Welcoming session** (Chair: **Tomasz Bergier**)

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09.30–09.35 **Welcome remarks by the City of Krakow** | **Jerzy Muzyk**

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09.35–09.40 **Welcome remarks by the University of Agriculture in Krakow** | **Agnieszka Filipiak-Florkiewicz**

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09.40–09.45 **Welcome remarks on behalf of the EFUF Board of Directors** | **Clive Davies**

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09.45–10.00 **Presentation on NBS in Krakow by ZZM Krakow** | **Piotr Kempf**

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10.00–10.15 **Setting the scene: the state of the art of urban forestry in Poland** | **Piotr Wężyk**

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10.15–10.40 **Keynote 1: Urban forests as a nature-based solution – CLEARING HOUSE and beyond** | **Clive Davies & Rik De Vreese**

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10.40–11.10 **Keynote 2: China National Forest City Programme** | **Cheng Wang**

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11.10–11.40 Coffee break

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11.40–13.00 **Plenary session** (Chair: **Bianca Bärlocher**)

1. Urban green areas maintenance standards developed for Polish cities and the IT system for managing the urban greenery resource in Wrocław | **Monika Pec-Święcicka & Łukasz Pawlik**
  2. Green space appropriation – ecopauperization as a parallel to ecogentrification | **Jakub Kronenberg**
  3. The 3-30-300 rule in practice – international experiences | **Cecil Konijnendijk & Johan Ostberg**
- 

13.00–14.00 Lunch

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14.00–18.00 **Study visit to Zakrzówek**

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18.00–19.00 **EFUF International Steering Committee**

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## DAY 2 | Thursday 25<sup>th</sup> MAY 2023

08.15–08.30 Registration of participants, coffee

08.30–10.00 **Plenary session** (Chair: **Clive Davies**)

1. Public perceptions and preferences for urban forests in China and Europe | **Rik De Vreese & Chang Zhang**
2. Application of the MINECRAFT computer game to involve children and youth in the participatory management of urban forests, their planning, and popularisation | **Agnieszka Arabas**
3. The challenge of transforming our urban areas into green urban areas: Forestami, a case study | **Maria Chiara Pastore**

10.00–10.30 **Poster/lightning talks** CONGRESS HALL (Chair: **Andreas Bernasconi**)

### Planning urban forests as nature-based solutions

**Jovanovic, Maja; Tripkovic, Dejan** | Plan of general regulation of the system of green areas in Belgrade.

**Kempf, Piotr; Szwałko, Przemysław; Wnęk, Dariusz** | Afforestation in the city in the long-term policies of the Krakow authorities.

### People, ecosystem services and values

**Antenucci, Eduardo; Marchetti, Marco; Garfi, Vittorio** | Urban forests and ecosystem services: air pollutant removal capacity in Campobasso, Italy.

**Arnberger, Arne; Eder, Renate** | Visitor perception of recreation conflicts in the UNESCO Vienna Wood Biosphere Reserve.

**Hegetschweiler, Tessa; Wunderli, Jean-Marc; Fischer, Christoph; et al.** | Multisensory dimensions of forest attractiveness.

**Kičić, Martina; Haase, Dagmar; Scheuer, Sebastian; et al.** | Diversity of urban green infrastructure provides cultural ecosystem services and disservices – results of a PPGIS study in Zagreb, Croatia.

**Rahman, Irvanu; Grunwald, Armin; Saha, Somidh** | Exploring the potential of participatory spatial-system dynamics modeling in assessing the importance of cultural ecosystem services from the urban forest for resilience planning in Jakarta and Bandung, Indonesia.

**Zoderer, Brenda Maria** | Profiles of (non-)users of urban forests and urban wastelands.

**Russo, Alessio; Goodenough, Alice; Sheppard, Adam; Cheshire, David; Cirella, Giuseppe T.; Escobedo, Francisco J.** | Urban rewilding aesthetics & people's needs into multifunctional blue and green infrastructure design.

**Beckmann-Wübbelt, Angela; Addo-Danso, Shalom Daniel; et al.** | Quantifying ecosystem services from urban forests and their importance in increasing social-ecological resilience in Greater Kumasi, Ghana.

**Trentanovi, Giovanni; Bartoletti, Roberta; Zinzani, Andrea; et al.** | New opportunities for urban regeneration by spontaneous woodlands: a socio-ecological assessment from Italy.

**Viskanica, Paolo; Antonacci, Gianluca; Fini, Alessio; et al.** | The engagement of citizens in the management of urban forests: the LIFE URBANGREEN experience in Krakow.

### Managing urban forests and urban trees as nature-based solutions

**Tucker, Alana** | High AND inclusive standards of urban forestry.

**Caggiu, Laura; Corradini, Elisa; Fiorani, Federico; Minelli, Alberto** | Urban tree management: a theoretical framework for prioritization of tree monitoring and intervention activities through a spatial analysis of risk exposure.

**Menon, Nicola; Brundu, Giuseppe; Kotze, D. Johan; et al.** | Italian monumental trees and biodiversity: a focus on origin and landscape settings.

## DAY 2 | Thursday 25<sup>th</sup> MAY 2023

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10.00–10.30  
cd.

### Modeling, measuring and inventorying urban trees and urban forests

**Sicard, Pierre; Coulibaly, Fatimatou; De Marco, Alessandra; Paoletti, Elena** | Canopy-based classification of urban vegetation from very high-resolution satellite imagery.

**Guo, Yasong; Chen, Wendy Y.** | Remote sensing of urban trees' health dynamics.

**Janowska, Ewa** | Climate tools based on local and Copernicus data in urban NBS implementation.

**Zięba-Kulawik, Karolina; Skoczylas, Konrad; Wężyk, Piotr; Omrani, Hichem** | Exploring the volumetric relationship between urban greening and build-up using a voxel-based approach: a city-level analysis.

**Saha, Somidh; Spoden, Lisa; Skiadaresis, Georgios; et al.** | Tree-ring analysis and impulse tomography on old native (*Quercus robur*) and exotic (*Quercus rubra*) urban oaks revealed a growing sensitivity to drought and internal trunk damage.

**Saha, Somidh** | Lessons learned from the GrüneLunge or GreenLung project to increase social-ecological resilience of urban and peri-urban forests (UPF) to climate change impacts by performing inter- and transdisciplinary research.

### Trees, forests and water

**Gray, Howard** | Application of blue-green infrastructure as nature-based solutions: practical examples from England, the Netherlands, and Wales.

### Biotic management aspects in the urban forest

**Moricca, Salvatore; Aglietti, Chiara; Benigno, Alessandra** | Management practices alter the endophytic mycobiota of an urban forest favouring pathogenic endophytes.

**Muscas, Desirée; Fornaciari, Marco; Proietti, Chiara; et al.** | Urban forest and climate change mitigation: most effective tree species in Perugia, Italy.

**Saha, Somidh; Kramer, Diana; Betting, Ferdinand; Schmidlein, Sebastian** | Morphological, tree health, and ecophysiological variations among Norway maple (*Acer platanoides* L.) trees planted along strips and pits near roads in the city of Karlsruhe, Germany.

**Shamsul Kamar, Nura Adilla; Banyang, Attlee; Mohamad Ramlee, Zunnuraina Raihana; et al.** | The study of the bleeding disease of rain tree (*Albizia Saman*) in the urban environment in Malaysia.

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10.30–11.00 Coffee break

### 11.00–12.45 Parallel session Number 1

Theme: **Planning urban forests as nature-based solutions** (Chair: **Alan Simson**)

**Vidal-Casanovas, Eugenia; Ilousi, Kyriaki** | NBS for socio-ecological metropolitan river restoration: H2020 CLEARING HOUSE and LIFE UrbanGreeningPlans experiences in the Llobregat River.

**Athanassiadis, Dimitris** | Urban forestscapes in the city of Umeå and their significance in the city's sustainable growth and development.

**Atmiş, Erdoğan; Günşen, Hikmet Batuhan** | The place of ecosystem services in urban and forest planning in Turkey.

**Gormus, Sevgi; Cengiz, Serhat; Atmis, Erdogan; Yilmaz, Bulent** | Evaluation of the adaptability of Istanbul's city plans.

**Piplas, Haris** | Reporting from the front: tackling social and ecological vulnerability in contemporary urban laboratories.

**Baines, Chris** | Delivery with developers – a 40 year perspective.



## DAY 2 | Thursday 25<sup>th</sup> MAY 2023

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11.00–12.45  
cd.

### Parallel session Number 2

Theme: **Human health and well-being aspects of urban green spaces** (Chair: **Renate Spaeth**)

**Chen, Wendy Y.** | Urban forests as a strategy for healthy cities.

**Pereira Barboza, Evelise; Cirach, Marta; Khomenko, Sasha; et al.** | Green space and mortality in European cities: a health impact assessment study.

**Giannico, Vincenzo; Sanesi, Giovanni** | Disentangling the relationship between green spaces and citizens' perceptions in Europe: the mediating effect of quality of life and role of per capita gross domestic product.

**Łaszkiwicz, Edyta; Sikorski, Piotr; Archiciński, Piotr; Parsa, Vahid et al.** | Socio-spatial inequalities in the distribution of benefits from school greenery.

**Dijkstra, Lotte** | Intersectional belonging: exploring senses of belonging for equitable access to urban forest places across communities.

**Stark da Silva, Priscila Weruska; Pauleit, Stephan** | Achieving human thermal comfort via green infrastructure in a future climate. A comparative analysis of the cooling capacity of two most common tree species in Munich, Germany.

**Sousa-Silva, Rita; Zanocco, Chad** | The role of urban green spaces in mitigating heat stress and promoting health: insights from a German survey.

### Parallel session Number 3

Theme: **Trees, forests and water** (Chair: **Jakub Kronenberg**)

**Viskanic, Paolo; Antonacci, Gianluca; Fini, Alessio; et al.** | Smart water management in urban forests: the approach of LIFE URBANGREEN.

**Amini Parsa, Vahid; Kronenberg, Jakub; Jabbarian Amiri, Bahman** | The Importance of urban landscape texture for the hydrological ecosystem service provided by urban trees.

**Heinrich, Axel; Saluz, Andrea Gion; Hertig, Tal; Stevanovic, Stefan** | Sponge city principle for sustainable urban tree growth: innovative substrate and vegetation systems in Zurich's industrial district.

**Stevanovic, Stefan; Hertig, Tal; Heinrich, Axel; et al.** | Structurally stable substrates for sustainable green infrastructure and stormwater management: a field trial with urban trees in Wädenswil.

**Łągiewka, Monika; Bergier, Tomasz** | The urban blue-green network as an important element of the management of ecosystem services: a case study of Krakow River Parks.

**Gray, Howard** | Application of blue-green infrastructure as nature-based solutions: practical examples from England, the Netherlands, and Wales.

### Parallel session Number 4

Theme: **Biotic management aspects in the urban forest** (Chair: **Nerys Jones**)

**Dimitrova, Anastazija** | Exploring the distribution of non-native tree species in urban environments: insights from a pan-European database.

**Augustinus, Benno A.; Belka, Marta; Kičić, Martina; et al.** | The extraordinarily high species richness in European urban trees – implications for invasive forest pests.

**Amer, Alaa; Hijazen, Amgad** | Physiological response and ecosystem services of *Tilia cordata*, *Robinia pseudoacacia* and *Acer platanoides* along an urban-suburban transect.

**Lyu, Hailiang; Saha, Somidh** | Species traits and growing conditions were related to crown dieback in community and city-owned peri-urban forests: a study from southwest Germany.

**Saha, Somidh; Petridis, Zoe; Schmidlein, Sebastian; Köhler, Mario** | Microhabitat richness and abundance varied between species origin (exotic vs. native), size, growing environment (park vs. street), and crown management intensity: a study on four species from the city of Karlsruhe, southwest Germany.

**Moricca, Salvatore; Benigno, Alessandra; Aglietti, Chiara; et al.** | Impact of thousand cankers disease of walnut on the urban greenery and proactive management.

**Saha, Somidh; Schober, Mia; Schmidlein, Sebastian; Köhler, Mario** | Crown damage of single-standing city trees after the catastrophic drought of 2018 – field observational studies on 79,753 trees from the city of Karlsruhe, Germany.

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12.45–13.45 Lunch

## DAY 2 | Thursday 25<sup>th</sup> MAY 2023

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13.45–15.00	<b>Option 1: Poster presentations</b> <b>Option 2: Project idea seed session (speed dating – are you looking for a project partner?)</b> <b>Option 3: Sharing urban forest stories: workshop on intersectional belonging in practice (limited to 24)</b> <b>Option 4: Urban Forestry &amp; Urban Greening Journal (meeting)</b>
15.00–18.00	<b>Study visit to the urban Wolski Forest</b>
18.00–19.30	Free time and/or travel time to conference dinner venue
19.30–late	Cruise and conference dinner (this is an additional paid for event)

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## DAY 3 | Friday 26<sup>th</sup> MAY 2023

08.15–08.30 Registration of participants, coffee

### 08.30–11.00 **Parallel session Number 5**

Theme: **People, ecosystem services and values** (Chair: **Tessa Hegetschweiler**)

**Pfund, Jean-Laurent; Konijnendijk, Cecil; Bernasconi, Andreas; Pellet, Jérôme** | Urban greening dynamics in Switzerland: pathways to gather forces and knowledge.

**Hand, Kate; Wheeler, Philip; Maseyk, Kadmiej; Doick, Kieron** | Growing the evidence base on the benefits of urban trees with citizen science.

**Mishra, Himansu Sekhar; Tyrväinen, Liisa** | Mainstreaming the use of experiential information with PPGIS in monitoring urban forests as nature-based solutions.

**Krajer Ostoić, Silvija; Kičić, Martina; Vuletić, Dijana; Marin, Ana Marija** | Use of focus group interviews for exploring and participatory mapping of cultural ecosystem services and disservices of urban green space – an example from the city of Zagreb, Croatia.

**Shaw, Roddy; Sheldon, Kate** | Trees for Climate Action – engaging and upskilling youth in tackling the climate crisis.

**Ffrench, Aidan** | Participatory tree care in a new 10-year urban forestry strategy in Ireland.

### **Parallel session Number 6**

Theme: **Managing urban forests and urban trees as nature-based solutions**

(Chair: **Eugenia Vidal Casanovas**)

**Woo, Holly; Wheeler, Philip; Davies, Sarah; Maseyk, Kadmiej** | Changes in ancient woodland flora after rapid urbanisation of surrounding landscapes.

**Biernacka, Magdalena; Bergier, Tomasz; Kronenberg, Jakub; et al.** | Complex challenges of integrated and interdisciplinary management of urban forests: a case study of the Drwinka River Park, Krakow.

**Armstrong, Andrea; Pulinx, Wim** | Managing military urban forests: a case study of Kamp Beverlo, Leopoldsburg, Belgium.

**Bakay, Ladislav; Miklášová, Katarína; Kollár, Ján** | Why do we need more urban trees established with close to nature management? (The method of the lazy urban forester).

**Darr, Barbara** | How can a modern forest authority push forward sustainable urban forest management?

**Keller, Anja** | Urban forest governance in Copenhagen in relation to contemporary urban greening concepts.

### **Parallel session Number 7**

Theme: **Modeling, measuring and inventorying urban trees and urban forests**

(Chair: **Chris Baines**)

**D'hont, Barbara; Calders, Kim; Verhelst, Tom; et al.** | Evaluating tree structure and biomass of city parks using lasers: a case study in Ghent, Belgium.

**Voets, Dirk** | How can we create large-scale country-wide single-entity tree databases for Europe?

**Wężyk, Piotr; Bobrowski, Rogerio; Winczek, Monika; Zięba-Kulawik, Karolina** | Pocket-size LiDAR mobile solution in urban tree inventories.

**Semenzato, Paolo; Cattaneo, Dina; Dezio, Catherine; et al.** | Dimension and determinants of urban canopy cover (UTC) in cities of north-eastern Italy.

**Kazik, Patrycja; Wężyk, Piotr; Winczek, Monika** | Mapping the ecosystem services provided by campus trees of University of Agriculture in Krakow (Poland) using ALS LiDAR, ground truth data and i-Tree Eco.

**Kasperidus, Hans Dieter; Hartmann, Timo; Hecht, Christian; et al.** | Forest growth modeling and 3D visualization: understanding development potentials in the urban forest ecosystems of the Elster-Luppe floodplain in Leipzig.

## DAY 3 | Friday 26<sup>th</sup> MAY 2023

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08.30–11.00 cd.	<p><b>Parallel session Number 8</b>                      Theme: <b>Biotic management aspects in the urban forest</b> (Chair: <b>Rita Sousa Silva</b>)  <b>Raum, Susanne; Pauleit, Stephan; Egerer, Monika</b>   Urban tree pests and pathogens, stakeholder risk perceptions, and remedial actions.  <b>Maxwell, Richard</b>   How to make citizen science work for disease monitoring and urban tree care.  <b>Tikvić, Ivica; Pernar, Nikola; Hrašovec, Boris; et al.</b>   Ecosystem-based solutions for urban tree revitalisation in Croatia.  <b>Kasperidus, Hans Dieter; Hüttner, Marie-Luise; Bartelt, Sandra; et al.</b>   Status and role of urban fruit orchard meadows in major German cities.  <b>Mielczarek, Łukasz Emil; Pawlik, Łukasz; Szwałko, Przemysław</b>   Increasing the ecosystem resilience by protecting biodiversity in Krakow.  <b>Wężyk, Piotr</b>   Time-series satellite-based monitoring of Biologically Active Areas of Krakow.</p>
11.00–11.30	Coffee break
	<b>Closing session</b> (Chair: <b>Jakub Kronenberg</b> )
11.30–12.00	<b>Keynote 3 – 25 Years of EFUF – how a European urban forestry community was built</b>   <b>Cecil Konijnendijk</b>
12.00–12.15	<b>Keynote 4 – The Second World Forum on Urban Forests (Washington DC) and Tree Cities of the World update</b>   <b>Simone Borelli</b>
12.15–12.30	<b>Introducing EFUF 2024 (Zagreb)</b>   <b>Silvija Krajter Ostoić, Vinko Paulić, Damir Dramalija and Martina Kičić</b>
12.30–12.55	<b>EFUF International Steering Group announcements</b>
12.55–13.05	<b>Announcement of European Young Urban Forester of the Year award</b>
13.05–13.30	<b>Forum summary</b>
13.30–14.30	Lunch
14.30	Early departures
14.30–18.00	<b>Study visit to the urban Mogilski Forest and the Polish Airmen Park</b>

## DAY 4 | Saturday 27<sup>th</sup> MAY 2023 optional excursion

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09.30–17.00	Post-conference excursion
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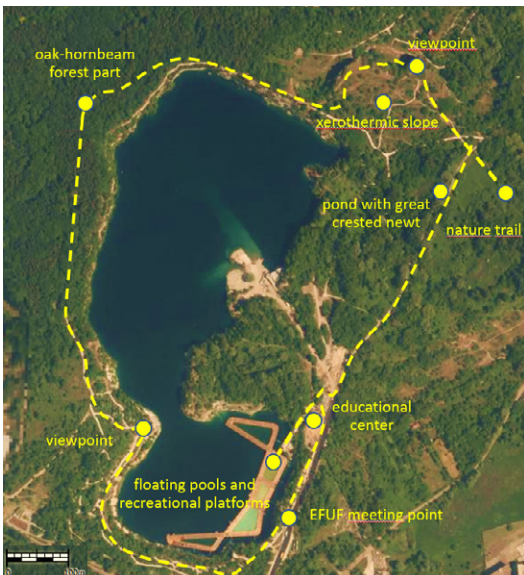
## Zakrzówek – pearl at the heart of the city



One of many fascinating views in Zakrzówek (photo by Przemysław Szwałko)



Modraszki Kolektyw – participants with blue butterfly wings (photo by Maciej Nazim)



The basic route of the EFUF study visit to Zakrzówek – map background satellite imagery 2022. Source: Portal MSIP Obserwatorium, <https://msip.krakow.pl>

The limestone cliffs above the blue sheet of crystalline deep water may resemble the Dalmatian coast. But it's almost in the centre of Kraków – just 3 km from the Main Market Square or 2 km from Wawel Castle. In fact, it is a natural pearl of the post-industrial landscape of the former quarry, which was still being exploited in the 1970s. During the Second World War, Karol Wojtyła, the later Pope – John Paul II, was a labourer here.

The attractiveness of the environment of the main excavation encouraged developers to buy private plots and create intensive residential development projects. This caused substantial social opposition, but the attempts made by nature and landscape defenders were not entirely effective. The spectacular media action of the spontaneously born group of activists 'Modraszki Kolektyw' (named after the protected Lycaenid butterfly occurring in the area) made the problem of Zakrzówek famous throughout Poland. It tipped the scales in defending the area against development. Thanks to the changes in local zoning plans and the creation of the legal form of nature protection of Zakrzówek, no residential development is being built here. Based on the results of an open architectural competition and environmental expertise, Zakrzówek has been created by the Krakow Municipal Greenspace Authority (ZZM). It's a public city park in accordance with nature with such elements as a nature education centre, a bathing beach with floating platforms and swimming pools, a water sports centre with a pool for scuba divers, wild zones and viewpoints. Protected butterflies from the Lycaenidae family, such as Scarce Large Blue and rare vertebrates, such as smooth snakes, still use the xerothermic meadows and grasslands.

## Wolski Forest – the largest urban forest and recreation complex in Krakow

Wolski Forest, together with several smaller enclaves, also located in the 7<sup>th</sup> District of the City of Krakow, form the largest urban forest and recreation complex with an area of 462 ha. Numerous roads, trails and recreational paths stretch over a total length of 40 km. But it is not only a great recreational place but, above all, a unique natural object area. For this reason, tourism and recreation need to be reconciled with the forest protection measures stipulated by the binding legal acts.

The stands have a typical species composition and a rich undergrowth characteristic of oak-hornbeam habitats. The oldest records concerning the part of the forests belonging to the Camaldolese (Bielany Forest) date back to 1603. The first known forest management plan was created in 1824. Most of the area of today's Wolski Forest was formerly owned by Prince Marceli Czartoryski. The heirs and subsequent owners of the main part of the area sold it in 1917 to the Krakow City Savings Bank, which donated it to the city. By resolution of the City Council, a forest donation with an area of 335.13 ha was allocated for the so-called 'People's Park'. In the interwar period, prof. Edward Chodzicki (outstanding forester and scientist of the Jagiellonian University, detained during the Sonderaktion Krakau – released from the concentration camp in Sachsenhausen thanks to the efforts of Swedish scientists) recommended stopping all logging, allowing only intermediate and sanitation cutting.

In 1963, an independent foundation was established under the name of the "City Park and Zoological Garden". To this day, the foundation manages the main complex of Wolski Forest, while the neighbouring smaller complexes and the Okocimski Pavilion (currently the SYMBIOSIS



Wild garlic in front of the SYMBIOSIS Ecological Education Centre (photo by Dawid Masło)



The basic route of the EFUF study visit to Wolski Forest – map background satellite imagery 2022. Source: Portal MSIP Obserwatorium, <https://msip.krakow.pl>

Ecological Education Centre), together with the immediate surroundings, are under the management of the Krakow Municipal Greenspace Authority (ZZM).

The zoo, located in the middle of Wolski Forest, was opened in July 1929. Today, it covers an area of 10 ha and exhibits over 1,400 animals belonging to about 270 species, of which over 100 are endangered and threatened with extinction. The most interesting points of the study visit are the the SYMBIOSIS Ecological Education Centre at the Julius Leo Meadow, getting to see the Bielany Monastery (the Monastery of the Camaldolese fathers, generally closed to the public visitors), the Piłsudski Mound (393.6 m above sea level) and the Panieńskie Skały nature reserve. The sounds of exotic animals and perhaps the specific smells from the zoo will ensure a unique character of the study visit.



## Mogilski Forest – the most valuable forest complex in Nowa Huta

Mogilski Forest is situated on the Vistula River, near the Dłubnia estuary and the Mound of Wanda. It is a small ash-elm riparian forest, but it is the largest and best-preserved fragment of this unique habitat in Krakow, listed in Annex I of the Habitats Directive. It is the remainder of land once owned by the bishop of Krakow and has been owned since the 13<sup>th</sup> century by the Cistercian monks.

In the 1950s, when Nowa Huta came into being – an extraordinary city, quite quickly merged with Krakow – this small forest complex, with an area of about 22 ha, became a public commodity. Seen against the background of the other forest complexes of Nowa Huta and other parts of Krakow, the nature in Mogilski Forest stands out for its avian richness – 39 bird species live here, including those listed in Annex I of the Birds Directive: the grey-headed woodpecker, the middle spotted woodpecker and the red-breasted flycatcher. In 2020, the hermit beetle – a priority species in Annex II of the Habitats Directive – was discovered here.



A monumental white elm in the Mogilski Forest  
(photo by Lukasz Mielczarek)



The basic route of the EFUF study visit to Mogilski Forest – map background satellite imagery 2022. Source: Portal MSIP Obserwatorium, <https://msip.krakow.pl>

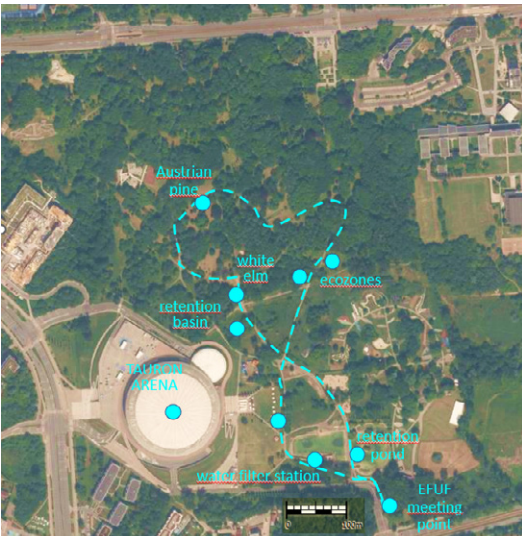
# The Polish Airmen Park – a good example of nature-based solutions



A recently created pond in the the Polish Airmen Park (photo by Adam Kulczycki)



IT sensor in the Polish Airmen Park (photo by Łukasz Mielczarek)



The basic route of the EFUF study visit to Zakrzówek – map background satellite imagery 2022. Source: Portal MSIP Obserwatorium, <https://msip.krakow.pl>

This largest city park in Krakow (covering over 50 ha) is an example of comprehensive actions to adapt the city to climate change but also to protect biodiversity. Care and maintenance practices that can increase the efficiency of the ecosystem services provided by trees are introduced and tested here. Most innovative tools and best practices were developed by the LIFE URBANGREEN project <https://krakow.lifeurban-green.eu/en/green-areas/#/district/947>.

Created under the name of Cultural and Recreational Park in 1966, it was to separate Krakow from the steelworks of nearby Nowa Huta. A large retention pond was only built in recent years. Currently, a popular place for walks and active recreation, the Polish Airmen Park showcases nature-based solutions introduced during its modernisation. In designated natural zones, nature lovers, of course with due care, will feel like they're in a forest where 'wild' nature is at their fingertips.



## Presentation on NBS in Krakow by ZZM Krakow

**Kempf, Piotr** | Krakow Municipal Greenspace Authority (ZZM) (Poland), pkempf@zzm.krakow.pl

### Abstract

Krakow Municipal Greenspace Authority is a municipal unit established in 2015 with a brief to develop and manage public green areas. The presentation includes presents examples of Krakow's green areas, from the semi-natural Drwinka Park to accessible public infrastructure-rich city parks. Innovative solutions, such as pocket parks, blue and green infrastructure and water retention schemes make Krakow a regional source of NBS ideas. Due to the large variety of greenspaces, almost every inhabitant in Krakow can find a facility that meets their needs for rest and recreation.

# Setting the scene: the state of the art of urban forestry in Poland

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**Matczak, Piotr** | Adam Mickiewicz University, Poznań (Poland)

**Zaraś, Ewa** | Warsaw University of Life Sciences (Poland)

**Rosłon-Szeryńska, Edyta** | Warsaw University of Life Sciences (Poland)

**Winczek, Monika** | University of Agriculture in Krakow, Faculty of Forestry (Poland)

## Abstract

A green revolution is sweeping through the streets of Polish cities, linked to the rapid awakening of citizens' environmental awareness and to city managers' solutions forced by global trends often linked to climate change mitigation. The blue-green infrastructure needed to ensure the quality of life of city dwellers is an important topic in practice, science and policy. The presentation is divided into groups of issues:

- Citizen/community initiatives: presentation of selected grassroots initiatives of local urban citizens focusing on the protection of green areas or, for example, initiatives for mapping trees in the city, replacing impervious surfaces with green ones, creating community gardens, urban farms or the use of participatory budgets. The impact of COVID-19 on residents' growing awareness of the role of green spaces in supporting a good quality of life will also be referred to. Furthermore, the use of social media in the creation and management of citizens' initiatives will be discussed, as well as the role of journalists and the change in the attitude of decision-makers in public policies towards public participation, e.g. the change in awareness of all parties in investment processes.
- Academic-educational: initiatives of universities where new courses are opening up for students in the first and second degree and postgraduate studies in UF. Webinars, educational projects, etc. run by associations or foundations promoting the role of UF in cities will be discussed.
- Administrative: the fluctuation of the law on the protection of trees and shrubs in 2016–2017, which has resulted in losses to urban trees that are difficult to estimate (felling without a permit was allowed periodically). The role of the State Forests PGL LP, which has issued a special ordinance on the role of forests in urban and peri-urban areas (allowing a change from economic to pro-social functions), will be highlighted. Establishing Urban Greenery Boards – dedicated entities for greenery management in many cities – will be discussed.
- Technological: implementation projects and technological solutions implemented in Polish cities for UF using state-of-the-art IT solutions and Geoinformatics systems (e.g. GIS, aerial and satellite remote sensing, LiDAR, IoT sensors, etc.).

# Urban forests as a nature-based solution – CLEARING HOUSE and beyond

**Davies, Clive** | European Forest Institute (EFI), Newcastle University School of Architecture Planning and Landscape, [clive.davies@efi.int](mailto:clive.davies@efi.int)

**De Vreese, Rik** | European Forest Institute (EFI), [rik.devreese@efi.int](mailto:rik.devreese@efi.int)

## Abstract

The Sino-European CLEARING HOUSE project (<http://www.clearinghouse-project.eu>) looks into using urban forests and urban trees as nature-based solutions. During the presentation, we will highlight some outcomes of the project that is ending February 2024.

The project has been developing an innovative typology for urban forests as nature-based solutions, based on an Ontology Web Language (OWL) approach. OWL allows for the combining of aspects of use, form, function, composition, and surroundings into one typology. The typology will be supporting decision-support tools for planners and managers of urban green space, the Spatial Impact Assessment and Classification tool (SIAC).

Another highlight of the project is the education package “City of Trees” that immerses teenagers (10 to 14 years old) in the world of urban trees and urban forests. In contrast to other education packages that focus on learning about nature, this package is learning with nature, and integrates nature in several other subjects.

A governance analysis, based on 22 case studies, highlights barriers and facilitating items for urban tree-based sustainable urbanisation. A societal survey in China and Europe has indicated that most citizens do visit urban forests and parks, and that ecosystem disservices related to urban forests and urban trees are important only to a minority of the respondents.

Finally, the presentation will look ahead into upcoming tools and outputs by the project, including:

- guidelines on planning, designing, and managing urban forests and urban trees as nature-based solutions, including stakeholders and transforming institutions into more tree-friendly organisations;
- the SIAC tool that will allow for a comparable assessment of UF-NBS and an assessment of the tree-based benefits;
- the Spatial Information and Knowledge Hub (SIK-hub), an interactive web-based application synthesising the CLEARING HOUSE findings.

CLEARING HOUSE has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No. 821242 and the National Key R&D Programme of China under grant No. 2021YFE0193200.

## China National Forest City Programme

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**De Vreese, Rik** | European Forest Institute (EFI), [rik.devreese@efi.int](mailto:rik.devreese@efi.int)

**Chen, Wendy Y.** | The University of Hong Kong (China), [wychen@hku.hk](mailto:wychen@hku.hk)

**Yin, Luqin** | Research Institute of Forestry, Chinese Academy of Forestry (China)

### Abstract

With the rapid development of urbanisation, high urban density and the continuous expansion of individual cities, many regions have the trend of developing into urban agglomerations, resulting in several environmental issues and social challenges such as the heat island effect, air pollution, lack of leisure space and biodiversity conservation. In response to the environmental pressure brought about by urbanisation, the National Forest City Construction Programme (NFC) in China was launched in 2004 with the aims of restoring the city's ecological connection with its natural elements, providing urban forest-based solutions for urban ecological security and residents' quality of life. It is an innovative practice to promote ecological construction in urban and rural areas in China. It adapts to China's national conditions and developmental stages and is based on the experience of developed countries. The core aim of the NFC is to restore and improve the urban and rural natural forest ecosystems. In general, the main characteristics and practices of China's NFC can be summarised in four key aspects:

- (1) The construction of China's forest cities covers the whole administrative region of a city, taking into account not only the academic interest in urban forests but also the reality of China's urban administration. At the technical level, it ensures the integrity of an urban forest ecosystem and meets the internal legal requirements of ecosystems. At the practical level, it ensures the implementation of the construction task and fits the government operational modes of Chinese cities.
- (2) China's forest cities adhere to the principle of 'double consideration' between urban ecology and residents' well-being, including the construction of forest ecosystems, forest well-being systems and forest industry systems, so as to meet the demands of different stakeholders for various functions such as ecology, living environment, recreation, landscape, culture and economy.
- (3) China's forest cities have formulated 36 assessment indicators, put forward the standard requirements of combining the qualitative and quantitative, and ensured the implementation and quantitative assessment of the construction elements, tasks and achievements of forest city construction.
- (4) China's forest cities have paid attention to the comprehensive follow-up and implementation of knowledge popularisation, planning, standard

guidance, task implementation, government implementation, public participation, effect evaluation, experience sharing, publicity and promotion, system improvement and other links, so as to realise the unity from theory to action.

Based on the above summary, countermeasures and suggestions are put forward for the future development direction of urban forests and the problems existing in China's forest city construction.

This talk also takes Beijing as a case study to introduce the whole cycle of Forest City creation progress, including the master plan of National Forest City and the evaluation of Forest City KPIs.



## Urban green areas maintenance standards developed for Polish cities and the IT system for managing the urban greenery resource in Wrocław

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### Abstract

In 2021, Krakow and Wrocław cities, in cooperation with The Sendzimir Foundation, initiated a project to create standards for urban green area maintenance that could be widely implemented in Polish cities. 35 cities and a broad group of scientists have been invited to the co-creation process to guarantee practical and scientific approaches. As a result, “Urban green areas maintenance standards” were published in 2022. That publication responds to new trends in maintaining green areas related to climate change, current knowledge about nature, and increased social engagement in co-deciding. When successfully introduced, the standards are expected to lead to improved conditions of green areas, including more nature-based solutions, on a national scale. The standards cover, among others: planting and caring for plants, maintaining cleanliness, creating eco-zones, managing water reservoirs, and requirements for employees and equipment. They are available under an open licence to all entities.

Knowledge about green areas and their condition is needed to implement the standards. To develop that knowledge, the Wrocław Municipal Greenspace Authority (ZMZ) started a project entitled “System for managing the urban greenery resource.” The implementation of the project includes ordering the system and purchasing equipment, a dendrological inventory of 40,000 trees and an information base of objects, and assistance in supplying the Data System.

The ZMZ is responsible for maintaining greenery in the city of Wrocław: 62 parks, 240 squares, municipal forests, agricultural land, and green areas along the streets – over 2,700 ha, which is 9.3% of the city area. Thousands of trees are inspected, cared for, felled and planted every year. The project aims to improve resource management and implement communication with citizens by providing selected data on the geoportal and serving e-services. The system will support the following processes: green maintenance, cutting and planting trees, recreational facilities, leases and agreements. The project partners are ZMZ Wrocław and CUI. Aspello implements the system.

## Green space appropriation – ecopauperisation as a parallel to ecogentrification

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### Abstract

Much of the literature on environmental justice (and in particular on ecogentrification) focuses on how people of lower socio-economic status are affected (even if inadvertently) by various upgrades of urban green spaces. Meanwhile, there are also instances when the opposite happens – when, as the result of certain management practices or activities carried out in green spaces, those of higher socio-economic status are mostly affected. We propose to call such instances ecopauperisation and provide several examples from the literature, as well as our own case study of popular entertainment events organised in Łagiewniki Forest in Lodz, Poland. To reduce costs and attract more visitors, the City Office leases a recreational site in the forest to a private company, which manages it for its own commercial interest. Since 2015, the company has organised a series of frequent loud pop music (disco polo) festivals, as well as beer and family barbecue festivals. To check whether ecopauperisation occurred in this case, we carried out a survey of forest users (N=418), supplemented with the analysis of the institutional setting within which the events were organised. We found that the festivals were more appreciated among those of lower socio-economic status, and that a proportionally larger fraction of people with higher socio-economic status disapproved of the festivals and felt forced to change their routes in the forest to avoid the festival-related ‘nuisance’ (being pushed away from the part of the forest where the festivals were held). We discuss the findings in the context of environmental justice, private vs. public interests, critical events studies, and the geography of events, referring to conflicts and trade-offs related to urban green spaces and to neoliberal governance.

## The 3-30-300 rule in practice – international experiences

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### Abstract

Based on the importance of viewing greenery, living amongst greenery, and using greenery, and the scientific evidence that lies underneath, Cecil Konijnendijk introduced the now world-famous 3-30-300 rule for greener and healthier urban spaces. The rule states that everyone should see at least 3 well-established trees from their home and workplace, have a minimum of 30% canopy cover in every neighbourhood, and live not more than 300 metres from a greenspace.

So, how can this rule be implemented and used when working with urban trees and greenspaces? This presentation will present several cases from across the world where the rule has been adopted and used in, for example, communication with politicians, policies, and protection of trees during construction work. Several cities in Sweden have also included the rule in their masterplan, and an entire region has now been analysed to see how well all larger towns and cities are following this important rule. In the Netherlands, many cities have started working with 3:30:300 and assessment maps are available for all municipalities. In Scotland, a new urban forestry programme uses the rule as the key target. International organisations have also started recommending the rule, and countries like Zimbabwe use it as part of their urban greening programmes.

# Public perceptions and preferences for urban forests in China and Europe

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## Abstract

**Background:** urban forests need to be tailored to the various ecosystem services citizens expect from them. Thus, it is essential to know the public perceptions and preferences regarding urban forests, urban trees, and parks. However, studies on the perceptions and preferences for urban forest across China and Europe are still insufficient.

**Objective:** this study aimed to figure out the public perceptions regarding ecosystem services provided by parks, urban forests and urban trees, and the aesthetic preferences for urban greenery on the national (in Europe, 33 countries) and provincial (in China) scale.

**Methods:** public perceptions and preferences were measured through a questionnaire (a survey on the role of forests, city parks and trees for human well-being and quality of life, in 30 national languages), with 7,323 respondents in China and 10,391 respondents in Europe (numbers after data cleaning) collected between March and July 2021. We described the differences of a) societal ecosystem service perception and b) aesthetic preferences related to landscapes by Kruskal-Wallis (or Wilcoxon) test and chi-square test, respectively. The socio-demographic influence on ecosystem services, on the other hand, was analysed through multiple categorical regressions.

**Results:** respondents indicate a higher requirement for regulating and cultural ecosystem services of urban forests than provisioning ecosystem services. The perceptions of ecosystem services were varied according to age, gender and place of origin. Income, education and rurality were the main predictors for the perceptions of provisioning and regulating of cultural ecosystem services respectively. Results in China and Europe are largely comparable, except for the time needed to go to the forest, and the transport used. The cultivated urban forest landscape (park-like) was both the most attractive, while Europeans – overall – prefer a wilder version of the urban forest when it comes to the aesthetic benefits; as benefits to the society, both Chinese and European respondents preferred the park-like woodland. Ecosystem disservices are more important to Chinese respondents than to European respondents.

**Conclusion:** the general public speaks highly of the value of urban forests. With regard to the optimum protection, construction and optimization strategies, the most important ecosystem service of a region or for a population group should be recognised.

# Application of the MINECRAFT computer game to involve children and youth in the participatory management of urban forests, their planning, and popularisation

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## Abstract

Effective protection and restoration of urban forests and other types of nature-based solutions (NBS) require the involvement of many social groups. To build the awareness of stakeholders, it is crucial to include them in the decision-making process and to create strong partnerships, which is a key aspect of the modern management of urban forests and ecosystems. A particularly important and sensitive target group for this type of activity are children and young people. On the one hand, engaging them is crucial and extremely prospective, on the other hand, it is not easy and requires unconventional approaches and methods. In the context of the protection of nature and biodiversity, one of the most promising and innovative methods of reaching youth is employing games and simulations in educational activities or even the active inclusion of these key stakeholders in the co-design and co-creation with the use of computer tools.

In our contribution, we will present the possibilities and perspectives of using MINECRAFT to authentically involve children and youth in decision-making processes and planning urban forests. MINECRAFT is software with particularly high potential in this respect: it is very popular among young users; has a large and active community; it is an apt tool to recreate the local space in its environment, and then simulate various variants of the participatory development of the best solutions for the study area.

We will discuss the practical actions we have taken in cooperation with partner cities of the INTERLACE project. We will share the practical results, challenges, and feedback from young people from the Krakow Metropolis (Poland), where we have been directly involved in co-creating a model of study space in the MINECRAFT environment with them, as well as the effects of their work, especially the ideas and vision of greening the study space and transforming it into urban forests. Practical conclusions from these activities and the lessons learned will also be discussed, as well as guidelines and hints for people and institutions that would like to use MINECRAFT in similar educational activities and engage stakeholders in the protection and management of urban forests, and sustainable local development in general.

# The challenge of transforming our urban areas into green urban areas: Forestami, a case study

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## Abstract

Forestami is a project started in 2018 thanks to research by the Polytechnic of Milan. The main goal is to plant three million trees within the metropolitan area of Milan. This project is being implemented thanks to an agreement signed by Città Metropolitana di Milano, Comune di Milano, Parco Nord Milano, Parco Agricolo Sud Milano – Lombardy Region and the Fondazione Di Comunità.

The Metropolitan Area of Milan is a densely urbanised area, placed in one of the most densely populated regions in Europe, with high levels of soil sealing, land use and pollution.

The great challenge of the project is to trigger the change in our cities (physical, environmental, and cultural), reconsidering nature as a structural part of the urban space. To trigger this change, it is necessary to define the priorities, potential, and availability of land to plant trees.

The paper describes the process of engaging the municipalities within Milan's metropolitan area to build land availability.

Of the 133 municipalities, the research group engaged 62 with a signed MoU to participate in the project. This MoU defines the political and technical willingness, as well as the strategy through which green systems will be implemented. Moreover, the research group has built a live database in which we record the available lands to plant trees thanks to the continuous work with the different administrations. Since starting the project, 41 sites have been subject to intervention funded directly by Forestami funds, equal to 50,000 new trees and shrubs. The common effort, public and private, accounts for 427,475 plants since the beginning of the project.

To conclude, as the paper describes the physical spaces entangled in the transformation as a way to reflect where policies and projects should take shape in our cities, a change of approach is needed by the population but also by those who plan, manage and govern the territory.

## 25 Years of EFUF – how a European urban forestry community was built

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### Abstract

In 1998, the first European Forum on Urban Forestry (EFUF) was held in the city of Wuppertal, Germany. Forestry professor Max Krott initiated the Forum as a platform for researchers and practitioners working with primarily 'city forests' to meet and exchange ideas. Since then, EFUF has been held annually in cities throughout Europe – with an incidental online event during the COVID-19 pandemic. The Forum has been broadened to include all aspects of urban forestry, from street trees to peri-urban woodland. In 2023, EFUF even became a legal association of its own under Belgian law, further strengthening its position as one of the leading urban forestry networks in Europe and the world. This presentation looks back at the history of EFUF and its essential role in building a European urban forestry community. Some of the key achievements and spin-offs of the Forum are highlighted.

# The Second World Forum on Urban Forests: greener, healthier and happier cities for all

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## Abstract

Public spaces within our cities are being redefined through a wide range of nature-based interventions. If well planned and managed, urban forests and trees can promote social inclusiveness by enhancing the liveability of neighbourhoods and shaping more socially inclusive and sustainable cities. The importance of public green spaces in cities has become especially clear during the current COVID-19 pandemic, inasmuch as they provided quality spaces for recreation and exercise while maintaining social distancing (for those who were allowed to use them) or simply delivered mental restoration for residents who only had visual access to greenery during the lockdown. City-wide policies and strategies should ensure proper planning, design, and management of green spaces at different scales as places for use by multiple and diverse social groups. In order to meet this objective, however, it is crucial to look at the context in which solutions should be implemented. The creation of new green space does not automatically lead to socially just and inclusive development; co-benefits should be available and accessible to the entire community. Prejudices, marginalisation, and discrimination because of socio-economic condition, ethnicity, religion, gender, age, or disability still prevent the equitable distribution and access of these benefits and need to be fully understood before any planning process is undertaken. It is important, therefore, to identify ways to ensure the integrated and transdisciplinary participation of diverse actors in all the phases of the planning and implementation process of urban forests and green spaces. Experts and planners must also be aware of and take into account possible social inequalities to ensure that all voices are adequately heard. The 2<sup>nd</sup> World Forum on Urban Forests (WFUF), which will be held in Washington DC in October 2023, aims to address this crucial theme by creating a global stage promoting exchange among practitioners, scientists, and decision-makers concerned with both the environmental and social aspects of urban development. To discuss how the benefits of urban forests and trees can be made equally available to all, the technical and scientific programme of the Forum will focus on health, inclusion and resilience, providing examples of ways in which cities can take action to become greener, healthier and happier cities for all!





## Project idea seed session

This interactive session will be a marketplace where new project ideas can be presented, upcoming calls can be discussed and interest in participating in project proposals can be indicated.

Every participant can present a project idea and discuss it with other EFUF delegates. Participants can also opt to contribute to an upcoming project proposal.

# Sharing urban forest stories: workshop on intersectional belonging in practice

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## Abstract

'Sharing Urban Forest Stories' is the workshop component of ongoing PhD research by creative practice, exploring how a sense of belonging contributes to equitable access to urban forest places across communities. Because although urban forest places offer countless benefits for the environment and human well-being, quantitative data shows how engagement with and access to urban forests and their benefits is unequal. Age, ethnicity, health, and deprivation influence levels of engagement and time spent in nature. Allowance for a sense of belonging is an important factor in mitigating this unequal access. But what does it mean to belong in an urban forest place? And how can urban forest practitioners, policymakers, researchers and managers work with this notion?

A methodology of place-based storytelling and critical reflection through writing is being developed in the PhD research. The intersectional approach moves beyond binary thinking: we are more than just our gender, age, class, health, or other identity aspects. Place-based storytelling sessions are used to explore intersecting identities of human dwellers, more-than-human occupants and the very place itself. The lived experiences of those sharing their stories allow for qualitative and creative contributions to expand our understanding of how equitable access to urban forest places can be achieved.

This workshop is a demonstration of such place-based intersectional storytelling. In an hour [with a possibility to shorten/lengthen the demonstration], up to 24 participants will work outside on campus or in the forest [weather permitting, alternatively inside]. After a short introduction, the majority of the time will be used for prompted intersectional explorations. The event concludes with sharing the collected stories in the group, comparing experiences and taking note of emerging themes and applicable tools.



## NBS for socio-ecological metropolitan river restoration: H2020 CLEARING HOUSE and LIFE UrbanGreeningPlans experiences in the Llobregat River

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### Abstract

The abstract focuses on the recovery of the metropolitan section of the Llobregat River. To do so, it explores the social and environmental benefits of nature-based solutions (NBS) related to trees and shrubs, as well as the lessons learnt from two valuable experiences: H2020 CLEARING HOUSE (CH) and LIFE UrbanGreeningPlans (UGP).

The Llobregat River is one of the key areas of the metropolitan green infrastructure in terms of ecological, economic and social values. The Metropolitan Area of Barcelona (AMB) has been working for years to improve the environment and landscape of the river, seeking a balance between its environmental values and social use. From 2006 until today, the incorporation of NBS has grown in significance each time it has been used. With the support of CH and UGP, AMB is currently studying the environmental and social impact of these solutions, as well as their contribution to creating awareness of the river's value and involving people in its conservation.

UrbanGreeningPlans aims to improve green infrastructure and increase the ecosystem services and the environmental quality of the metropolis. In AMB, in particular, the project focuses on the environmental and social impact of the NBS implemented in the Llobregat River. The main goals are to identify gaps and opportunities, to create knowledge and disseminate the benefits of these types of solutions, as well as wider use of these solutions in metropolitan river environments.

CLEARING HOUSE aims at analysing and developing – across China and Europe – the potential of Urban Forest NBS for enhancing the resilience of cities and metropolitan areas that face major ecological, socio-economic, and human well-being challenges. In the case of AMB, the project seeks to involve people, entities and other local agents from the territory of the Llobregat River to provide a close and participatory governance model. The main objective is to share and create collective knowledge related to NBS, especially those based on urban forests and trees.

The main challenges from these two experiences refer to planning and governance, and consideration of tree-based NBS in all phases of a project (planning, design, management, monitoring and dissemination). The major concerns are how to encourage a more extensive use and range of NBS in the river and other urban and peri-urban areas, as well as how to increase the synergies with the different actors and stakeholders with competencies in the river area.

# Urban forestscapes in the city of Umeå and their significance in the city's sustainable growth and development

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## Abstract

Umeå is situated around a river and near the sea, surrounded by forest and cultivated plains with snowy and cold winters and sunny summers. Having a very accessible green and blue infrastructure and providing a variety of possible activities and experiences to its inhabitants is central to Umeå's sustainable urban planning.

The Umeå municipality has a population of 120,000 today. Umeå Municipality's overarching goal is that Umeå will reach 200,000 inhabitants in 2050 and that this growth must go hand in hand with social, ecological, cultural and economic sustainability. This means that tens of thousands of houses will be built together with schools, preschools and nursing homes. Substantial infrastructure (e.g. houses, schools, preschools and nursing homes) investment is ongoing and will continue. Umeå will be climate neutral by 2040 and, together with eight other cities, has signed a climate contract with the government to lead Sweden's climate transition. In order to cope with this transition, cooperation and collaboration, e.g. with local universities, is required. There are many challenges to cope with to achieve sustainable growth, such as the climate, skilled human resource procurement, transport, construction, energy, digitalisation, integration and food.

In this talk, I discuss the sustainable development of the city of Umeå through the urban forestscape lens, i.e. management of urban forests; management of parks and trees in the city and the construction of commercial and residential multi-storey buildings from wood. I will present a few projects (Field research station Röbbäcksdalen; Urban and peri-urban green infrastructure for biodiversity and ecosystem services; Climate Neutral Umeå 2030) that are cooperation between Umeå City and the Urban Futures platform at the Swedish University of Agricultural Sciences.

# The place of ecosystem services in urban and forest planning in Turkey

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## Abstract

With rapid and unplanned urbanisation in Turkey, the urban population's need for green spaces has been inevitably increasing. In this study, the urban forests, protection forests, and nature parks around or in the cities with high potential for ecosystem services are taken as examples. Although these areas are 1.6% of the country's forest areas, they play a vital role for the urban population, which makes up 93.2% of the country's population. Protection forests correspond to areas managed to maintain protective functions such as soil and water protection and protection against natural disasters. There are 55 protected forests in Turkey, covering 247,705 ha. 137 urban forests, which meet city residents' expectations from forest areas, currently cover 10,266 ha. Nature parks, one of the protected areas in the forest regime, have been declared since 1983. Today, 260 nature parks cover an area of 109,638 ha.

National forestry policies and scientific studies have been considered to determine the ecosystem services these three forest types provide to society. In this concept, plans, programmes, and legislation have been examined. A total of 24 ecosystem services have been classified and defined. It was found that protection forests in Turkey included services from all ecosystem services except habitat or supporting services. Nature parks also have services from three categories but none from provisioning services. Finally, urban forests include services in only two categories: regulating and cultural services. Unfortunately, due to the rapid increase in the urban population, these forests are only used for recreational purposes and other ecosystem services are ignored. Moreover, commercial facilities built for recreational uses cause the deterioration of the forest's integrity in these areas.

Although the number of scientific studies on ecosystem services provided by forests has increased in recent years, the number of cases defining and elaborating on them in the forestry legislation or plans in Turkey is limited. Ecosystem services must be considered both in city and forest planning. Even though forest administration in Turkey is only under the responsibility of the Forestry Service, the municipalities should consider forests as one of the main parts of urban planning. Also, the scientific studies on forest ecosystem services for healthy cities should be increased, and the results should be implemented.

## Evaluation of the adaptability of Istanbul's city plans

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### Abstract

Planning, as a forward-looking action that evaluates physical, environmental, and social concerns together, is the most important tool for the adaptation of a city to new situations. In metropolitan cities where physical, environmental, and social problems become complex and unresolved, the adaptive function of planning comes to the fore. However, while the rent-based construction practices in these cities prevent the planning from fulfilling its functions, it is a serious threat to the urban ecosystems.

The increasing influence of political approaches based on economic rent on planning decisions in Istanbul, Turkey's most populous city and one of the world's metropolises, is an obstacle to protecting urban ecosystems and developing adaptation.

In this study, the adaptability of Istanbul's urban planning studies was investigated based on land cover/land use, surface temperature, and NPP (net primary production) change rates. Land cover/land use change, surface temperature, and NPP change determined by using multi-time satellite images of Istanbul covering the years 1984–2020, climate change, deforestation, green area losses, floods, and urban heat show that it makes it difficult to adapt to global problems that are now turning into disasters. For example, while urban open green spaces and forest areas made up 57.2% of the city in 1984, this rate decreased to 47% in 2020. During this period, urban open green areas and forest areas decreased by 321.5 km<sup>2</sup> and turned into built-up surfaces. Therefore, with the effect of dense housing, the average surface temperature in the city increased by 7°C between 1984 and 2020, and there were negative changes in NPP values. While an annual average of 0.490 tonnes of carbon was stored in 1 m<sup>2</sup> of urban open green spaces and forest areas in 2002, this rate was determined as 0.418 tonnes in 2020. According to these data, the understanding of planning in Istanbul needs to change in favour of the ecological system immediately. Otherwise, artificial surfaces will cover a significant part of the urban ecosystem. In such a case, it will be very difficult for Istanbul to adapt to global problems.



# Reporting from the front: tackling social and ecological vulnerability in contemporary urban laboratories

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## Abstract

According to UN-HABITAT, cities are responsible for 80% of greenhouse gas emissions while only comprising 2% of the land mass – an immense ecological footprint showing the inseparable link between nature, cities and sustainability. This evidence shows that the art and process of making and managing cities and all its aspects must go through a process of re-thinking.

We tend to take only the built volume: the mobility infrastructure and buildings of a city as the only determining characteristics of a sustainable city. In this sense, urban landscapes possess immense potential for proactively improving the sustainability of cities because of their direct connection to urban natural systems.

The presentation argues that urban landscapes need to become more flexible and adaptable offering important services for the city, which would also enhance the socio-cultural and political implications of constructed space. We require a multi-scale, multi-functional and inter-disciplinary approach for designing and planning to adapt to the needs of a peak-oil society.

This presentation proposes an increase in the importance of integrated urban solutions in which urban landscapes and their ecosystem services can firmly contribute to urban sustainability and self-sufficiency – and help decrease social and ecologic vulnerability. It will focus on real-world applied research and practice examples from Ukrainian cities, Mannheim, Sarajevo, Basel and other 'urban laboratories'.

## Delivery with developers – a 40 year perspective

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### Abstract

In the UK, the housing industry has a reputation for disregarding, damaging and destroying the trees that stand in its way. This presentation draws on work with local councils, commercial developers and communities in order to make the urban forest an integral and sustainable feature of a wide range of residential developments.

Positive examples are varied in size and context. They include the following:

- Problem inner city public housing in Belfast, London, Liverpool and other major British cities which were characterised in the 1980s by civil unrest, and where public involvement with landscape renewal was used as a tool to encourage positive community empowerment and cooperation.
- Sophisticated retirement housing, where success in national award schemes identified the market appeal of high-quality communal landscapes for elderly clients with a lifetime's love of gardening.
- The London 2012 Olympic athletes' village, where a high level of international attention prompted a commitment to a housing landscape designed to address the urban impacts of climate change, and to provide sustainable waste-water management.
- The Heygate estate in London's Elephant and Castle district. Hundreds of 1970s high-rise apartments, abandoned and empty for ten years, were demolished and replaced with new homes – all in the context of a mature urban forest. Housing layout redesign, ground penetrating radar surveys of root-spread and services, a training film for the workforce, sensitive site-engineering and positive community engagement all combined to achieve the highest levels of professional and public recognition. The renewed housing, now known as Elephant Park, has won major local, national, and international awards including two nominations for the Sterling Prize, and London's top Placemaking award.



## Urban forests as a strategy for healthy cities

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### Abstract

Urban forests provide multiple ecosystem services for city dwellers, amongst which improving public health via mitigating mental stresses and providing attractive spaces for diverse physical activities has attracted increasing attention from scholars and policy makers facing the urgently-needed post-pandemic urban transformation towards healthy cities. This talk aims to summarise existing empirical evidence pertinent to the linkage between urban forests and public health maintenance and improvement. It highlights three underlying mechanisms, i.e. physiological, psychological, and immunological pathways, and outlines practical implications for the establishment and management of urban forests as a strategic solution for healthy cities.

# Disentangling the relationship between green spaces and citizens' perceptions in Europe: the mediating effect of quality of life and role of per capita gross domestic product

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## Abstract

People perceive many health and well-being benefits from urban green spaces, including improvement in quality of life. So far, these benefits have been studied mainly at a city level, while research on a larger scale, such as a European one, is lacking. There is no evidence of the association between green spaces and benefits perceived by citizens based on socio-economic differences between cities. This study aims to clarify the relationship between urban greenery, perceived quality of life, environment, social inclusion and urban management in 51 European cities, and the role of per capita income in moderating the effects of greenery on the overall quality of life. Through structural equation modeling, we tested the effect of greenery on the overall quality of life perceived by citizens (i.e. on the environment, social inclusion and urban management). We also investigated the role of metropolitan gross domestic product per capita in moderating the relationship between greenery and citizens' perceptions of overall quality of life. Our results confirm the influence of greenery on citizens' quality of life. More importantly, the influence of greenery on the perceived overall quality of life was much more evident in low-income cities. This study represents one of the first attempts to explore complex mechanisms underlying the association between green space and citizen well-being at a continental level. Practical implications for urban planners and European policy makers are discussed.

## Socio-spatial inequalities in the distribution of benefits from school greenery

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### Abstract

The quality of the school's outdoor environment is essential for children's physical health and well-being. One of the essential factors shaping the outdoor environment is greenery. Although the provision of greenery has been studied broadly in the urban context, little attention has been paid to specific spatial and socio-spatial inequalities among children and their access to environmental benefits from school greenery. This study assesses socio-spatial disparities in the provision of greenery around primary schools. We conducted comprehensive on-site environmental measurements of greenery in the schoolyards. A spatially stratified sample of  $N = 54$  schools was drawn randomly from all primary schools in Lodz (Poland). For each schoolyard, we took environmental measurements in two locations most frequently used by children – close to the school building entrance and the school's recreational site. Environmental measurement consisted of air temperature and air pollution (PM<sub>2.5</sub> and PM<sub>10</sub>). Also, we took panoramic pictures and thermal photos and listed the major vegetation structures, such as trees, shrubs, and grass and quantified their leaf area index. Our results show that school greenery is distributed unevenly among schools and within schoolyards. We found that the structure of vegetation in schoolyards depends on the location of a school in the city. Our findings support urban planning and design by highlighting the necessity of focusing more profoundly on the amount and structure of greenery around schools.

# Intersectional belonging: exploring senses of belonging for equitable access to urban forest places across communities

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## Abstract

Places can mean different things to different people. Forested places, especially, have a long history of capturing people's imaginations. Now that most humans dwell in cities, urban forests often are nature closest to home. And although such urban forest places offer countless benefits for the environment and human well-being, quantitative data shows how engagement with and access to urban forests and their benefits is unequal. Age, ethnicity, health, and deprivation influence levels of engagement and time spent in nature. Allowance for a sense of belonging is an important factor in mitigating this unequal access. But what does it mean to belong in an urban forest place?

This talk presents ongoing PhD research by creative practice on exploring how a sense of belonging contributes to equitable access to urban forest places across communities. The intersectional approach moves beyond binary thinking: we are more than just our gender, age, class, health, or other identity aspects. Through place-based storytelling sessions, intersecting identities of human dwellers, more-than-human occupants and the very place itself are explored. The lived experiences of those sharing their stories allow for qualitative and creative contributions to expand our understanding of how equitable access to urban forest places can be achieved. This intersection of urban forestry, environmental justice and community engagement makes explicit how bias in design, planning and legislation impacts accessibility for end-users of urban forest qualities. The results can support urban forest practitioners, policymakers, researchers and managers in creating more inclusive and accessible urban forests for all.

# Achieving human thermal comfort via green infrastructure in a future climate.

## A comparative analysis of the cooling capacity of two most common tree species in Munich, Germany

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### Abstract

Climate change has been evidenced in multiple ways, affecting the health and well-being of humans in cities through an increase in heat stress. Green infrastructure is increasingly recognised as a means for cooling cities and enhancing thermal comfort in outdoor spaces. Urban trees are particularly effective as they provide shade in addition to evapotranspirational cooling. However, they are increasingly at risk of harsh urban growing conditions which are exacerbated by more frequent and prolonged drought events in Central Europe.

Munich is the third largest city in Germany and holds appr. 13.6% of the urban area as public open spaces. Among the public spaces, Munich's green urban squares represent an important resource for improving human thermal comfort. Two of the most common species observed in Munich's urban squares are *Tilia cordata* and *Robinia pseudoacacia*, which have been the focus of previous studies in comparing their growth and ecosystem services in different urban environments. The species contrast in size, leaf morphology, and density, among other aspects. Rahman et al. observed that the cooling ability of these two species depends on their water use efficiencies. Despite *T. cordata* having a better performance in current climates due to higher transpiration and 35% higher leaf area index, *R. pseudoacacia* seems to be more adapted in climate change scenarios due to its better water use efficiency.

In a systematic approach, this study analyses the impact of these two tree species on human thermal comfort in the summer season considering the IPCC 2.6 and 8.5 future scenarios. Microclimatic simulations were carried out using ENVI-met. The model now allows simulation of the tree's physical characteristics, but not yet their physiological characteristics like their strategies under water stress.

Marstallplatz square was selected as our study case. Initial results suggest that, despite the better water use efficiency of *R. pseudoacacia* compared to *T. cordata*, frequent drought stress can affect irremediably the tree's health, compromising its ecosystem services. In the following stages of this research, we intend to improve the tree's modeling in ENVI-met, to reproduce their physiological characteristics to contribute to the discussion regarding the appropriate tree selection to maintain future outdoor thermal comfort in Munich city.



# The role of urban green spaces in mitigating heat stress and promoting health: insights from a German survey

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## Abstract

Urban green spaces (UGS) are increasingly recognised as critical components of cities, providing many benefits that improve the environment and support our physical, psychological, and social health. This includes mitigating the urban heat island effect and its negative impact on public health and the environment, as well as providing opportunities for people to interact, recreate, and connect with nature.

To explore attitudes towards UGS, we surveyed a nationally representative sample of German adults (n=1015) after the unusually warm summer of 2022. As part of our questionnaire, we asked respondents to identify their preferences, frequency and duration of use and perceived benefits and challenges of these spaces. We also developed specific questions to measure their perceptions and views of UGS as a climate adaptation strategy to mitigate heat stress.

Our results reveal that the primary reason for visiting UGS is the potential positive impact on health and well-being. Interestingly, more respondents reported visiting these spaces to enjoy a healthy environment and the opportunity to unwind than for physical activity or social interactions. The survey also revealed that more than half of the respondents live within a 15-minute walking distance from their nearest green space. Although less than 20% of respondents frequently visited parks or forests on very warm days, UGS remained a popular option for those seeking relief from the heat, as they were preferred over using air conditioning or visiting cooled buildings.

In terms of policy preferences, over 70% of respondents believed that local governments should prioritise the creation of more parks and shaded green spaces to address the impacts of warm weather, and over 80% of respondents supported the planting of more trees along streets as a solution to these impacts. Interestingly, this level of support was much higher than that for other potential solutions, such as air conditioning or expanding public access to cooled buildings.

These findings suggest that citizens recognise the significant role UGS can play in mitigating the impacts of rising temperatures in urban areas. Local governments should take note of these sentiments and prioritise the creation and maintenance of UGS as part of their efforts to address the impacts of climate change. By investing in these solutions now, cities have the opportunity to create more resilient communities and ensure the well-being of their residents for years to come.



## Smart water management in urban forests: the approach of LIFE URBANGREEN

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### Abstract

Urban trees are exposed to increasing levels of stress due to extended droughts. This affects not only the health of trees but also the quantity of benefits which trees serve to the city environment. A tool to monitor the tree vigour, based on their characteristics, but also on meteorological data and on scientific parameters to estimate the transpiration rate, can be very effective in detecting trees under stress and help maintainers with instructions on irrigation needs.

In the LIFE URBANGREEN project an IT tool was developed to assess the water balance available to trees. Based on scientific research carried out by the University of Milano (Italy) on about 500 urban trees in Rimini (Italy) and Krakow (Poland), species coefficients (Ks) were calculated as the ratio between actual evapotranspiration (ETE, measured using leaf gas exchange techniques) and potential evapotranspiration (ET0, calculated from weather data). Using weather data, Ks, and tree crown projection area, it is now possible to estimate the water balance in the soil and indicate every day which trees need water.

The information on irrigation needs is calculated in the management software GreenSpaces and generates a work programme to carry out the irrigation task. The work schedule is transmitted to the mobile phones of operators indicating which trees need irrigation, their position and the amount of water required. Once the irrigation has been carried out, the information on the amount of water provided to trees is used again to update the total water balance available to the specific tree in the management platform.

The scientific basis, the methodologies applied, and the final tool developed in the GreenSpaces platform were tested in Krakow and Rimini during the last year of the LIFE URBANGREEN Project (2018–2021).

# The importance of urban landscape texture for the hydrological ecosystem service provided by urban trees

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## Abstract

Urbanisation and climate change disrupt the urban hydrological cycle, resulting in increased surface water runoff. The runoff reduction ecosystem service provided by urban trees (RRES) is a sustainable approach to mitigate urban runoff. Landscape changes disrupt the sustainability of RRES. Improving our knowledge of the links between urban landscape structural texture (ULST) and RRES is essential for properly managing urban landscapes to maintain a sustainable RRES supply. Through developing a novel approach, this study provides scientific evidence to understand how RRES responds to the multiple measures of ULST in Tabriz, Iran.

The capacity of urban trees for RRES was quantified using i-Tree Eco. Landscape texture of land use and cover (LULC) classes were quantified through aggregation metrics: interspersions & juxtaposition index (IJI), percentage of like adjacencies (PLADJ), aggregation index (AI), clumpiness index (CLUMPY), landscape shape index (LSI), normalised landscape shape index (nLSI), patch cohesion index (COHESION), number of patches (NP), patch density (PD), landscape division index (DIVISION), splitting index (SPLIT), effective mesh size (MESH) and Euclidean nearest neighbour distance distribution (ENN\_MN)) using FRAGSTATS. Landscape aggregation metrics (as independent variables) and the provision of RRES (as dependent variable) were entered into a stepwise regression analysis to specify which metrics would better explain the RRES provision. The results indicated that trees in Tabriz reduced 196,854.15 m<sup>3</sup> of runoff annually. The findings of the regression modeling showed the effects of the ULST on the annual RRES. Regression models ( $p \leq 0.05$ ) suggested that the provision of RRES could be significantly predicted using the measures of the AI ( $r^2=0.977$ ), CLUMPY ( $r^2=0.962$ ), MESH ( $r^2=0.964$ ), and nLSI ( $r^2=0.978$ ). The findings demonstrated that the aggregation of the given LULC patches might affect the patches' functions, which consecutively affects the provision of RRES. The findings indicated the significance of the aggregation for the RRES supply and revealed that the aggregation metrics for LULC patches could be utilised to develop the RRES prediction model. Our approach helps effectively manage urban landscapes and resiliently maintain and enhance the sustainability of RRES supply.

## Sponge city principle for sustainable urban tree growth: innovative substrate and vegetation systems in Zurich's industrial district

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### Abstract

The escalating threat of heatwaves and heavy rainfall in urban areas has raised pressing challenges that necessitate suitable solutions. One of the proposed solutions is the sponge city principle, which gives prominence to urban trees. A pilot project commissioned by Grün Stadt Zürich in Zurich's industrial district aimed to show the feasibility of this principle. The proposed concept has a common denominator based on structural measures combined with adapted substrates and vegetation.

The actual construction method involved a classic tree lawn as a tree trench without additional structural measures for water retention. This was feasible because of the availability of adequate space for the continuous green strip. The focus was, however, on an innovative substrate mixture and a functioning vegetation system based on scientific findings. The decision-making process for the project in Zurich resulted in the selection of three tree species: *Salix alba* 'Liempde', *Gleditsia triacanthos* 'Skyline', and *Ulmus* 'Rebona'. Deep-rooted steppe vegetation was established on the street side, and functional perennials were planted to support the urban trees. The vegetation system under the trees served not only as an eye-catcher but also as an indicator of the changing substrate properties.

Since additional measures for water retention, storage, and purification were not incorporated in the structural implementation, the substrate was designed to meet these requirements. The unique substrate was developed for the specific situation in Zurich, utilising the basis of the Wädenswil principle and the Stockholm construction method. The 'sandwich' structure consists of a two-layer construction with a humus layer that represents the preferential root area and a filter layer. This design aimed to provide optimal support in nutrition availability and water filtration, ensuring a sustainable supply balance for the urban trees. A specially constructed inlet shaft ensured that no salty rainwater flowed into the green area during the winter season but was directed to the sewage system.

Large differences in tree development were observed after two years. These differences were evident not only among tree species but also between individuals and perennials. Since no irrigation was required during the heatwave summer of 2022, it can be expected that this sponge city component has fulfilled its crucial role.

# Structurally stable substrates for sustainable green infrastructure and stormwater management: a field trial with urban trees in Wädenswil

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## Abstract

The availability of space for urban trees has been continuously decreasing due to the increasing densification of urban areas, compaction of planting substrate, and the presence of underground pipelines. Urban trees are an integral part of green infrastructure in urban areas, providing valuable ecosystem services such as shading and cooling, as well as opportunities for stormwater management to reduce pressure on wastewater systems. To address these challenges, the use of structurally stable substrates that resist compaction and have increased water storage capacity is a potential solution for sustainable green infrastructure and stormwater management.

To develop such substrates, Grün Stadt Zürich has commissioned an investigation of structurally stable substrates to be used in future urban projects. A field trial on the Grüental campus in Wädenswil was conducted, in which twelve elms (*Ulmus 'Rebona'*) were planted in three different substrate compositions, all containing biochar and large gravel stones that increase water and air capacity and can be compacted to 100 MN/m<sup>2</sup>. The three substrate mixtures differ in stratification (two- and three-layer) as well as composition (lavalite vs. expanded shale). Structurally stable substrates were placed under a simulated pavement to provide an opportunity for extended root development. Rainwater accumulating on the pavement was discharged into the tree pit and infiltrated, with the substrates in the tree pit containing smaller grain sizes and a higher proportion of components with high water-holding capacity. Soil sensors were installed to measure water content in the tree pit and under the pavement. Transparent root tubes allowed observation of subsoil and root development. Above-ground tree development and vitality were assessed using tree bonitures several times a year.

These innovative substrate compositions are intended to show that they can be beneficial when used under the pavements, thus enabling extended root development. This not only improves the living conditions of urban trees, but also increases the drainage capacity of green spaces in cities, offering a potential solution to the challenges of extreme weather events due to climate change, despite the increasing density of urban areas.

# The urban blue-green network as an important element of the management of ecosystem services: a case study of Krakow River Parks

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## Abstract

The application of urban forests and other forms of blue-green infrastructure (BGI) or nature-based solutions (NBS) is an important element of sustainable management of urban areas, especially in the context of climate change. In this context, a big challenge is the linking of BGI/NBS in Blue-Green Networks (BGN). The implementation of such projects requires the development of scientific methods for assessing the continuity of BGN, activities aimed at maximising and optimising the ecosystem services they provide, and finally, developing interdisciplinary integrated methods of creating and supporting the network. On the one hand, the benefits of the network approach in protecting and creating forests are well documented and understood by practitioners and scientists; on the other hand, its effective use in city management encounters many various barriers (legal and administrative; ownership and financial; technical and organisational, etc.). Therefore, the actual development of this type of BGN in an urbanised and intensively used space is still a novelty and a real challenge. The main aim of our contribution is to discuss and analyse the above-described subject on a case study of Krakow, and its system of River Parks. Thus, in the first part of our presentation, the research stages which have already been completed will be presented, i.e. detailed characteristics of the Krakow BGN and analysis of its current extent and continuity carried out on the basis of field research and orthophoto map analyses, existing planning documents and analysis of hydrographic maps, land records and local development plans of Krakow, as well as spatial analysis performed using QGIS software based on the Municipal Spatial Information System in Krakow. To make full use of the potential of BGN, it must be created, developed and supported with the participation of all municipal units responsible for city areas (green areas, water and sewage management or road infrastructure). Therefore, in the second part of our presentation, the most important research questions and challenges will be defined and discussed, especially the technical, financial and administrative tools required to extend the physical range of the Krakow BGN and to enrich the ecosystem services provided by it. We will then also propose ways to strengthen and support the sustainable management of urban forests and other forms of BGI/NBS in the city of Krakow, which faces several social, ecological and financial challenges.

# Application of blue-green infrastructure as nature-based solutions: practical examples from England, the Netherlands, and Wales

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## Abstract

This contribution introduces three European case studies demonstrating the practical integration of blue and green infrastructure, where trees were planted with the help of suitable infrastructure to deliver nature-based solutions within the urban environment.

An English case study is an example of how alterations to the road network in and around a historical town centre, driven by a municipality's desire to alleviate traffic congestion, can achieve additional benefits with the help of blue and green infrastructure. A new tree planting scheme along a redesigned section of a road not only contributes to greening the town, but the trees play an important role in reducing air pollution. Faced with a combined sewer at capacity, the tree planting is concurrently utilised as a multi-functioning system for stormwater attenuation and as treatment pits for road runoff pollution.

A Dutch case study, delivered as part of an EU-funded Interreg project, demonstrates how retrofitting a road by planting trees in hard surfaces using a suitable infrastructure not only aids future temperature regulation as a primary objective, but also addresses public health issues and improves a city's climate change resilience. Having such foresight means the blue-green infrastructure installed as part of this intervention can simultaneously act as an effective stormwater management solution during periods of high rainfall.

A Welsh case study shows how retrofitting high-density residential areas with suitable blue and green infrastructure not only reduced pressure on an ageing sewer network but delivered a myriad of benefits for its local communities, including new cycle-friendly routes.

Implementation of innovative sustainable urban drainage solutions benefited the natural environment too, significantly improving water quality in nearby watercourses. This ground-breaking project involved the water company with several partners, including the municipality, which has the ambition to be the lead city in Europe for sustainable urban drainage, positioning itself as a 'Water Capital'.

The case studies show that blue and green infrastructure – water and trees – are not mutually exclusive, but can complement each other. In our towns and cities where available space is limited, turning blue and green ideas into blue-green realities not only resolves the common lack of space issue, but enables the delivery of nature-based solutions, maximising benefits for nature and local communities.





# Exploring the distribution of non-native tree species in urban environments: insights from a pan-European database

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## Abstract

The early inhabitancy, along with the climatic conditions and terrain characteristics, have allowed for relatively free mobility of non-native tree species (NNTs) across Europe. The urban environments have been, and continue to often be, the introduction point for NNTs. Frequently, they are also conservation points for certain species, e.g. city parks, botanical gardens, arboretums, etc. While there has not been a widespread agreement on the usage of NNTs, previous research efforts have focused mainly on revealing the potential risks and benefits. This has indeed allowed for a better grasp of their physiological and adaptive properties. However, in the European context, we currently do not have abundant, inclusive, and consistent knowledge regarding the distribution of NNTs.

Utilising the network of researchers and practitioners from the COST Action 'Pan-European Network for Climate Adaptive Forest Restoration and Reforestation' (PEN-CAFoRR, CA19128, 2020–2024), we have established an open database to gather information regarding NNTs. During the development, we concluded that restricting the use of resources to peer-reviewed studies causes a substantial limitation. Thus, we have also encouraged a planned and structured use of grey literature. While the database remains open and future entries are welcomed, we have recently produced a publication using the data provided by the members over the course of 10 months (January – October 2021) (Dimitrova et al. 2022). The data gathered from 20 European countries was integrated with the EUFORGEN and EU-forest datasets regarding the distribution, and further literature revision was conducted. The results from this study highlight numerous under-studied NNTs that are not necessarily less distributed. Furthermore, they emphasise the likely bias in past studies towards species of particular interest due to their benefits and/or invasive behaviour. Finally, the majority of the entries allow us to directly correlate the urban environments as introduction points for NNTs, as well as the practice and interest for their use in urban forestry.

Future studies on the distribution of NNTs in urban environments, as well as the potential risks and benefits they hold across various European cities, may be crucial for deciding which species to use to create new urban forests and green spaces that can deliver more social and environmental services, especially in the light of the anticipated climatic challenges in the future.

# The extraordinarily high species richness in European urban trees – implications for invasive forest pests

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## Abstract

Urban tree inventories give an insight into the species compositions of urban trees. In Europe, there are many more tree species in urban environments than in the surrounding forests. While much work has focused on future climate-resilient trees, ecosystem services provided, and biodiversity, there is comparably little attention paid to the role of urban trees as the first potential hosts that introduced invasive species. Most invasive forest pests are first introduced in urban or peri-urban environments before they spread further, making urban trees potential steppingstones for pests of trees in other cities or surrounding forests.

To examine what the extraordinarily high species richness of urban trees means for biosafety, we collected European urban tree inventories as part of the eCOST-action ub3guard. We obtained >100 tree inventories with >2.5 million individual trees from >2,000 species. We then explored how many of these urban trees are hosts of quarantine pests as defined by the European and Mediterranean Plant Protection Organization. We found that tree species composition in European cities is influenced by climate and culture and show how these factors indirectly influence frequencies of hosts for quarantine pests in Europe. We suggest considering potential invasive forest pests when choosing urban tree species for future planting.

# Physiological response and ecosystem services of *Tilia cordata*, *Robinia pseudoacacia* and *Acer platanoides* along an urban-suburban transect

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## Abstract

Urban green spaces play a crucial role in mitigating the negative impacts of urbanisation by providing important ecosystem services. This study aims to understand the relationship between sealing percentage, growth rate, and the ecosystem services of urban tree species along an urban-suburban transect in Bavaria, southern Germany. Three species (*Tilia cordata*, *Robinia pseudoacacia*, and *Acer platanoides*) were selected based on age and distribution and classified as street trees, parking place trees, and park trees. The study will answer the following questions:

1. Do the three species' growth and ecosystem services (e.g. shade area, transpiration, carbon fixation, and microhabitat) differ?
2. Does sealing percentage affect tree dimensions and stem growth?
3. Are there differences in ecosystem services and growth between urban and suburban sites?

A mixed methods approach was used, including measurements of tree structural variables, physiological variables, meteorological variables, and surface temperatures. The findings suggest that the tree species contribute to the ecosystem services in various ways. Our results showed no significant differences in carbon fixation among the species. *A. platanoides* were significantly different in the transpiration rate from *T. cordata* and *R. pseudoacacia*. *T. cordata* differed significantly in shade area from *R. pseudoacacia*, but *T. cordata* and *R. pseudoacacia* had no significant difference from *A. platanoides*.

Sealing percentage influences the tree height of all three species significantly, while the relationship with crown volume was significant for *A. platanoides* and *R. pseudoacacia*, and non-significant for *T. cordata*. The relation between DBH and crown diameter was significant for *Robinia* but non-significant for the other species. The Shannon's diversity index was 0.88, indicating a diversity difference of microhabitats between the species. Our results provide valuable information for urban forestry management and planning in urban areas in temperate regions.

# Species traits and growing conditions were related to crown dieback in community and city-owned peri-urban forests: a study from southwest Germany

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## Abstract

Community and municipality-owned forests within the city's administrative boundaries are part of peri-urban forests in southwest Germany, which have been facing an intense problem of crown dieback in recent years. As climate warms and global change-type droughts and heat waves intensify in southwest Germany, we posed three questions: 1) which variables are mainly contributing to crown dieback? – species, size, OR site conditions; 2) what was the spatial or species pattern of tree crown dieback? 3) were there any hot spots, focused species, or species groups of tree crown dieback?

To answer these, we sampled 2,578 trees from 68 randomly selected peri-urban forest plots in Karlsruhe and Rheinstetten, southwest Germany, during the summer of 2019 and 2020. 2018 saw a catastrophic drought in our study area, with continuing drought in 2019 and 2020. We did dendrometric surveys and measured crown dieback. We identified thirty-five common tree and shrub species in the peri-urban forests and compared crown dieback of different tree species and species trait groups.

We found that compared to introduced trees, native trees had better health conditions and lower crown dieback. Tree species with low drought tolerance had significantly higher crown dieback than medium and high drought-tolerant species. The species with medium drought tolerance had the best performance against crown dieback. We found that the lowest crown dieback in trees was with the diffuse-porous xylem type and the highest crown dieback was with the non-porous xylem type. In addition to tree traits, an increase in competition from neighbouring trees and tree size intensified the crown dieback across the species. However, the Gini coefficient and the Shanon-diversity index had no significant effect on crown dieback.

Our results suggested that future research should focus more on species traits to improve tree health and species selection under certain growth conditions and climate change.

# Microhabitat richness and abundance varied between species origin (exotic vs. native), size, growing environment (park vs. street), and crown management intensity: a study on four species from the city of Karlsruhe, southwest Germany

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## Abstract

Tree-related microhabitats (TreM) on single-standing urban trees may play a crucial role in urban biodiversity and the food chain, although our knowledge of urban TreM is still inadequate. Therefore, our objectives were to compare microhabitat richness and abundance between selected tree species from parks and streets. We assumed that microhabitat richness and abundance would change between species origin (e.g. native vs. exotic) and growing habitat (e.g. park vs. street). We selected two exotic (horse chestnut or *Aesculus hippocastanum* and black locust or *Robinia pseudoacacia*) and two native (linden or *Tilia cordata* and Norway maple or *Acer platanoides*) tree species in our study region of Karlsruhe, southwest Germany. Eighty trees from each species (N=320) equally distributed between parks and streets were randomly selected across the city in a factorial design. We only selected living trees with a minimum DBH (diameter at 1.3 m height) of 20 cm. We did a full dendrometric inventory of trees following the guidelines of the US Forest Service. We have used guidelines from the European Forest Institute to quantify TreM during field inventory. The mean DBH of the trees in the street and park, including all trees, was 42 cm and 45 cm, respectively. The mean living crown volume in the street and park were 325 m<sup>3</sup> and 408 m<sup>3</sup> per tree, respectively. Black locusts had the highest frequency of microhabitats, followed by linden, horse chestnut, and Norway maple, when all trees from parks and streets were combined. Microhabitat frequency was higher in park trees of linden, horse chestnut, and Norway maple trees than in their street counterparts. However, street trees of black locusts had more microhabitats than in parks. Microhabitats such as crown deadwood, cavities, twig tangles, crypto, and phanerogams were found more on native Norway maple and linden trees than exotic horse chestnut and black locust trees. However, microhabitats such as concavities, nests, and exposed sapwoods were more on exotic black locusts and horse chestnut trees than native linden and Norway maple trees. We have found that microhabitat richness and frequency increase significantly with tree size and decline with management intensity, such as increasing the number of pruned branches. We conclude that proper tree species selection and management intervention, such as optimizing pruning and allowing trees to grow larger, are essential for microhabitat provisions in the city.

# Impact of thousand cankers disease of walnut on the urban greenery and proactive management

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## Abstract

Black walnut is a valuable ornamental and timber tree of North American origin, extensively planted in Europe in the urban greenery since the end of the 17<sup>th</sup> century and, in recent decades, in woody plantations. This species began to show symptoms of widespread decline in the USA starting from the early 2000s. About ten years later (2011) an insect-fungus disease complex was identified as the cause of tree mortality. The agents responsible for this disease, called 'thousand cankers disease' (TCD), are the fungus *Geosmithia morbida* and, its vector, the beetle *Pityophthorus juglandis*. After a few years, the disease was also reported in Italy, the only country outside the USA where TCD is currently present. With both the fungal pathogen and its vector categorised as quarantine organisms in Europe, regulatory measures against them are compulsory. Italy is therefore the only European country that is currently facing the problem of TCD management. A different approach to this phytosanitary issue is needed in Italy (and Europe) compared to the USA. In fact, while in North America natural forests of black walnut have a high ecological and economic value, in Europe this is an introduced species. Therefore, it is not present in natural woods. The effort in the Old Continent must be aimed at eradicating existing TCD outbreaks and preventing new introductions. Here we report the management strategies that have been implemented in order to control the disease in Tuscany, particularly in the urban area of Florence, where the pests have been recently detected. Management efforts include: i) the development of fast and accurate diagnostic protocols; ii) phytosanitary surveillance at vulnerable sites (ports, airports, plant nurseries, wood-processing companies, loading stations); iii) monitoring of the territory for the detection of new disease foci at an early stage; and iv) disease eradication campaigns. Furthermore, since black walnut often grows in parks and public gardens, citizen science could validly support professionals in the early detection of new disease outbreaks.

# Crown damage of single-standing city trees after the catastrophic drought of 2018 – field observational studies on 79,753 trees from the city of Karlsruhe, Germany

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## Abstract

Recurrent extreme drought events coupled with a long spell of heatwaves are becoming common in southwest Germany. The impact of such extreme weather events on single-standing or lonely city trees can be higher than on trees in forests due to high exposure to solar radiation, wind, pollution, and varying water availability due to soil sealing and the mixture of technosol with natural soils. However, field observational studies on the health performance of a sizeable single-standing tree population after a catastrophic drought are rare in literature. Here, we would like to present the result of a study on how crown damage in single-standing city trees can be related to different biotic and abiotic factors after the catastrophic drought of 2018. We were interested in how crown damage can vary between tree species based on traits like leaf greenness (evergreen vs. deciduous), origin (neophytes vs. non-neophytes), drought tolerance, soil compaction tolerance, salt tolerance, waterlogging tolerance, and late frost tolerance. In addition, we aimed to test how abiotic variables like imperviousness of surfaces, land surface temperature, and trees' distance to groundwater may influence tree health. We used the spatially explicit data from the Tree Cadaster of Karlsruhe City, which comprised 152,105 trees. However, we shortlisted 79,573 trees with more than 100 species for the analyses based on multiple selection criteria. City tree inspectors physically measured tree crown conditions qualitatively using five crown damage classes. We only considered the trees evaluated in 2020 and 2021. We showed that nearly 25% of the trees in the sampled population had a 10% or higher level of crown damage. In addition, crown damage showed a variation between and within species. As the distance to groundwater increased, the health of trees declined as well. Tree species with a greater tolerance to drought and frost had lower crown damage. Non-neophyte or native trees had better tree health than neophyte or exotic trees. Evergreen coniferous trees had poorer health than deciduous broadleaved trees. We call for Germany-wide and EU-wide monitoring of city trees' health conditions as the climate warms in Europe. Understanding the pace and magnitude of crown damage in city trees and its underlying causes will help us to improve urban tree care, optimise our irrigation, and plan for short and long-term adaptation.





# Urban greening dynamics in Switzerland: pathways to gather forces and knowledge

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## Abstract

Large Swiss cities, such as Geneva, Zürich and Lausanne, have been forerunners in developing strategies for future greener urban structures. Countrywide local movements, notably driven by young people and representatives of 'green' parties, are emerging to support tree planting or creating micro-forests. However, despite a growing and large interest in urban forestry, national monitoring information has reported a slight decrease in urban tree cover in past years.

To better understand the national context and define elements that could support an improved dialogue on urban forestry at national level, the Federal Office for the Environment launched two studies on tree values and perceptions across Europe and Switzerland, as well as on the role of biodiversity in Swiss public and private tree planting schemes.

Trees are perceived positively, as long as they do not represent a neighbourhood constraint, notably in terms of view or security. Urban communities in general are increasingly concerned with the local tree environment and take an active stance in cases of tree cutting or replacement interventions. The risks posed by urban heat islands to citizens represent a further opportunity in terms of communication. However, practical constraints, in particular due to climate change effects, render it difficult to develop more generic planning guidelines. In addition, to preserve rural landscapes from urban sprawl, urban planning has to steer more towards multifunctionality which makes the implementation of nature-based solutions complex due to space requirements and economic constraints. Common barriers to the integration of trees in urban planning, such as the lack of a regulatory framework and standards, are observed, along with the difficulty of assembling and making coherent, the growing wealth of data and local initiatives. Overcoming silos and influencing policies remain core issues. Priorities have to be made across sectors, but appropriate structures are still missing for several cross-sectoral issues.

Our presentation intends to help better understand why the local growing interest in urban tree planting remains difficult to support through national and decentralised authorities. This contribution seeks to identify policy, planning and technical pathways that would allow an adaptive and collaborative framework to emerge, including coordination between public and private owners and sectors. A tentative national roadmap is presented as a basis for discussion.

## Growing the evidence base on the benefits of urban trees with citizen science

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### Abstract

Urban areas are increasingly looking to grow their urban forests to expand the environmental, social and economic benefits they provide. But our ability to inform how to best grow an urban forest to deliver the most benefits is limited by missing information on the current state of our urban forests. Further, our knowledge on urban trees and their benefits is often based on a small number of studies, which may not be transferrable to the diversity of urban forests and their various environmental and anthropogenic influences. Given this diversity within and across urban forests, there is a daunting data gap to be filled. We aimed to identify methods that can help to bridge this data gap. We focused on the opportunities offered through citizen science and new technologies, which could help gather data at pace and scale, while also engaging people with their local trees.

We identify three areas where improved data could facilitate better understanding of urban trees. Firstly, we address measuring the basics of tree size, such as height or crown size, which are often missing from urban tree inventories. We find a new 'tree-odolite' tool that allows tree size to be estimated from Google StreetView imagery collects urban tree size accurately and much faster than field measurements.

Secondly, we address how best to measure urban tree leaf area, a little studied but integral metric for ecosystem service estimation models. We test eight different methods of measuring leaf area, varying from citizen scientist friendly smartphone approaches to more advanced technological solutions (LAI meters and laser scanning), against 13 full destructive samples of urban trees. We find commonly applied allometric methods perform poorly, but identify opportunities for other accessible methods to measure leaf area quickly and cheaply.

Lastly, we explore tree growth, key to improving our ability to predict how our urban forests will change over time. Our two-year growth study found citizen scientists could robustly measure urban tree growth, allowing trends in growth for different species, land uses and climatic conditions to be uncovered.

Our project has highlighted the valuable role citizen scientists can play in helping us better understand our urban forests. In tandem with taking advantage of emerging technologies we can take greater steps in expanding our understanding of urban trees to help grow more productive and sustainable forests for our towns and cities.

# Mainstreaming the use of experiential information with PPGIS in monitoring urban forests as nature-based solutions

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## Abstract

Major cities in Europe are expected to experience urban population growth greater than 35% by 2030 (Lavalle et al. 2017) and are investing in UF-NBS, and associated ideas and technologies to address societal and environmental issues. The use of Participatory Public Geographic Information Systems (PPGIS) in natural resource monitoring and mapping has shown growth in technological innovation (Brown and Faberholm, 2015) and analysis of social-ecological impacts of natural resources (Korpilo et al. 2018; Ostoic et al. 2020). There is, however, less discussion regarding the integration with urban forest management and governance. Although digital public participation is rapidly growing, its impact on social capital is still scant (Mandarano et al. 2010). We present a framework for optimising the delivery of UF-NBS cultural ecosystem services by a practice-oriented model that provides a conceptualisation of citizen science data integration into UF-NBS planning and management. This model is designed to improve the social impact of citizen science data (e.g. PPGIS). We conceptualise the PPGIS application steps within the context of a Governance-Ecological-Social-Technological (GEST) system, which is adapted from a socio-ecological-technological (SET) systems framework for urban ecosystem services (McPhearson et al. 2022). This GEST system illustrates the role of PPGIS in connecting and being informed by the transactions between various UF-NBS sub-systems. Firstly, we describe UF-NBS cases in the CLEARING HOUSE project using a GEST framework to highlight the emerging transactions between GEST sub-systems. The model demonstrates how the transactions are expected to drive the PPGIS flow cycle for UF-NBS mapping and, as a result, improve PPGIS's social impact. Secondly, we illustrate how using the GEST framework could help to identify the key questions and issues to be addressed in a PPGIS survey and how to consider its application scale. These theoretical considerations aim at informing practitioners, policymakers, urban forest managers and researchers about the essential aspects during the design and implementation of PPGIS for urban forest mapping and monitoring. Linking PPGIS to the GEST framework may help in enhancing the provisioning of UF-NBS, increase the social impacts of PPGIS and improve the possibilities to address complex environmental and social challenges in urban forest planning and management.

# Use of focus group interviews for exploring and participatory mapping of cultural ecosystem services and disservices of urban green space – an example from the city of Zagreb, Croatia

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## Abstract

According to the recent EEA report, Zagreb is among the greenest cities in Europe. Indeed it boasts that forests cover one-third of its territory, one-third is agricultural land, and one-third is a built environment. However, in the eyes of the citizens, it may be perceived differently. Previous studies in Zagreb showed that public participation still needs improvement, a commonality that Zagreb shares with many Eastern European cities. We explored several cultural ecosystem services of tree-based urban green space (UGS) – place attachment, aesthetics, recreation, cultural identity and educational value of nature – by using focus groups as a participatory approach. Additionally, focus group discussions included negative perceptions of tree-based UGS. Using the ‘focus group’ as a method provides an in-depth understanding of the phenomenon and can be very useful for eliciting perceptions of UGS. As part of the focus group interviews, we conducted participatory mapping of tree-based cultural ecosystem services and negative perceptions of UGS. The study included focus groups with citizens in all city districts, with 94 participants. We will show some of the main results of this research. The study confirms the importance of having various types of tree-based UGS. Practical experiences with conducting focus groups (advantages and disadvantages) and implications for urban green space planning and management will be discussed.

## Trees for Climate Action – engaging and upskilling youth in tackling the climate crisis

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### Abstract

“Trees for Climate Action” (TfCA) is a new three-year project which will take bold new steps to bring different generations together, creating opportunities for young people to mobilise, learn new tree-related skills, and take positive action against climate change. Led by Trees for Cities (TfC) in partnership with the Field Studies Council, the UK’s leading provider of natural history training courses, TfCA will take place across two major cities, Glasgow and Bradford, with an aim to engage 20,000 young people across both regions. In Glasgow, with the city having hosted COP26, there is considerable local appetite to maintain a climate legacy in the region. Meanwhile, Bradford is one of the youngest cities in Europe, with 29% of its population <20 and nearly 25% <16. Both cities have phenomenal appetite and potential in engaging young citizens with urban forestry.

Climate change is a source of considerable concern. This is particularly true among young people, who may lack the channels or skills to meaningfully engage and feel like they are making a difference. TfCA will provide a variety of opportunities for engagement, from training courses to school projects. Central to its ambitions is the creation of a new Youth Panel in each city and support for these panels in engaging with the necessary stakeholders to see them learn how to plan, develop and deliver urban tree-planting projects. The ultimate aim is the creation of two new “Youth Climate Woodlands” in each region.

This project was recently launched and currently undergoing extensive consultation with stakeholders in each city (concluded by the time of EFUF). This presentation will see the results of this consultation examined and explore the views and perceptions therein. With the experience of community-led urban forestry, as well as the creation of youth panels, we will share TfC’s aspirations for the first 12 months of delivering this project and welcome discussion and input from partners present on how we might maximise this ambitious project’s potential.

## Participatory tree care in a new 10-year urban forestry strategy in Ireland

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### Abstract

Dún Laoghaire-Rathdown County Council – one of the Dublin Region’s four local authorities – has prepared a new, ambitious and citizen-focused Urban Forestry Strategy (2022–31), entitled: “A Climate for Trees: A Natural Approach to Human Health and Well-being”. The approach to preparing and implementing the Strategy relies on a dynamic led by the Council. Preparation over two years involved a robust audit of the outgoing Trees Strategy, literature review and – critically – extensive and in-depth consultation and a stakeholder engagement process deliberately designed to build partnerships as a key foundation to ‘activating’ (delivering) the Strategy’s five goals and Action Plan. An innovative participatory model of engaging with a diverse range of ‘actors’ (youth, communities, NGOs, business/enterprise and Council staff) was key to Strategy development.

Activation of the Strategy is based on a shared vision of collective responsibility among stakeholders for care and conservation of the county’s trees. This vision is underpinned by an ethical eco-philosophy of co-habiting with and respecting trees as living organisms, not merely as decorative objects or ornaments in the urban environment.

The Strategy’s principles, policy statements and actions contain and reflect commitments to progressive practices in several areas, principally in: identifying new trees and woodland opportunities within greenspaces, achieving and re-balancing tree cover equity, ensuring biosecurity and biodiversity in procurement and in new planting schemes, and – not least – fostering and supporting citizen tree volunteers and citizen science. The Council recognises key existing and potential roles of a wide range of stakeholders in managing, planning and designing trees for climate adaptation and human health and well-being.





# Changes in ancient woodland flora after rapid urbanisation of surrounding landscapes

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## Abstract

Ancient woodland is a semi-natural habitat of high conservation concern, where continuous forest cover over at least 400 years has allowed a distinctive ecological community to develop. The National Planning Policy Framework for England recommends that, unless there are exceptional circumstances, development resulting in the loss or deterioration of this irreplaceable habitat should be refused. However, cumulative effects of urbanisation mean that as towns and cities expand into the surrounding countryside, ancient woodlands can become islands within an urban matrix, where they face more insidious threats, including pollutants, soil compaction and invasive species.

Milton Keynes – designed as a ‘new town’ in 1968 – provides a case study for the impacts of rapid urbanisation on semi-natural landscapes. As the town developed and expanded, three significant patches of ancient woodland became surrounded by roads, residential areas and industrial units. We are carrying out a space-for-time study to compare these three urban ancient woodlands with four rural ancient woodland sites nearby to assess the impacts of rapid land use change on vegetation structure and species composition.

Over 9,000 historic records of 585 flowering plant species were obtained from biological records centres to provide documented evidence of the change in the flora of the seven target woodlands before, during and after urbanisation. Results indicate that post-1990 nearly twice the proportion of non-native species were found only in urban woodlands compared to rural ones, which may be due to the introduction and naturalisation of species from urban gardens.

Detailed ground flora surveys of the Milton Keynes woodlands provide more spatially nuanced evidence of changes in vegetation over time. Surveys showed that plots near the woodland edge had fewer ancient woodland indicator species and the community composition of edge plots had changed more than inner woodland plots over an eight-year period.

These results illustrate the indirect effects of development on ancient woodland flora in a newly urbanised landscape. This evidence on the impacts of increased visitor pressure, nutrient enrichment and introduced species can be used to inform management and planning decisions, for example, through the implementation of buffer zones around ancient woodland sites that could be affected by urban development.

# Complex challenges of integrated and interdisciplinary management of urban forests: a case study of the Drwinka River Park, Krakow

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## Abstract

The Drwinka River Park in Krakow is a case study of an urban forest, where the complex and interdisciplinary challenges of modern urban forest management are focused. The Park of this case study is the area of the Drwinka riverbed with its valley, located within the administrative boundaries of the city of Krakow, surrounded by strongly urbanised and densely populated areas. However, the presence of wetlands, flood areas and steep slopes have caused limited accessibility and low investment attractiveness. This area has kept its wild character with very high biodiversity and is a habitat for many plants and animals, including species under strict protection. On the other hand, the surroundings of intensive development, especially residential and commercial, cause strong pressure both from residents looking for areas for active recreation and leisure and from investors and developers looking for investment areas. Particularly interesting aspects of this case study are: 1) complex social dynamics, especially intensive grassroots civic activity, which contributes to the effective protection of this area, but also to documenting its values and ecosystem services (citizen science); 2) multi-level and complex conflicts, resulting from different visions and needs of individual stakeholders (i.e. making the area available vs. nature and biodiversity protection; national and local spatial planning regulations vs. effectively counteracting investment pressure; preserving the character of the place vs. its development).

Within our contribution, we are going to present and discuss the complex challenges described above, which are crucial to protect the Drwinka River Park. Particular attention will be paid to the most important conflicts and social dynamics as well as ways and actions aimed at solving them undertaken by key stakeholders, including city services and the civic side (also represented by the co-authors of our contribution). In the second part of our contribution, the research challenges and questions will be defined, including those that are undertaken within the CLEARING HOUSE project, and for which solid solutions are crucial to achieve the sustainable management of the case study area. Enabling effective protection as well as providing a wide range of key ecosystem services for the area of the park itself, the surrounding residential areas and the entire city of Krakow.

# Managing military urban forests: a case study of Kamp Beverlo, Leopoldsburg, Belgium

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## Abstract

In the Flanders areas of Belgium, military domains are amongst the most unspoilt and extensive natural habitats. Kamp Beverlo is the largest of these military domains (55,000 ha) and it consists of a number of large forest cores (coniferous and deciduous) interconnected with open heathland, grassland and fens. The case study of Kamp Beverlo offers a rare insight into this mosaic natural landscape, with a particular focus on the forested areas and associated fauna species (e.g. wild boars, wolves, rare birds and insects). The military domain and associated nature are not in isolation though, as the area sits amidst the municipality of Leopoldsburg and is adjacent to four other municipalities. Granted unique access to the site, the management and maintenance of the military-owned urban forests are critically explored from the perspective of the various stakeholders involved, e.g. military, Agency for Nature and Forest (ANB), municipalities, hunters, recreational users (e.g. shooting club, fishing, cycling and hikers) and tourists. Overall, this case study demonstrates how different and often competing agendas can be accommodated through collaboration and cooperation to bring benefits for nature and people.

## Why do we need more urban trees established with close to nature management? (The method of the lazy urban forester)

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### Abstract

The establishment of newly planted urban trees brings up many issues. Our contribution deals with newly planted urban trees in the city of Nitra from 2016 to 2022. In total, 900 specimens were evaluated in three city areas with a focus on establishment success, survival rate, the occurrence of pests and diseases, maintenance level, increments (DBH, annual shoots) and vandalism. Our results clearly show that the municipality invests in new urban trees, but maintenance and tree care after planting are underfunded. This brings a lot of problems on the way to having healthy and functional urban trees in the urban space. During our field trips and data collection we noticed that spontaneous seedlings growing in shrub plantings have good potential and can even have better growth rates than the planted urban trees because they do not have to undergo transplanting stress and are better adapted to local conditions. These spontaneous seedlings will avoid a lot of problems which planted urban trees have (girdling roots, depth of planting etc.). We would like to present hereby the method of the lazy urban forester, which deals with the potential and the management of spontaneous seedlings of tree species in urban areas.

## How can a modern forest authority push forward sustainable urban forest management?

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### Abstract

The North Rhine-Westphalian Forest Authority 'Wald und Holz NRW' is experienced and broadly positioned as a service provider in terms of forest management and private forest management. The socio-scientific and socio-economic perspective of its work occupies little space in the forestry business. In order to preserve and multiply forests in urban areas and to communicate social needs (ESS), it is necessary to combine forestry expertise with communicative, open and attentive actions of foresters. In addition, with increasing urbanisation and growing awareness of the need for nature in urban areas, citizens should be involved to prevent carelessness, ignorance, vandalism and simply the disregard or destruction of valuable nature as part of their home environment.

This is where the forestry authority comes in with its main task of caring for urban forests and offers consulting and coordination 'services'. As an independent authority, 'Wald und Holz NRW' is not committed to any party but to the well-being and further development of the forest, its functions and users in urban areas.

The question is how participation in forest management by various people, institutions and groups in this conurbation can be made possible even more comprehensively in a modern form. The aim is to prevent conflicts from arising in the first place, to raise awareness of the value of urban forests and to build social control. This is to be achieved on the one hand through broad, proactive networking, education and public relations work, but also through cooperation and participation in the form of an advisory function as well as active participation by the citizenry. As a case study, the industrial forest project, which has been running for several decades, with its focus on urban wilderness, nature conservation, environmental education and social nature, will be used to transfer successful approaches to other urban forest areas.

# Urban forest governance in Copenhagen in relation to contemporary urban greening concepts

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## Abstract

Among the integrative natural resource management approaches that have been developed in recent years, the concept of urban forestry promises a lot of benefits with the role trees fulfil in the urban area. To take advantage of these benefits, urban forest governance is one of the most important factors to ensure effective environmental and land usage management. Despite the current high level of interest in urban forestry, research on communication in urban forest governance is omitted.

Since communication plays an important role in providing good governance, this project addresses the communication of governmental bodies through political documents in Copenhagen, Denmark. The organisational policy analysis is used for identifying governance features. Objectives, attributes, and elements of governance are derived from the practical framework of environmental governance from Bennett and Satterfield (2018) and used as a basis for deductive content analysis.

The results show a high focus on supporting the governance systems' integrity and functioning (= effectiveness), in contrast to the other objectives: equitability, responsibility, and robustness. Whilst the different document types and governance characteristics are related to each other, the documents not only function as a source for identifying governance characteristics but also operate as an important communication tool of Copenhagen's urban forest governance context.

The report concludes with reflections on the role of contemporary urban greening concepts in political documents and transformative planning, while also suggesting approaches for further research.



# Evaluating tree structure and biomass of city parks using lasers: a case study in Ghent, Belgium

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## Abstract

Terrestrial laser scanning enables accurate data capture of the 3D structure of trees. This technology enables us to perform detailed assessments in which structural parameters such as diameter at breast height, crown diameter, and even tree volume can be accurately determined.

One key application is the non-destructive estimation of woody aboveground biomass (AGB) in trees. Through quantitative structure modeling, the volume of the tree is approximated and the biomass can then be estimated via the average wood density of the tree species. Several studies have demonstrated high concurrence with destructively measured references. Using terrestrial laser scanning, recent studies (Calders, 2022) have also revealed a substantial underestimation of biomass by the models that have been used for decades across Europe's forests. This underestimation was in large part due to very large underestimations of large trees and outdated allometric models. Because tree structure in and outside forests is different and city parks often contain higher numbers of big monumental trees compared to typical forests, the question remains to what extent traditional methods work to estimate the biomass of monumental city trees.

To answer this question, we collected terrestrial LiDAR data for the Paul De Smet De Naeyerpark (2.6 ha) in the city of Ghent, Belgium. This park contains a high percentage of monumental, irregular and ancient trees, characteristic for many city parks in Europe. In this work, we will present a biomass assessment of the full park. In addition, we will also present laser scanning data collected in the park from other platforms (mobile and airborne laser scanning), to assess how they can be used to provide such biomass assessments on a larger scale. The work presented here serves as a demonstration of the importance of urban forests, and especially the large monumental trees, not only to policy makers but also to the wider audience.



# How can we create large-scale country-wide single-entity tree databases for Europe?

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## Abstract

With climate change having more and more of an impact on humans and trees alike, it becomes increasingly important to know in great detail where trees are and how many there are. Trees have a big impact on microclimates, but they tend to also be the first victim of changing climate conditions. This does not just affect the municipality-maintained trees, but all trees in any area. Tree inventories of all trees, irrespective of their owner or maintainer, become more and more important. Completeness is paramount for this.

Historically, canopy area mapping has been done using satellite images, and it can be done for larger areas all at once. This changes if you progress towards single-entity trees, every single individual tree being an individual entity in a database. This progress is needed to map carbon storage and ecosystem benefits in an accurate way. It also enables monitoring these ecosystem benefits since changes in trees can be mapped through time.

The ability to construct single-entity tree databases greatly depends on available data sources. Across Europe, access to these sources varies significantly. Depending on the type of source, and the specifications of these sources in terms of granularity, actuality, information depth, etc, defines to which extent these country-wide single-entity tree databases can be created.

In this presentation, we want to take a look at the different types of data available in Europe, and the pros and cons of using these data sources for the purpose of creating country-wide single-entity tree databases.

## Pocket-size LiDAR mobile solution in urban tree inventories

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### Abstract

Involving city dwellers in the planning and management of urban forests is commonplace today, and its continuous development can be observed, which is enhanced by access to mobile technologies.

New mobile devices, e.g. iPad Pro/iPhone (Apple) with a built-in LiDAR sensor, today enable the engagement of city communities, e.g. in mass (crowdsourcing) inventory creation of urban trees, which is an expensive activity of managing green infrastructure. Previous results of the authors' work have shown that the use of the iPad Pro allows for precise registration of tree locations, determination of DBH, the distance between trees, estimation of trunk diameter at different heights from the ground, or inclination of tree trunks. From the perspective of the local community, the iPad Pro/iPhone can be a solution for registering the location of trees and their DBH in the immediate vicinity, providing precise 3D point clouds, mesh models and textures – directly to the cloud computing server. Procedures of this type would certainly ensure faster and more frequent updating of data on trees and their growth or trunk condition. They would also allow a determination of the ecosystem services (ES) provided by trees or lost when they are cut, based on prediction models using DBH as an independent variable. The DBH value measured with mobile applications running on the iPad Pro can be almost as accurate as TLS measurements (FARO Focus 3D), of course, depending on the distance of the scanner from the tree. Measurement errors (RMSE) are 2.2 to 3.4 cm. The relative location of trees in a park or street can be precisely determined (RMSE 12.3 cm) and the absolute values are largely dependent on the quality of the GNSS reception. An experiment testing the estimation of ecosystem services in the i-Tree Eco (USDA Forest Service) software based on DBH measurements using the iPad Pro, TLS scanner, tape measure and other devices showed some limitations, and not only those due to the precision of the iPad Pro mobile solution itself. In terms of using the functionality of the iPad Pro/iPhone mobile solution for augmented reality (AR), the process of planning the planting or replanting of trees involves city residents in the care of urban forests. Engaged citizens can decide or request the planting of new trees or investment in landscaping (e.g. benches) for their community based on a more measurable practical approach.

## Dimension and determinants of urban canopy cover (UTC) in cities of north-eastern Italy

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### Abstract

In Italy, relatively recent national legislation on urban green space planning and management, and the national urban forest strategy deriving from it, have emphasised the need of increasing the urban tree canopy (UTC) cover as a nature-based solution to many of the environmental and social problems deriving from urbanisation. Currently, there is a lack of knowledge on the dimensions of the existing UTC, particularly in medium and small cities. Using random sampling points over aerial imagery, we estimated the UTC of the 62 cities with over 15,000 inhabitants in the Veneto region. The first objective was establishing a baseline of the region's UTC to use in setting medium and long-term targets, in monitoring urban tree populations and in tracking the effectiveness and contribution of planting programmes. A second objective was to investigate a broad range of factors that could be correlated to UTC heterogeneity in the study area. We, therefore, analysed the effects of geophysical variables, land use, and socio-economic indicators on tree canopy abundance. Values of canopy cover vary, excluding cities in the woodland areas of the foothills, between a minimum of about 6% to a maximum of about 20%, making the 30% UTC goal often reported in the literature quite difficult to reach in most cases. The results show a strong positive correlation between urbanised area and canopy cover, and a larger presence of trees in built-up areas than in the more rural areas of the towns and cities. The research also shows that cities with higher per capita income have a higher value of UTC. These results can provide planners and managers with information that can be used to increase UTC, guide tree-planting campaigns in decreasing inequalities and encourage more tree-oriented urban planning.

# Mapping the ecosystem services provided by campus trees of the University of Agriculture in Krakow (Poland) using ALS LiDAR, ground truth data and i-Tree Eco

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## Abstract

The Ecosystem Services (ES) provided by urban trees indicate the financial value that city governments and their inhabitants can derive from urban forests. Field measurements (DBH, tree species) and 3D ALS LiDAR point clouds (2017) were used to determine the ES value provided by trees growing in seven locations on the campuses of the University of Agriculture in Krakow (UAK, Poland). Tree top detection was performed using the segmentation running on Crown Height Model (CHM). Using specialised software (FUSION; LasTools; ArcMap ArcGIS), the location of tree tops and other vertical structure statistics of high vegetation (trees >2.0 m) on UAK campuses were analysed. Tree inventory field campaigns were conducted to obtain reference data on tree number, stem DBH and tree species (genus). In the next step, i-Tree Eco (USDA Forest Service) was used to model the ES provided by these urban trees. The results showed that 1,290 trees growing on seven UAK campuses in Krakow were detected with an average accuracy of 82%. The research revealed a rather unexpected (compared to Krakow's city parks) tree species (genus) composition, i.e. spruces (10%), pines (9.6%) and poplars (7.3%). The total amount of air pollutants removed by UAK campus trees reaches 314 tonnes per year. Trees growing on UAK campuses stored 563 tonnes of carbon, with black poplar being the undoubted leader among the analysed species (180 tonnes). Other important tree genus in terms of carbon accumulation are: Salix, Acer and Betula. Trees on UAK campuses produce 33.82 tonnes of oxygen per year and slow down the surface runoff of precipitation by approximately 443 m<sup>3</sup> per year.

In the final stage of the presented research, a survey was conducted using GIS tools. Among the academic community (153 people, 80% of whom claimed the status of a student) and people from the immediate vicinity using the UAK campus areas, a study was carried out in terms of the awareness of city residents concerning ecosystem services, satisfaction with using and spending time in green areas of the campus infrastructure, and an assessment of their proposals for further quality improvements. For example, 52% of students believe that there are too few trees on UAK campuses and 25% that there are definitely too few. Only 15% of respondents are not interested in the number of trees. This survey shows the great importance of trees for young people and confirms us in further educating society in terms of ecosystem values offered by urban forest.

## Forest growth modeling and 3D visualisation: understanding development potential in the urban forest ecosystems of the Elster-Luppe floodplain in Leipzig

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### Abstract

The assessment of the ecological status of the Elster-Luppe floodplain forest in the city of Leipzig, Germany, is a central task within the framework of the scientific monitoring of the project 'Lebendige Luppe'. Together with the reactivation of floodplain-typical hydrodynamics, the project aims in particular at the preservation and further development of typical forest stands of the urban hardwood floodplain, which still exist over large areas within the city of Leipzig. From 2013 to 2016, around 60 study plots were established with the aim of recording the current state of the forest ecosystem, as well as identifying and monitoring changes in ecological parameters and ecosystem services that can be expected from the revitalisation measures after completion of the project's implementation phase.

In this presentation, we will demonstrate how the initial inventory data from these plots can be used in a model-based comprehensive riparian forest ecosystem management for mixed stands with different age structures. For this purpose, the single tree-based forest growth simulator SILVA will be used to test its suitability for the special conditions in the Leipzig Elster-Luppe floodplain. In a further step, the results of the growth forecasts will be further processed using the Sketchup 3D visualisation tool. In multi-layered and mixed stands, it is necessary to consider the horizontal and vertical stand structure. This is especially important to determine if future forest stand development is a result of the proposed changes in hydrodynamics or is caused by forest management or other environmental conditions. Thus, visualising the respective tree species composition and their stratification within a plot allows a better understanding of the ecological conditions and indices from the field survey.

The state of the work shows that the combination of forest growth modeling, 3D visualisation, and analysis of key characteristics of urban forest landscapes is useful to gain a better understanding of the current ecological status of the Leipzig floodplain forest based on measured field data and other existing digital data.



# Urban tree pests and pathogens, stakeholder risk perceptions, and remedial actions

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## Abstract

Trees contribute greatly to urban environments and human well-being. Yet, relatively little is known about the extent to which a rising incidence of tree insect pests and pathogens may be affecting these contributions and what can be done about it. To address this issue, we examined current and emerging risks posed by urban tree pests and pathogens and identified remedial actions. We also analysed stakeholder risk perceptions. (1) Environmental risks, include tree damage, mortality, reduced growth, and changes in tree function; (2) social risks comprise diminished aesthetics, negative effects on human health and safety hazards; and (3) economic risks include costs of pest management and economic losses. Risk perceptions vary amongst different stakeholders with an interest in urban trees. Remedial actions include improved biosecurity, sanitary practices and tree management, urban tree inventories and risk maps, stable funding, stakeholder education, monitoring and reporting systems, and tree diversity. Above all, it must involve urban private tree owners. A greater understanding of risks and remedial actions is vital for effective urban green infrastructure governance and forward planning. The project has received funding from the European Union's Horizon 2020 research.



# How to make citizen science work for disease monitoring and urban tree care

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## Abstract

Climate change, policy demands, pressure on budgets, staffing shortages – all of these have left regional and local authorities struggling to meet urban tree care needs. Add disease and pest threats like Chalara/ash dieback to the mix and things get difficult.

There simply aren't enough resources to do the job.

Is citizen science the answer?

If so, how do you add citizen scientists to the mix without creating an organisational nightmare?! How do you engage largely unqualified, ordinary citizens and get meaningful tasks done? What tasks can they actually do? What are the tools they need? How do you motivate them? Is there a role for corporate sponsorship incentives and reward programmes?

And is citizen science more work than it's even worth?!

Environmental tech company Tremap set out to find the answers. Funded by the UK government (InnovateUK) and the ERDF, we spent six months collaborating with the Eden Project, Plymouth City Council, Cornwall Council (UK) and a host of other stakeholders to explore just how to create the necessary tools to make disease/pest monitoring and tree care citizen science projects a success in urban forestry. And we learned invaluable lessons along the way.

In this presentation, we'll share the valuable insights we gained on that journey and help you understand the pitfalls – and the power – of citizen science and urban tree care (in particular, disease and pest management).

We listened to councillors and arborists to understand the boots-on-the-ground situation. We grilled UK and international citizen science experts about their past projects (UK Tree Health Citizen Science Network, OPAL, Forest Research, Smithsonian Institution). We listened to academia to understand the science. We talked to major national and global corporate brand sponsors to explore what kinds of citizen science projects they'd back and why. And we talked to the citizen scientists themselves, to learn how they think. We ran roundtables and study groups and trialled rapid prototypes of tools to understand how citizen scientists and councils might use them to fight disease and care for urban trees together.

In this session, we'll share our findings and help you understand how citizen scientists CAN be a powerful resource for monitoring and managing the spread of disease and pests in urban forestry and we'll give you the insights you need, to make informed decisions when taking on projects.

# Ecosystem-based solutions for urban tree revitalisation in Croatia

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## Abstract

In recent years, forest trees in urban areas have been showing morphological signs of reduced vitality, including dead large and small branches, crown thinning, defoliation and discoloration during the vegetation period, decelerated growth in height, and irregular crown development. Reduced vitality of urban trees reduces non-market tree functions and the services they provide to humans and the environment, and their ability to perform vital functions such as fruit production, regeneration, growth in height and girth, underground growth, budding, leaf production, adaptation to living conditions, resilience to unfavourable factors and more. The management of urban trees implies monitoring their condition and taking measures to improve growth and development. These measures include determining the causes for the declining vitality and steps towards revitalisation. Declining vitality may be due to biotic or abiotic factors. Biotic factors causing reduced vitality, such as pest infestations, disease, and damage caused by domesticated animals and humans, are often successfully resolved. However, the abiotic causes for reduced vitality, such as pollution of the air, water and soil, climate change, soil degradation, changes in microrelief and others, are generally unknown, often unresolved, and in some cases improperly addressed. The revitalisation of urban trees involves arboriculture measures, ecological re-naturalisation of the habitat of urban trees, and revitalisation of the entire ecosystem of urban trees. The ecological re-naturalisation of urban tree habitats involves restoring the natural composition of the dead organic matter in the soil, adding sustainable nutrients to the soil, improving the physical, chemical and biological properties of the soil, ecological irrigation of urban trees, creating a favourable microclimate around the urban trees and protection of the area where urban trees stand. Revitalisation of urban tree ecosystems involves systematic examination establishing natural communities in terms of ground vegetation and the shrub layer, microfauna and mesofauna in the soil, microorganisms in the soil, mycorrhizal communities, bird communities and the like. This paper outlines several examples and models of an ecosystem approach to revitalising urban trees in Croatia, as well as methods in urban forestry that are unsuitable for the functioning of urban tree ecosystems.

## Status and role of urban fruit orchard meadows in major German cities

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### Abstract

The presentation's focus is on the status and role of urban fruit orchards in and around major German cities with more than 500,000 inhabitants. Fruit orchard meadows have a long tradition as common agroforestry practice in particular in Central Europe. In the past, many orchard meadows were lost due to intensification in agricultural use or changes into non-agricultural land use. This happens in the agricultural landscape as well as in urban and suburban settings despite their important and acknowledged role as hotspots of biodiversity. In fruit orchard meadows many rare and endangered plant and animal species find suitable habitats. The size, age and spatial structure of fruit orchard meadows are important characteristics for the determination of their high ecological value. However, there are many local and regional initiatives and projects to stop and reverse the ongoing degradation and loss of this traditional land use. Here, we want to draw particular attention to those fruit orchard meadows that exist in and around densely populated German cities. In these urban and suburban settings, they represent a special form of urban forests which require specific forms of management and a diversity of skills to protect existing areas or to establish new areas and to maintain this form of ecologically sound land use in the long run.

A Germany-wide overview of the current stock of orchard meadows showed that about two thirds of the areas are located in southwest Germany and that the number and density of areas declines to the north. Sources are spatial data from the Official Topographic Cartographic Information System (ATKIS) collected by the surveying and mapping authorities of the federal states of Germany. Similar results should be expected in and around 14 major German cities. In densely populated urban areas, orchard meadows are no match for the growing competition for land so that only few to no areas can be expected. However, a field survey and aerial photo analysis in a rural municipality with a high density of orchard meadows revealed large discrepancies and inaccuracies in the ATKIS data related to orchard meadows so we have to prove the real situation in urban areas as well with similar means. This can be done by comparing ATKIS data with current and historical Digital Ortho Photos (DOP) and/or published regional field surveys about urban orchard meadows. Since this is still work in progress, we will present first results from the current approach.

# Increasing the ecosystem resilience by protecting biodiversity in Krakow

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## Abstract

The rapid development of a modern city poses many threats to the stability of the functioning of the natural environment. The most important threats include invasive species of plants and animals that find many free niches in heavily transformed habitats in urban areas.

Krakow implements numerous actions which increase biotic resilience, preferring native plant species, maximising biodiversity, creating ecozones and protected areas, protecting rare and endangered species, improving soil enzymes and increasing sorption capacity. The presentation deals only with some selected examples of activities which increase the biodiversity of the city.

Management of urban trees leads to creating of numerous microhabitats, which are essential for existing endangered species as well as being the reservoir of those beneficial organisms. Trees in city greenspaces are often solitary, large individuals which provide numerous microhabitats. This process of creating and disappearing microhabitats is ongoing and continues for a long time during the tree's life and after it dies. Tree-related microhabitats are a hotspot of biodiversity in the city.

# Time-series satellite-based monitoring of Biologically Active Areas of Krakow

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## Abstract

Mitigation of the negative effects of climate change must be based on continuous monitoring, management and support of activities in urban green areas of all forms of ownership. UF are not only green areas in the form of organised green complexes for public purposes (forests, parks) but also any other areas covered with vegetation, i.e. capable of sequestering CO<sub>2</sub> and producing oxygen or absorbing pollutants. Such areas for the purpose of the presented study were called Biologically Active Areas (BAA). A very good method of monitoring the state of urban greenery in the area of entire cities is satellite remote sensing technology. Today, Earth Observation (EO) technologies enable the acquisition of satellite images with high (HR; GSD < 5.0 m) or very high spatial resolution (VHR, GSD < 1.0 m). Images recorded in several (4–8) spectral channels can be successfully used to monitor health status, vigour, and water content in vegetation or control current treatments in urban green areas. Non-public urban green areas, usually inaccessible to inspectors, do not require any permits from private owners in the case of using satellite data (EO).

In the process of classifying satellite images of Krakow, which were used in satellite monitoring in the period 2006–2021, the GEOBIA method was used, in which, apart from the MS and PAN channels, the vegetation index (NDVI), normalised surfaces models (nDSM/CHM), ALS LiDAR point clouds and vector GIS (outlines of buildings, roads and railways, waters, etc.) were used. The spatial resolution of images ranged from 0.5 m GSD (WorldView-2) through 3.0 m GSD (PlanetScope Dove scenes) to 10 m GSD (Sentinel-2 ESA).

The results of many years of research clearly show that biologically active areas (BAA) currently (2021) occupy almost 71.29% of Krakow city's area, which is actually a decent result. However, in the period of 15 years (2006–2021), as much as 1626 ha (4.99%) of the BAA areas disappeared. Assuming a linear trend of changes, it can be concluded that 108 ha of the area considered as BAA is transformed into infrastructure, mainly buildings (houses, roads, areas devoid of vegetation cover). In the same analysed period, investment areas increased by 4.88%. At the same time, the classification of satellite images and GIS analyses showed that 71.5% of the BAA of the city of Krakow are not publicly owned. Hence it is so important to continue satellite monitoring and cooperating with all BAA owners.



# Plan of general regulation of the system of green areas in Belgrade

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## Abstract

The goal of the development of the Plan in question was to create a complete planning basis for: the preservation of existing forests and green areas within the current limits; improvement of forests and green areas of lower quality and value; improvement of existing forests and green areas in terms of achieving their multifunctionality; improving the typology of green areas; preservation of areas of valuable biotopes (habitats).

Provision of locations for the construction of new forests and green areas in order to equalise spatial distribution and representation, adaptation to European standards regarding the provision of suitable forests and green areas for the purposes of improving the quality of the environment, recreation, etc., which would establish a unique system of green areas in Belgrade.

The territory of Belgrade, with a total area of about 77,955 ha, is within the limits of the Plan in question.

Plan of general regulation of the system of green areas in Belgrade is a document that was financed by the city administration of Belgrade in 2019. And since then, it has been actively applied in the city in order to increase the number of green areas of the city and, above all, the urban forests.

For the City of Belgrade, this is an umbrella document and the main tool for increasing the urban green areas.

## Afforestation in the city in the long-term policies of the Krakow authorities

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### Abstract

Krakow, compared to larger Polish and also similar Central European cities, had until recently one of the lowest proportions of forest cover, exceeding slightly more than 4% of the land area. The “Poviat programme for increasing the forest coverage of the city of Krakow for the years 2018–2040” was developed based on the Resolution of the City Council of Krakow of May 25, 2016. The Forest Coverage Programme (FCP) sets out the rules and conditions for increasing the area of forests in the Municipality of Krakow to at least 8%. The “Krakow Development Strategy” focuses on a sustainable environment. Its implementation is aimed, among others, at achieving high-quality standards of the natural environment, with particular emphasis on improving air quality and reducing noise levels. Almost doubling the area of forests in the city area is one of the key objectives.

Land with a total area of 1,630 ha (including reserve land) included in the FCP has been earmarked for reclassification to forest land (574 ha) or for afforestation and reclassification in the longer term. In total, about 856 ha of land was selected for afforestation and supplementing the initial succession under the FCP. Lands for afforestation were, to a large extent, selected where succession towards forest communities had already appeared. 200 ha were selected as reserve lands for further implementation of the FCP.

Enlarging green areas, including forest parks and forests as a background for existing buildings is highly desirable from the point of view of the broadly understood public interest. It contributes to the improvement of air quality and has a positive impact on people on many levels. As areas accessible to the public, they serve as places of rest and recreation as well as ecological education for residents. The impact of the provisions of the FCP should be considered in the context of broadly understood social benefits as well – albeit on a much smaller scale – by ensuring work and income for professional groups related to forestry (employment and financial benefits while performing tasks planned in the FCP, such as afforestation, tree stand maintenance).

The FCP, through the preservation of existing forest communities and the creation of new ones, is part of the broadly understood protection of biodiversity of the environment of the city, as habitats and breeding sites for birds and for many other animals, so – as corridors enabling their migration. The poster presents the current status of FCP implementation in Krakow.





# Urban forests and ecosystem services: air pollutant removal capacity in Campobasso, Italy

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## Abstract

Urban areas are characterised by high levels of air pollution caused by anthropogenic sources. The urban forests are the major provider of multiple ecosystem services able to improve and maintain human well-being. This work aims to assess the capacity of the urban forest of Monte Sant'Antonio, in Campobasso city (Italy), to remove air pollutants and atmospheric carbon. For this purpose, the pollutant absorption modeling tool called i-Tree Eco (v.6) was used. This area was affected by four reforestation activities that have created four different stands, mainly composed of *Pinus nigra*, *Cupressus sempervirens* and *Fraxinus ornus*, which cover about 13 ha. The absorption capacity of stands, called '61, '75, '81 and Adulte (respectively in accordance with the year of planting), have been studied. The analysis of the values per hectare shows that the stand with the highest sequestration capacity is '81 with 16,691.71 kg · ha<sup>-1</sup> · yr<sup>-1</sup> of air pollutants removed. This result is probably due to the diversity of tree species present in the '81 stand, which is also characterised by a more significant presence of large broadleaf trees (e.g. *Acer platanoides*). The results obtained by i-Tree Eco were compared to results obtained by using allometric equations constructed for the species of the Italian environment, such as those developed by Tabacchi et al. (2011). The comparison took place following the definition of linear regression models that contained the total tree biomass, expressed as dry weight, as an independent variable. In general, it can be said that all models have found a very good correlation ( $r^2$  between 0.66 and 0.92) and that the trend, although different, is very similar. The variation over time in the removal capacity of air pollutants by *Pinus nigra* and *Fraxinus ornus*, species present in all four stands, was also analysed. *Pinus nigra* subtracts an average of 108.7 kg · yr<sup>-1</sup> of air pollutants, whereas *Fraxinus ornus* removes an average of 32.15 kg · yr<sup>-1</sup>. Moreover, the comparison showed that there is a slight tendency for the air pollutant removal capacity to increase with increasing age. This variation in air pollutant removal capacity may be due to the increase of the plants in both woody volume and crown size over the years. From the results obtained, we can say that when planning urban forests, it is important to consider the specific composition and diversity of air pollutant removal capacity and how it varies over time to optimize this ecosystem service.

# Visitor perception of recreation conflicts in the UNESCO Vienna Wood Biosphere Reserve

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## Abstract

Urban and suburban protected areas are exposed to high recreational use pressure due to the high number of inhabitants. Due to the attractiveness of the landscape and the numerous recreational facilities in the UNESCO Vienna Wood Biosphere Reserve, a wide variety of recreational activities are practised there. This can lead to frequent encounters of different user groups with different needs and consequently to conflicts. Therefore, for the development of successful visitor management strategies and recreation plans, it is necessary to know the existing conflict potential between recreationists.

An on-site face-to-face survey of 978 recreationists in the urban and suburban parts of the Wienerwald Biosphere Reserve was conducted. This study was co-financed by the Austrian ESS-MAB Programme. The results of the study suggest that the perception of conflicts in the biosphere reserve is not very pronounced. The respondents estimated the frequency of conflicts as rather low. The results also show that the high number of visitors on weekends is an issue for many respondents and that crowding has an influence on the perception of conflict. Recreationists who did not keep their dog on a leash were rated as the most disruptive user group, followed by mountain bikers, bicyclists, and e-bikers. The most sensitive group was equestrians. The study shows that intergroup conflicts predominate and value conflicts are rather negligible. Conflict areas mentioned by the respondents were mainly areas close to settlements in Vienna with a high number of visitors and shared-use trail sections.

Even though the frequency of conflicts among recreationists does not seem to be high based on the study results, further monitoring of the recreation situation – both visitor numbers and neuralgic trail sections – is recommended. Not only the constantly increasing number of inhabitants in the Vienna metropolitan area, but also the increased demand for stays in nature, as shown in the COVID-19 crisis, will probably lead to a further increase in the frequentation of the already heavily used Vienna Wood.

## Multisensory dimensions of forest attractiveness

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### Abstract

In most studies, the attractiveness of forest plots is determined by visual aspects. However, forest perception is not only influenced by visual impressions – all sensory dimensions play a role. In this project, we investigated the influence of forest characteristics, measurements of the sounds of nature and external noise, as well as visitors' perceptions of sounds, scent and the general feel of nature on forest attractiveness. Forest visitors were asked to take part in go-along interviews, during which they were accompanied by an interviewer on their normal route through the forest and prompted to comment on what they saw, smelled, heard and felt. In addition, we conducted a forest visitor survey with a standardised questionnaire at 20 plots of the Swiss National Forest Inventory NFI concerning forest attractiveness, preferences, motives, noise sensitivity and perception, and socio-demographic information. At all plots, forest characteristics were assessed according to the criteria of the National Forest Inventory NFI. We also conducted continuous noise measurements and regular sound recordings for a week in each location. Results showed that whether people liked a forest or not depended largely on their individual preferences, motives for visiting forests, forest visit behaviour and also whether they perceived the sounds in the forest as pleasant or unpleasant. Forest attractiveness also depended on the presence of certain forest characteristics, although to a lesser extent, for example the presence of moss and ground vegetation contributed positively, dead wood negatively to forest attractiveness. The recorded sounds also played a role – birdsong had a positive, sounds birdsong had a positive effect, while sounds of dogs had a negative influence. We conclude that especially the types of sounds people hear have an influence on perceived forest attractiveness in addition to the vegetation and the people's individual characteristics.

## Diversity of urban green infrastructure provides cultural ecosystem services and disservices – results of a PPGIS study in Zagreb, Croatia

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### Abstract

Cultural ecosystem services are one of the most important ecosystem services to citizens in urban environments. Their provision is directly connected with a higher quality of life and citizens' health and well-being. On the other hand, perception of disservices can have the opposite effect, where their existence in urban green infrastructure can hinder its use and sometimes negatively affect citizens' health and well-being. Cultural ecosystem services and disservices are inherently subjective, and their perception by people is affected by the characteristics of the urban green infrastructure, among others. In 2021, a PPGIS questionnaire was designed and conducted with citizens of the city of Zagreb, Croatia, to explore the relationship between the perception of cultural ecosystem services, disservices, and different types of urban green infrastructure. In total, 384 respondents marked 5,757 points with attributes of cultural ecosystem services and disservices in the city's urban green infrastructure on a digital map. Results indicate that citizens of Zagreb perceive all explored cultural ecosystem services of different types of urban green infrastructure, such as place attachment, recreation, aesthetics, educational services/potential, and cultural identity, as well as disservices, e.g. places perceived as unmaintained or scary. In direct comparison, positive perceptions outweigh the negative ones. Parks, forests, and park forests are the most important types of urban green infrastructure for citizens. However, a variety of other types also proved essential, such as unmanaged green spaces, botanical/zoo gardens, greenery around water features, and many more. Synergies and trade-offs were detected between perceptions and urban green infrastructure types that can help shape understanding and, consequently, the management of urban green infrastructure in Zagreb. This research is among the first in the spatial and cultural scope of Southeastern Europe to employ a PPGIS questionnaire to explore the perception of urban green infrastructure resulting in findings relevant to scientific research and practice alike.

# Exploring the potential of participatory spatial-system dynamics modeling in assessing the importance of cultural ecosystem services from the urban forest for resilience planning in Jakarta and Bandung, Indonesia

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## Abstract

Urban forests provide important cultural ecosystem services that benefit city residents. They offer space for recreational activities, spiritual and aesthetic experiences, and cognitive development, thus contributing significantly to the physical and mental well-being of the population. However, the importance of cultural ecosystem services has been an often-overlooked component in urban resilience planning and ecosystem governance which inflicts an unequal distribution of benefits and burdens among different social groups such as differences in access to green space and exposure to environmental hazards. The increasing pressures from urbanisation, climate change, and natural disasters also pose significant threats to society, urban forests, and the cultural ecosystem services they provide, making them vulnerable to extreme, disturbing events. Henceforth, this presentation aims to address these gaps by highlighting potential contributions from the use of participatory spatial-system dynamics modeling for assessing the importance of cultural ecosystem services from urban forests in the two rapidly urbanising Indonesian cities of Jakarta and Bandung. The participatory approach engages stakeholders to participate in the mapping and model building, enabling bottom-up identification of culturally significant areas to communities, building a spatially grounded understanding of influencing socio-ecological drivers, supporting spatial-system dynamics model development, and assessing how different forest management and transformation scenarios can impact cultural services provisions. Involving community members and city planners in these modeling processes sheds light on the emerging field of cultural ecosystem services valuation, particularly on the limited understanding of integrating the services into resilience planning and forest ecosystem governance. The presentation concludes by highlighting the potential benefits drawn from this participatory spatial-temporal model in addressing environmental injustices related to access to green space, health equity, and well-being.

# Profiles of (non-)users of urban forests and urban wastelands

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## Abstract

Urban greenspaces with high levels of self-regulating capacities (i.e. wild-ness) can play important roles in addressing societal challenges such as climate change and biodiversity. Despite long-standing debates on the perceptions and acceptability of 'urban wildscapes' among local citizens, little is known about their user profiles and why locals use or avoid such greenspaces. This paper presents an analysis of two types of urban wildscapes, 'urban forests' and 'urban wastelands', which represent two distinct biocultural systems exhibiting different biophysical conditions, governance and management arrangements, as well as stewardship systems. The analysis is based on data obtained from 800 completed questionnaires distributed online among residents based in Vienna, Austria, in June 2022. A cluster analysis of use patterns for each urban wildscape reveals similar results in terms of two different groups – 'occasional strollers' and 'multifunctional users' – whereby the two groups differ in terms of both frequency of use and the activities performed onsite. However, while 'occasional strollers' dominate in urban forests (67% of users), urban wastelands attract more 'multifunctional users' (58% of users). The most important predictor of use is the availability of urban greenspaces in the respondents' neighbourhoods. Furthermore, 'multifunctional users' attribute greater and more diverse values to urban wildscapes than 'occasional strollers' and 'non-users', indicating a positive relationship between use and valuation. In addition to a lack of urban wildscapes in urban neighbourhoods, concerns about anti-social behaviours can especially prevent women from using such greenspaces despite valuing urban wildscapes higher than men. The paper concludes that providing safe access to urban wildscapes in people's neighbourhoods represents a key lever for increasing social acceptance.

# Urban rewilding aesthetics & people's needs into multifunctional blue and green infrastructure design

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## Abstract

The purpose of this article is to provide an overview of the ongoing project "Urban rewilding aesthetics and people's needs into multifunctional blue and green infrastructure design" which is funded by the RECLAIM Network Plus. Specifically, this project investigates both the challenges and the multi-functional benefits of rewilding in urban contexts. Focusing on and collaborating with local authorities, public land managers and local communities, it examines the implementation challenges and consequences of moving towards 'wild' aesthetics and management aims. It explores what local authorities hope to accomplish through current policy initiatives and the difficulties of making those aspirations a reality. In association with this, it investigates the interface between biodiversity ambitions and whether changes in objectives/aesthetics ultimately reinforce or eliminate disparities in access to, and experiences of, green space. The main objective of this research is to create a set of resources able to help local authorities and other land managers determine how, where and what types of urban rewilding might benefit local communities in provisioning health and wellbeing through access to increased and higher quality green infrastructure (GI), alongside solutions for avoiding disbenefit and creation or amplification of inequality.



# Quantifying ecosystem services from urban forests and their importance in increasing social-ecological resilience in Greater Kumasi, Ghana

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## Abstract

West African cities are witnessing rapid urbanisation and urban sprawl and have lost large parts of their urban and peri-urban forests (UPF) in recent decades. The city of Kumasi in Ghana is no exception. The decline of UPF may contribute to biodiversity loss, reduce human well-being, accelerate climate change impacts, and reduce social-ecological resilience. However, field studies on the supply of UPF's ecosystem services and the implications to social-ecological resilience are lacking in West African cities.

In the presented study, we take an interdisciplinary approach that incorporates spatial analysis and quantification of both biophysical and cultural services, as well as access, use, and valuation of UPF by the local population in Greater Kumasi, Ghana. In the contribution, we will first demonstrate an analytical and methodological framework that combines a field-based forest inventory of regulating, provisioning, and supporting ecosystem services with participatory mapping of cultural services with the local population and in-depth interviews to assess stakeholder perceptions of UPF ecosystem services and management. Secondly, the first results of the tree inventory that took place in 238 plots distributed all over the Greater Kumasi area between August and December 2022, will be presented, and we will give an overview of the UPF's spatial distribution and structure as well as its biophysical ecosystem services. The plots were installed following the guideline of i-Tree Eco from the US Forest Service, and the data collected in 2022 are now being analysed.

Our trade-off analyses between different ecosystem services may help to identify potential areas and land uses in the city where interventions would be required to minimise trade-offs and maximise synergies. In addition, the quantification of ecosystem services and the influence of biophysical, social, political, and cultural variables on their supply and use can help to create best practice guidelines for managing UPFs in Greater Kumasi, which are currently missing. We emphasise that results from this study can help us to identify opportunities for UPFs to be designed as nature-based solutions to simultaneously tackle urban climate and societal challenges in Kumasi, Ghana. We are optimistic that our study can also serve as an orientation and starting point for similar research in other African cities.

# New opportunities for urban regeneration by spontaneous woodlands: a socio-ecological assessment from Italy

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## Abstract

Urban woodlands can be a major component of urban green infrastructure and are linked to many social, cultural and ecological benefits. Emerging urban woodlands are a type of urban woodland that develops spontaneously through successional processes on vacant or abandoned areas both in growing and shrinking cities. Such rewilded spaces have an intrinsic socio-ecological complexity that requires an interdisciplinary approach, linking natural and social science perspectives, and aiming at highlighting the role of novel urban ecosystems in the reconfiguration of urban policies. This work summarises evidence based on recent studies conducted by the authors on this topic. The overall aim is to deepen emerging woodland ecological and sociological dynamics and the implementation within the urban green infrastructure. We identified a sample of woodlands developed from different original land use types (i.e. former industrial, military, agricultural and mining areas) and scattered throughout Italy. We collected data on the abandoned areas and woodland characteristics (e.g. area, age, surrounding landscape matrix, ownership) coupled with land use zone designation and provisions in former and current urban plans (i.e. before and after woodland development). For a sub-sample, we performed a targeted analysis of citizens' involvement and activism. Our results highlight shortcomings of the planning process in considering urban woodlands for many of the analysed cases. Most urban plans designated land uses that require new soil sealing or newly equipped green areas in substitution of the novel woodlands. Even in cases where woodlands are recognised by the planning instrument, this may only result in temporary provisions driven by economic and social interests. Nevertheless, citizens play a pivotal role in the recognition and awareness of these woodlands. Interestingly, grass-roots participation processes generate new strategic visions to consider this kind of woodlands within the framework of urban planning policies. Our study highlights that a complex and modern array of planning and management approaches, driven by bottom-up citizen initiatives, could capitalise on the potential benefits of emerging urban woodlands.

## The engagement of citizens in the management of urban forests: the LIFE URBANGREEN experience in Krakow

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### Abstract

How do we make the ecosystem services of urban green areas and their benefits against climate change visible in real-time and even more effective? The cities of Krakow (Poland) and Rimini (Italy), in conjunction with their technological and scientific partners, addressed these topics in the EU-project LIFE URBANGREEN (LIFE17 CCA/IT/000079). This project developed innovative tools to assist the green area managers in their daily work and tested the effectiveness of these tools in the parks and streets of Rimini and Krakow.

To ensure a broad understanding of the LIFE URBANGREEN project, along with the promotion of the importance and values of urban greenery, communication activities played a crucial role in engaging citizens in these topics.

The most relevant communication activities the project carried out were:

- creating awareness of urban forests among the target audience;
- calculating and understanding the value of ecosystem services provided by trees and green areas for the two analysed cities;
- communicating the environmental benefits and the overall importance of trees to the citizen.

An important communication channel developed within the project is the web portal “Trees of Krakow and their benefits” (<https://krakow.lifeurbangreen.eu>). Here citizens can consult the main green areas of the city and retrieve information, including the benefits of these areas in terms of carbon assimilation, sequestration and storage, air amelioration and ambient air cooling. The data displayed on the portal is calculated in real-time, based on the spatial database of trees in Krakow, daily updated during maintenance activities.

The data on ecosystem services is based on new algorithms developed during the LIFE URBANGREEN project, which consider the tree species, their age and size, the current weather condition and transpiration coefficients developed by the scientific component of the project with measurements on hundreds of trees over a period of three years.

Citizens showed great interest in the project activities. The public portals of Krakow and Rimini are registering high consultation numbers, even a year after the LIFE URBANGREEN project ended. Since the environmental benefits served by urban trees are calculated dynamically and updated every night, the values represented reflect the actual situation of the two cities.



# High AND inclusive standards of urban forestry

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## Abstract

In recent years, many have called for global and uniform standards for urban forestry, including the UNECE, UN FAO, Sustainable Forestry Initiative, and the UN Decade on Ecosystem Restoration. Though urban forests themselves look drastically different across countries, ecosystems, climate zones, and built environment typologies, sound urban forest management practices do not look so different.

Several sets of standards are emerging to help urban forestry practitioners 'speak the same language' when it comes to managing trees in cities. One of these sets of standards is the Arbor Day Foundation and FAO's Tree Cities of the World recognition scheme, that aims to be the entry point for cities seeking a roadmap for developing a thriving urban forest. The five foundational Tree Cities of the World standards can be paired with any number of these new schemes and standards.

It should go without saying by now that planting trees alone does not result in liveable cities. Trees are only one ingredient of a thriving urban forest. Only by providing a roadmap for excellence, awareness, and investment in urban forestry for people – citizens, foresters, and politicians – can we achieve the end goal: resilient and healthy cities. And each city, no matter how small, can do it. The Tree Cities of the World programme was designed with that in mind.

Furthermore, the future of urban forestry includes international knowledge sharing and benchmarks for what management activities are resulting in tangible and positive outcomes in the urban forests.

This talk will cover new and emerging standards in urban forestry for cities of all sizes and governance structures. It will then discuss what a flexible and inclusive, rather than rigid, structure provides, with global examples of how cities meet these standards in different ways and contexts. And last, this talk imagines a future where big data from programmes like Tree Cities of the World can tell us about the health of our collective urban forest ecosystems and what it takes to keep them healthy.

# Urban tree management: a theoretical framework for prioritisation of tree monitoring and intervention activities through a spatial analysis of risk exposure

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## Abstract

**Introduction:** in Europe, more than two-thirds of the population live in urban areas. Thus, the management of urban green areas and trees is becoming increasingly relevant, with a great level of complexity, involving different players and stakeholders, as well as keeping a focus on Sustainable Development Goals. Society and policy makers are often unaware of the disservices that neglecting these areas can cause. Appropriate monitoring and maintenance interventions can protect both citizens and trees themselves.

**Aim:** to define the priorities of monitoring and intervention activities in Bologna suburbs (Italy).

**Materials:** three target variables identifying the number, and categories, of Streets, Buildings and Walking and cycle paths near each tree in the city of Bologna were considered as covariates. A multiple regression model assessing the relationship between a dependent synthetic spatial variable (Digital number, DN) and the three target categories was estimated.

**Results:** the DN value ranges from a minimum of 57 to a maximum of 255. Both the number of Streets and Walking and cycle paths in the surrounding area are shown to be significantly associated with the DN value ( $p$ -value < 0.001). The number of streets shows a positive association with the DN value: a unit increase in the number of street geometries in the area surrounding the tree corresponds, on average, to a 4% increase in the DN value; therefore, as the number of road geometries increases, the level of failure propensity of the tree decreases. However, a negative association is estimated between the Walking and cycle paths variable and the DN value, with a 9% mean decrease for every single increase in the number of paths. The number of buildings is not significantly associated with the outcome.

**Conclusions:** open data can be used to support decisions for the planning of appropriate monitoring and maintenance interventions in urban green areas. The use of a valid and unique tool in the urban context, in addition to satisfying the criteria of sustainability, effectiveness and efficiency, promotes a virtuous circle model among stakeholders in the urban system.

## Italian monumental trees and biodiversity: a focus on origin and landscape settings

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### Abstract

The scientific community, policy-makers and citizens have increased the attention paid to monumental trees and their ecological, landscape and socio-cultural values. Monumental trees represent only a small portion of the population of trees, but require specific planning and management to maintain their notable and specific cultural and biodiversity values. These trees are generally identified for their exceptional size (e.g. trunk diameter, height), shape (e.g. crown and trunk shape), age, and/or for their intrinsic cultural values, having witnessed important historical events. Because of their specific structural and functional traits (e.g. tree-related microhabitats), monumental trees are essential for supporting complex and distinct assemblages of a wide range of species. However, little attention has been paid to the importance of monumental trees for biodiversity, especially in urban environments. In the project “MONIVERSITY – MONUmental and urban trees for biodiveRSITY: improving our knowledge on their origin and microhabitats”, we aimed to analyse and describe the monumental tree community of Italy, highlighting their importance for the conservation of biodiversity. We analysed the most updated version of the database of Italian monumental trees as identified according to the Italian Ministerial Decree 23/10/2014. Currently, it includes 4,006 monumental trees, both as single (ca. 90%) and groups of plants (ca. 10%). Over 90% of monumental trees were identified based on their age and/or size, followed by tree shape and habit, highlighting their importance in the Italian decision-making procedure in determining the monumentality of a tree. We coupled this with other databases reporting information on the origin (i.e. the national list of native and non-native flora) and spatial explicit variables. Knowledge of the composition and spatial distribution of monumental trees, distinguishing between native and non-native species, in urban and non-urban areas and cover types, allowed us to better understand their cultural value and their potential role in biodiversity. These results help propose management practices that aim to protect individual trees, their cultural significance, and their role for biodiversity, as well as the surrounding environment and the benefits to future generations.





# Canopy-based classification of urban vegetation from very high-resolution satellite imagery

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## Abstract

Cities are facing too many challenges. Urban trees are essential as they provide services in terms of air pollution mitigation, freshness, biodiversity, and citizens' well-being. The potential contribution of residential areas and gardens to urban sustainability is recognised worldwide. For a realistic and proper quantification of the benefits of urban vegetation in terms of providing ecosystem services at the city scale, a consistent inventory of vegetation (location, species, structural characteristics) within residential and public areas, is needed to avoid a large underestimation and to establish an efficient Urban Greening Plan. However, the cost of measuring thousands of individual trees through field campaigns can be prohibitive and reliable information on domestic gardens is lacking due to difficulties in acquiring systematic data.

The main objective of this study was to investigate the suitability of very-high-resolution satellite imagery, e.g. WorldView-2, for detecting, delineating, and classifying the dominant plant species in both public and private urban areas.

The characterisation of urban trees is difficult due to the complexity of the urban environment (buildings, shadows, open courtyards), the diversity of species and the spatial proximity between trees. To overcome these constraints, a canopy-based classification was developed with the selection of new relevant spectral and texture-based features for each tree species. Four spectral bands (blue, green, yellow, red) and four texture features (i.e. energy, entropy, inverse difference moment, Haralick correlation) were found to be the most efficient attributes for canopy-based classification from WV-2 images (at < 0.5 m of spatial resolution). Then, a classification of vegetation types, by using a Random Forest classifier, and ground validation were performed.

In the two study areas, 420,000 and 555,000 canopies were successfully classified in Aix-en-Provence (France) and Florence (Italy), and 22 and 20 dominant species were identified and classified with an overall accuracy of 84% and 83%, respectively. In both study areas, 85% of the trees grew on private land. The highest classification accuracy was obtained for *Pinus* spp. and *Platanus acerifolia* in Aix-en-Provence, and for *Celtis australis* and *Cupressus sempervirens* in Florence. The lowest classification accuracy was obtained for *Quercus* spp. in Aix-en-Provence, and *Magnolia grandiflora* in Florence.

## Remote sensing of urban trees' health dynamics

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### Abstract

Urban trees are an important natural-cum-cultural asset for cities. However, the triadic relationship between the species selection, the habitats in which they are planted, and their health dynamics remains unclear. The openness of information on tree species distribution makes it difficult to explore this relationship, but advances in remote sensing-based tree species identification methods offer new ideas. First, we identified 12 common urban tree species in the Kowloon Peninsula of Hong Kong by the seasonal vegetation index developed from integrating field, government databases and remote sensing data. Secondly, the trees were assigned to the four urban regions of roads, parks, wilderness and residential neighbourhoods by their habitats. Finally, three vegetation indices were used to assess the health dynamics of trees in terms of canopy photosynthetically active component, non-photosynthetic component and water content, respectively. The results from 2016 to 2020 show the heterogeneity of the effects of tree species and their location on their health. The increase in photosynthetically active component and water content of the canopies of *Ficus virens*, *Falcataria falcata*, *Bombax ceiba* and *Grevillea robusta* in the road region indicates their greater adaptation to this harsh habitat. In contrast, the two super typhoons in 2017 and 2018 caused a decline in non-photosynthetic component for all species in all habitats and two years were not sufficient for urban trees to return back to their previous state. This study provides a scientific reference for enhancing the health management of subtropical urban trees under human and natural disturbances.

# Climate tools based on local and Copernicus data in urban NBS implementation

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## Abstract

The poster presentation will focus on the implementation of spatial data-based tools that help local governments to better adapt cities to climate change using the example of Gdynia, in northern Poland. We will present the process of tool development, challenges and barriers, and lessons learned as they relate to planning NBS solutions in cities.

Gdynia is testing the Safer\_RAIN tool. It is a response to the phenomenon of flash floods and flooding, which are increasingly threatening the city due to the changing climate. Their cause is the progressive sealing of the city and the insufficient capacity of the rainwater drainage system during torrential rains.

Safer\_RAIN is a tool that quickly maps the risks and hazards of urban flooding. It allows you to assess the potential of nature-based solutions to increase urban resilience. It takes into account different scenarios of climate change and increasing urbanisation. Based on rainfall event scenarios, surface characteristics and socio-economic features, Safer\_RAIN predicts the extent of flooding, population exposure and damage required to assess the effectiveness of proposed NBS solutions.

The second tool being implemented is the CRC tool, which is a planning tool for the various stakeholders involved in public consultations. The tool allows a comparison of the most effective NBS solutions to be implemented in a selected area of the city.

The tools are being developed as part of the REACHOUT project (European Horizon 2020 programme). More information about the project: <https://reachout-cities.eu/>.

# Exploring the volumetrics relationship between urban greening and build-up using a voxel-based approach: a city-level analysis

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## Abstract

The rapid growth of the global urban population causes the dynamic development of cities, and hence the re-composition of urban green spaces, which are increasingly coming under pressure. Therefore urban space must be appropriately shaped to be as resident-friendly as possible. Particular attention needs to be paid to urban vegetation, which is an essential component of a suitable quality of life. Research has often relied on two-dimensional (2D) mapping of urban vegetation using remote sensing imagery and vegetation indicators, where greenery is evenly distributed regardless of the cubature. However, vegetation's spatial and vertical structure varies, and the layers often overlap.

The study aims to investigate the spatial relationship between the volume of vegetation and buildings in the rapidly developing Luxembourg City. We proposed 3D spatial indices: Vegetation 3D Density Index (V3DI) and Vegetation Volume to Building Volume (VV2BV). The 3D indices can assist in future recommendations for supporting the city districts' sustainable development and presenting the current state of liveability. The vegetation volume was calculated using airborne laser scanning point clouds (ALS LiDAR) processed into voxels (0.5 m). The volume of the buildings was calculated based on the results of 3D ALS LiDAR point cloud modeling. We compared the results of 3D GIS spatial analyses with population statistics to determine the residents' environmental situation as an essential component of the quality of life and to indicate possible deficits of vegetation in urban space. Proposed spatial indices were estimated for districts and cadastral parcels in a cell grid of 100 m and for each building individually, using a 100 m buffer.

We found that in 2019, urban forests covered 1.689 ha of Luxembourg City, accounting for 33% of the entire administrative area. The 3D GIS analyses show that the total volume of vegetation (> 1.0 m above ground) was about 40 million m<sup>3</sup>, equating to 328 m<sup>3</sup> of greenery per resident. The value of V3DI reached a level of 0.77 m<sup>3</sup>/m<sup>2</sup>. The overall VV2BV(%) index calculated for Luxembourg was 41.6%. Only five districts of Luxembourg were characterised by a high value for the VV2BV index, which indicates that areas with a high level of green infrastructure contribute to health and a better quality of life.

## Tree-ring analysis and impulse tomography on old native (*Quercus robur*) and exotic (*Quercus rubra*) urban oaks revealed a growing sensitivity to drought and internal trunk damage

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### Abstract

Recurrent extreme drought events in urban areas can predispose single-standing city trees to drought-induced mortality. In this presentation, we will show the results of a study where we aim to 1) understand oak trees' resilience, recovery, and resistance to the past event of droughts and the annual correlation between drought and stem growth; 2) compare the recovery time of oak trees from droughts occurring between 1959 and 1991 in contrast to droughts of 2003 and after; 3) assess internal trunk damage in trees and its relation to the frequency of drought faced by a tree in its life. We expected drought responses would vary between species based on their origin (i.e. exotic *Q. rubra* vs. native *Q. robur*) and between growing conditions (i.e. park vs. street). We randomly selected 40 *Q. robur* trees and 40 *Q. rubra* trees from across the city, evenly distributed between parks and streets in Karlsruhe, southwest Germany for the taking of two tree ring cores per tree. We measured the internal trunk defect by impulse tomography using an ARBOTOM® and performed a tree health and dendrometric survey for every tree. The selected trees' minimum diameter at 1.3 m height was kept to 50 cm. We found that the mean age was 85 and 70 years for *Q. robur* and *Q. rubra*, respectively. The radial growth was higher in park trees compared to street trees in both species. The correlations between stem growth and drought (standardised precipitation-evapotranspiration index) were more substantial in *Q. robur* than in *Q. rubra*. Mainly, *Q. robur* was more sensitive to winter and spring drought than *Q. rubra*. We took eight past drought events and found that resilience recovery and resistance often showed alternating trends between species and years of drought. The recovery time after the drought has almost doubled since 2003 compared to droughts between 1959 and 1991 in both species. *Q. rubra* needed more time to recover than *Q. robur* trees, and this was also longer among park trees. Interestingly, our impulse tomography result showed that trees with higher growth depressions in their life due to drought also had higher internal wood damage. *Q. robur* had more wood damage inside the trunk than *Q. rubra*. We can conclude that as climate warms and droughts get frequent, both *Q. rubra* and *Q. robur* trees are taking more time to recover from droughts which might lead to higher internal damage to the trunk due to secondary pathogen infections that warrant further investigation.

## Lessons learned from the GrüneLunge or GreenLung project to increase social-ecological resilience of urban and peri-urban forests (UPF) to climate change impacts by performing inter- and transdisciplinary research

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### Abstract

The concurrent increase in the supply of ecosystem services and resilience in UPF warrants involving multiple stakeholders and disciplines. Therefore, we applied holistic inter-and transdisciplinary research approaches in the “GreenLung” (“GrüneLunge”) project (2018–2023, <https://www.projekt-gruenelunge.de/>) in the Karlsruhe region, southwest Germany. We executed an inventory and health survey by installing 201 random circular plots (404 m<sup>2</sup> each) in the study area. Further, we sampled City Tree Register’s (CTR) trees for dendroecological, dendrochemical (C, O, and N stable isotopes), biodiversity, and meteorological analyses. During heatwave conditions, mobile measurements allowed study of the thermal influence of land use, urban morphology, tree species density, and diversity to atmospheric conditions. A participatory map-based questionnaire survey with the respondents from the two cities was carried out to identify the perceptions of cultural ecosystem services, especially during the COVID-19 pandemic. During a series of excursions, training, expert meetings, and workshops in real-world labs with citizens and stakeholders, we identified possible solutions for improving the current management of UPF. Our study revealed a significant trade-off between supporting and regulating ecosystem services. For example, exotic oak species (*Quercus rubra*), for example, had less microhabitat diversity, abundance, and bat activities than native oaks (*Quercus robur*) but had a higher supply of regulating ecosystem services than native oaks. An increase in drought tolerance at the species level reduced the magnitude of dieback in our study area. Dendroecological and stable isotope analyses revealed high plasticity in climate-growth relationships between species. *Quercus robur* and *Platanus* hybrids had the highest tolerance to periodic droughts. The relative air temperature (2 m from the surface) cooled down with increasing vegetation cover during night and morning at the time of heatwaves. The participatory map-based questionnaire survey revealed a high public appreciation of cultural ecosystem services. During the pandemic, citizens without access to private gardens and balconies visited public green spaces more often to reduce psychological stress. Our project was a unique attempt to combine inter- and transdisciplinary research to develop solutions for climate change adaptation and mitigation in urban forests.



# Application of blue-green infrastructure as nature-based solutions: practical examples from England, the Netherlands, and Wales

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## Abstract

This poster presentation is to accompany an oral presentation of the same title for which a submission is being made separately. The poster presentation's focus is on the infrastructure and technical solutions that enabled the nature-based solutions to materialise.

An English case study is an example of how alterations to the road network in and around a historical town centre, driven by a municipality's desire to alleviate traffic congestion, can achieve additional benefits with the help of blue and green infrastructure. This project required irrigation and aeration components. The need for large soil volume tree pits was supported with GreenBlue Urban RootSpace soil cell systems. Other products used were: Root Management for guidance along with utilities, Mesh, Geonet and ArborSoil Hydro, specifically blended as a result of research and testing, perfect for sustainable urban drainage tree pits.

A Dutch case study, delivered as part of an EU-funded Interreg project of retrofitting a whole street with tree planting in hard surfaces. This transformation saw trees planted in full GreenBlue Urban ArborFlow tree pit systems, taking stormwater from the hard paved areas, and storing this asset within the growing medium.

A Welsh case study shows how retrofitting high density residential areas with suitable blue and green infrastructure not only reduced pressure on an ageing sewer network, but delivered a myriad of benefits for its local communities. Load bearing soil cells from GreenBlue Urban were used extensively to provide optimal soil volumes, and maintain uncompacted aerated soil conditions, ideal for root growth, water attenuation and air supply within the root zone.

The products utilised in the case studies are manufactured in the UK using 100% recycled plastic – i.e. plastic material diverted from incineration or landfill.

The case studies are exemplars of what can be achieved by adopting a nature-centric approach to addressing urban challenges our societies increasingly face. In the case studies local areas were transformed by retrofitting existing hard surface urban environments using blue and green infrastructure. The case studies show that blue and green infrastructure – water and trees – are not mutually exclusive, but can complement each other.





# Management practices alter the endophytic mycobiota of an urban forest favouring pathogenic endophytes

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## Abstract

Urban parks and forests have been demonstrated to play an important role in the general well-being of society, providing multiple ecosystem services. Trees help to clean the air, generate oxygen, provide shade, reduce the heat islands effect, improve the microclimate, and are visually important within the urban environment. In recent years, however, tree health in urban areas has been increasingly compromised by environmental stresses. Climate change has been shown to induce physiological impairment in trees, predisposing them to attack by various agents of damage. This study was conducted in the Parco Nord Milano (PNM), in the city of Milan, where many trees have exhibited extensive dieback and mortality during the past years. Park managers, in an attempt to halt or at least mitigate the decline of some forest stands, had started to thin out some plots, removing dead trees or trees in an advanced state of decline. The purpose of this silvicultural intervention was to reduce the density and therefore the competition among the trees. Furthermore, by making more resources (water, light, nutrients in the soil) available to the remaining trees, it was hoped that it would be possible to improve tree health and reduce the decline. Unfortunately, thinning exacerbated the suffering of trees and influenced in a negative way the species composition of the endophytic fungal community. In fact, thinning made trees more vulnerable to pathogen attacks (e.g. more prone to infection by leaf pathogens during the spore rain), and also induced a shift in the fungal endophytic assemblage, favouring massive colonisation by the more aggressive, thermotolerant, horizontally-transmitted fungal pathogens. This negative outcome was also a consequence of improperly conducted thinning operations, the damage caused by spreading infected material within park areas, and not properly cleaning pruning equipment.

## Urban forest and climate change mitigation: most effective tree species in Perugia, Italy

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### Abstract

Cities' intrinsic characteristics tend to exacerbate the extreme temperature gradients that impact ecosystems, housing, livelihoods, and the health of urban communities. In accordance with the EU strategy on adaptation to climate change, to increase urban resilience to climate change, cities need to plan and implement urban investments and managerial strategies to fulfil emissions targets. In this context, urban green infrastructures (UGI) offer a significant climate change mitigation potential providing multiple ecological, social, economic, and health benefits, also called ecosystem services (ES). The vegetation acts like a 'natural air cooler', attenuating the thermal excesses which characterise the urban heat island effect. However, every typology of UGI performs differently, with various levels of positive effects on the local climate, air quality, noise levels, and psychological restoration. Urban trees, by shadowing and by evapotranspiration, can decrease the air temperature up to 6°C in the Mediterranean area, also reducing the energy demand for building cooling systems, with further indirect positive impacts on air quality and greenhouse gases emission. The LIFE CLIVUT (Climate Value of Urban Trees) is a European-funded project that aims to increase the awareness of the urban forest ES amongst public administration and planners, private companies, and citizens to improve the green urban 'capital' and maximise their benefits by also developing an urban green asset strategy. Tree census data of the four CLIVUT pilot cities was used to model and integrate the current knowledge on tree growth in the urban environment. The tree growth models obtained were implemented on a free web app to permit the tree ES evaluation (and prediction) per individual tree, per species, and per green infrastructure type. The main ES indicators considered in this case study were the potential carbon storage, PM10 absorption, and tree crown shadow effect of the main tree species encountered, in addition to the Shannon-Wiener index for biodiversity. In the parks analysed, *Pinus pinea*, *Quercus ilex*, *Q. pubescens*, *Ulmus carpinifolia*, *Populus alba* and *Aesculus hippocastanum* showed the highest estimates of CO<sub>2</sub> stored. *Q. ilex* and *Q. pubescens* among broadleaf and *Pinus pinea* among conifers were the most effective in terms of PM absorption in the study areas. Finally, the Shannon evenness index indicates a fairly homogeneous species distribution at sampling time.

# Morphological, tree health, and ecophysiological variations among Norway maple (*Acer platanoides* L.) trees planted along strips and pits near roads in the city of Karlsruhe, Germany

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## Abstract

Frequent catastrophic droughts and intense heat waves threaten the health of urban trees in cities of the upper Rhine River Valley in southwest Germany. The morphological, health and ecophysiological performance of trees growing in small-sized pits compared to larger elongated strips near streets was rarely compared in the literature. We collected dendrometric and crown health data from 235 randomly selected Norway maple trees from pits and strips in Karlsruhe. In addition, each tree's leaf area index (LAI) was calculated using hemispherical images. A subset of 20 trees was studied for the ecophysiological variables such as stomatal conductance, quantum efficiency, and electron transport rate. A new building index was developed to quantify the impact of surrounding buildings on the sunlight availability of the trees. The influence of neighbourhood interaction was quantified by calculating Hegyi's competition index. GLMs and LMMs were used to investigate the influence of site type, the height of the crown base, distance to the road, crown light exposure, vegetation cover of the open surface area, Hegyi index, canopy openness, crown volume, and pruning intensity on leaf area index, crown projection area, crown openness, crown missing, dieback, discoloration, sun-scald, epicormic shoots, stomatal conductance, and electron transport rate. Trees on strips had, on average, five times more open surface area than trees in pits. Crown dieback, leaf discoloration, and crown openness due to low foliage were significantly higher in pits than in strips. A high Hegyi index reduced the crown projection area and the crown's density and increased the proportion of missing crowns while preventing the occurrence of sun-scald. The vegetation cover of the open surface area reduced the proportion of missing crown and stomatal conductivity. High light exposure harmed most of the variables studied and led to higher stomatal conductance during heat waves. This study shows the complexity and diversity of possible interactions and emphasises the importance of a multidimensional view of possible influencing factors to explain and interpret the occurrence of different tree characteristics. For example, managing urban trees may require a trade-off between large and dense canopies, affecting the overall cooling effect and shading areas.

# The study of the bleeding disease of rain tree (*Albizia Saman*) in the urban environment in Malaysia

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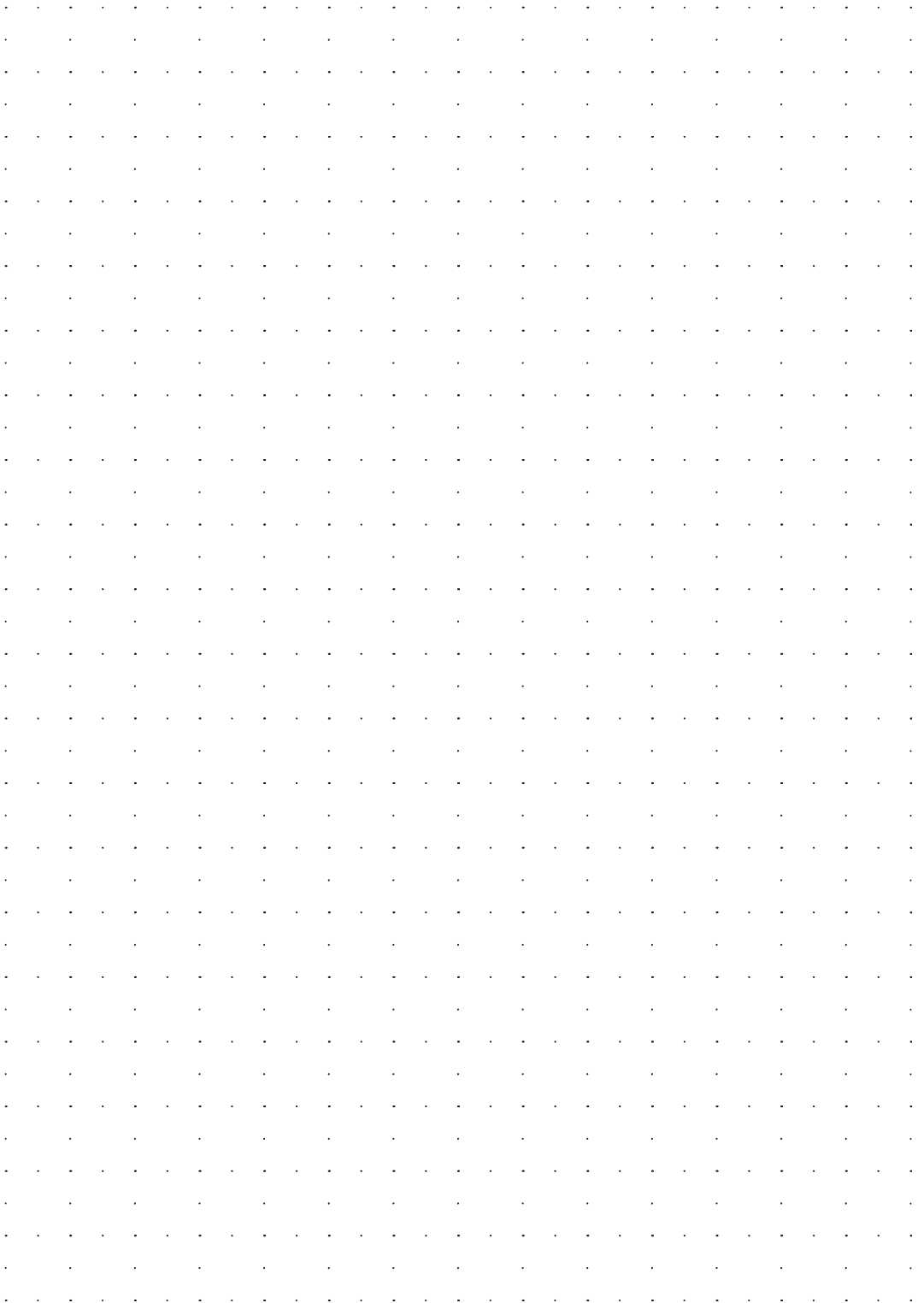
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## Abstract

*Albizia saman* (Jacq) Merr is a native species from northern South America and Central America, cultivated and naturalised throughout the tropics. The plant was initially planted in Malaysia and later introduced to urban areas in the 1900s. Over the past years, a problem bleeding disease followed by the gradual tree failure of the affected trees has been observed in various parts of the urban environment in Malaysia. *A. saman* showed bleeding and gummosis symptoms, which were observed and investigated. The obvious symptoms of the infected *A. saman* trees are trunk discoloration, sap oozing from the infected area, gummosis exudation on the tree trunk, crusty exudate when dry, boring insect holes, abnormal cavities on the trunk, cracked or sunken, and splits on the bark. In this study, we attempt to explore the causal agents (pathogens) that cause the bleeding disease of *A. saman*. The studies are conducted to assess the health of *A. saman* trees in the urban area by identifying the pathogen that causes the symptoms, testing out the pathogenicity, and determining the best fungicide to control the disease. Isolation of fungi from gummosis and pest samples of affected rain trees revealed one fungal isolate to be the most dominantly and consistently isolated fungus. The causal agent of bleeding disease in the rain trees was identified using DNA sequence-based method (ITS,  $\beta$ -tubulin, Calmodulin, and TEF-1) and morphology identification by scanning electron microscope (SEM), microscope and a compound microscope. The results show that *Paecilomyces dactylethromorphus* was the causal agent and fulfilled Koch's postulates through a pathogenicity test. The result of the pathogenicity test revealed that there was a similarity in symptoms that arise between artificial inoculation and natural symptoms in the field. The effects of incorporating different concentrations (0.125%, 0.250%, 0.50%, 1.00%, and 2.00%) of each of the five fungicides (dimethomorph, thiram, copper hydroxide, mancozeb, and prochloraz manganese chloride) in 2% PDA medium were tested in vitro at the laboratory for 7 days and have shown that thiram fungicide with a concentration of 1.0% and 2.0% caused total inhibition of *Paecilomyces* growth. From this study, the susceptibility of fungal infections was due to injuries from anthropogenic and natural causes, and the application of fungicide of a thiram mixture at 2.0% can help control the disease at the field level.











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