“Urban green infrastructure: ecosystem services and nature-based solutions”

Carlo Calfapietra

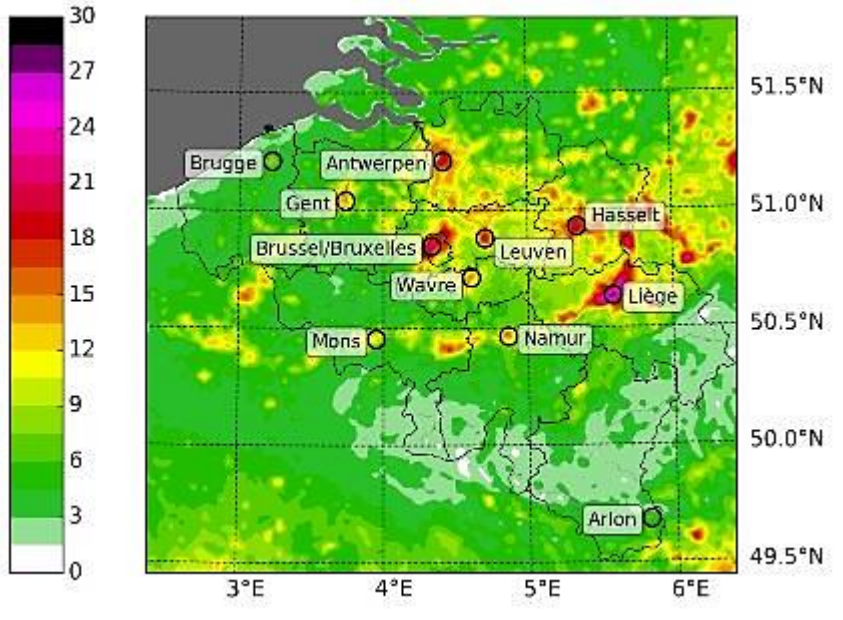
-CNR-Institute of Research on Terrestrial Ecosystems
Porano (TR), Monterotondo Scalo (Roma), Firenze, Pisa, Napoli, Sassari, Lecce
-EU Commission- Expert on Nature-Based-Solutions

Email: carlo.calfapietra@cnr.it **www.carlocalfapietra.com**

Urbanization impacts

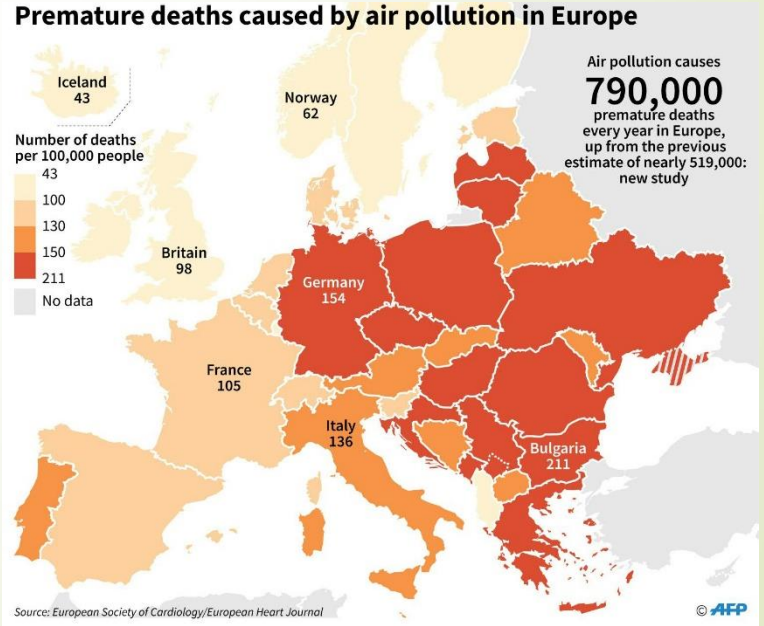
- **Cities** host **more than half** of the **world's population** (75% by 2050) and are responsible for **70%** of **greenhouses gas emissions**
- **Climate change impact** on **environment** and **human health** in urban areas (soil consumption and pollution)

Heat stress in cities



Wouters et al. 2017 (Geophys. Res. Lett)

Air pollution effects on human health



Source: European Society of Cardiology/European Heart Journal

European Commission leader in NBS and environmental protection

European Commission

Green Deal Proposal
THE EUROPEAN GREEN DEAL
Guarda più...
Condividi

Nature Based Solutions

CO_2 sequestration

Microclimate effect
(avoided emissions)

Directorate-General for Research and Innovation Climate Action, Environment, Resource Efficiency and Raw Materials – 2015.

Nature-based solutions simultaneously provide environmental, social and economic benefits by bringing more nature and natural features and processes into cities, landscapes and seascapes.

This report presents the main findings of the **Horizon 2020** *Expert Group* on 'Nature-Based Solutions and Re-Naturing Cities'

HORIZON 2020

“Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience.

Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions”

Source: EU Research and Innovation policy agenda on Nature-Based Solutions

What is NBS?

GEORGETOWN CLIMATE CENTER
A Leading Resource for State and Federal Policy
green infrastructure
toolkit

NBS IMPLEMENTATION PROCESS

- Multistakeholders
- Co-design; Co-implementation; Co-management
- Multipurpose
- Cost-effective
- Locally-adapted
- Easily upscaled spatially and temporally
- Effectiveness assessment

Urban Forest as the best expression of **NBS**

Improve quality of life

Reduce Soil Erosion

Improve Air Quality

Save Energy

Reduce Runoff

Reduce Noise

Ecological functions

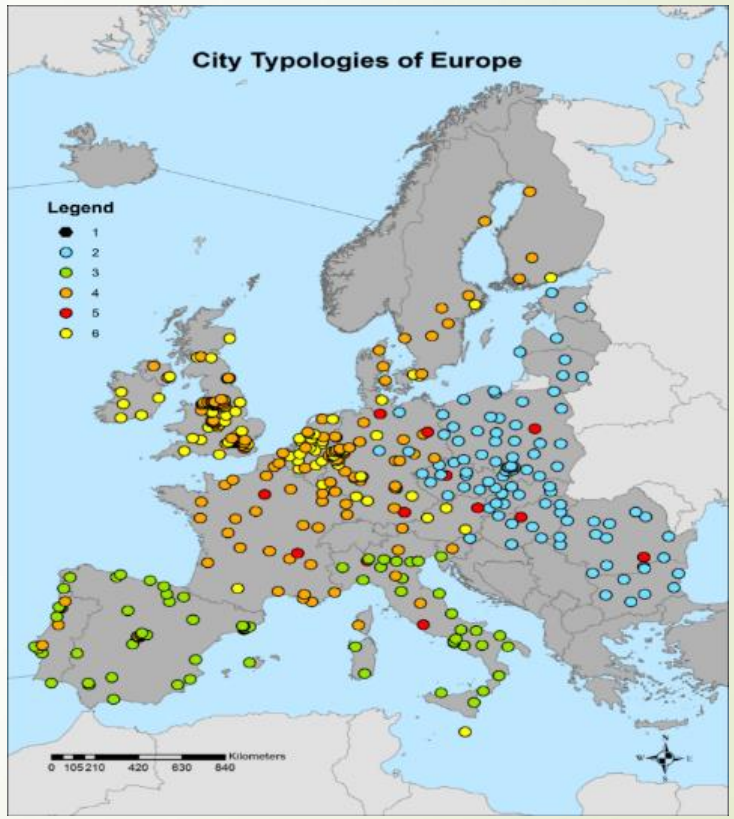
Benefits society

Modify Urban Microclimate

Back in action: NBS projects in Europe

Since **2016**, the EC has funded 17 NBS sister projects (and a new call is now ongoing) to:

- implement NBS in the European cities
- develop participatory models based on the quadrupole helix
- investigate the NBS benefits
- create an open access repository where all the NBS case studies are described and compared
- provide stakeholders and decision-makers with guidelines to implement NBS able to answer to specific, local challenges



Oppla case studies

Case study finder

Displaying 1 - 95 of 95

SEARCH

enter search terms:

SCALE

- ☐ Global
- ☐ Continental
- ☐ Sub-continental
- ☐ National
- ☐ Subnational
- ☐ Local

APPLY RESET

proGIreg

ProGIReg

«Productive

Green Infrastructure

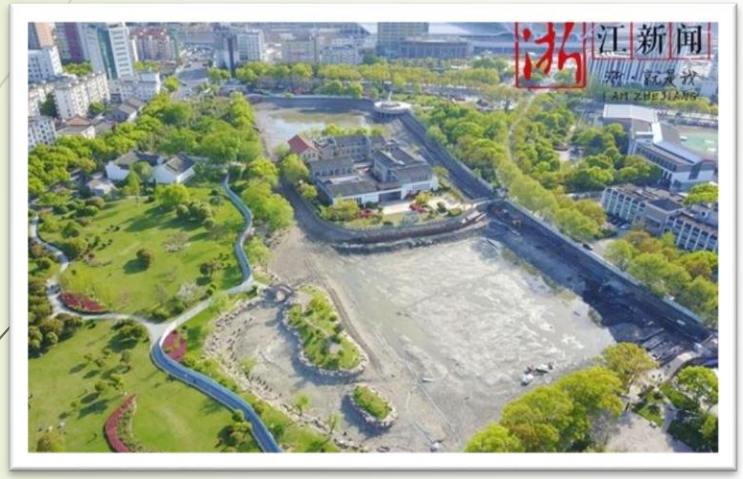
for post-industrial

urban regeneration»

2018-2023 (11M€)

NBS 3 in Ningbo LL area

- Using **aquatic plant** to re-nature a **5 km corridor** surrounding the **urban lake**

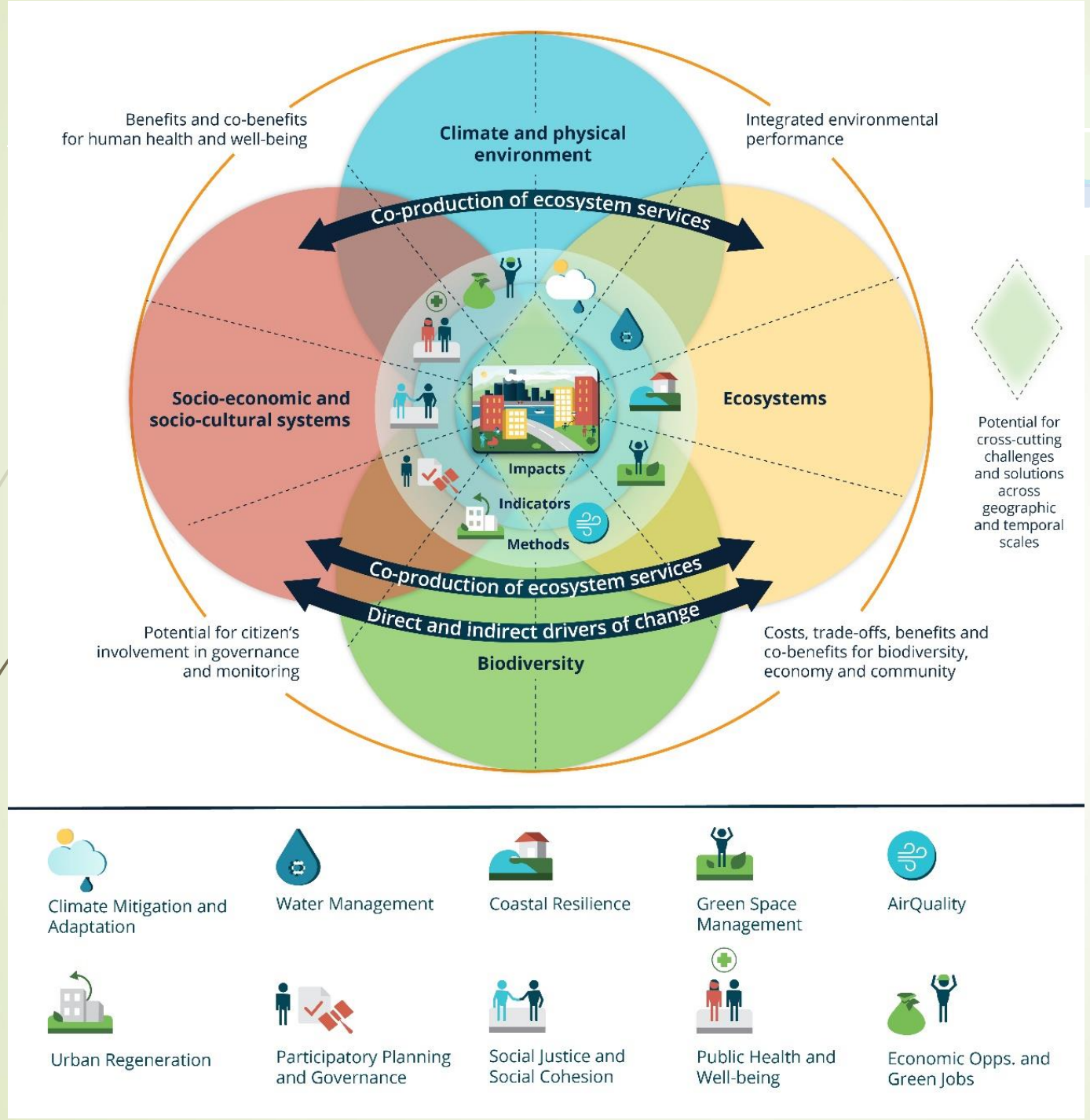


We are now able to
quantify ES&DES
provided by
UF and NBS

and this
<u>should emerge</u>
in all
plans and projects

EKLIPSE
Knowledge & Learning Mechanism
on Biodiversity & Ecosystem Services

IMPACT ASSESSMENT FRAMEWORK



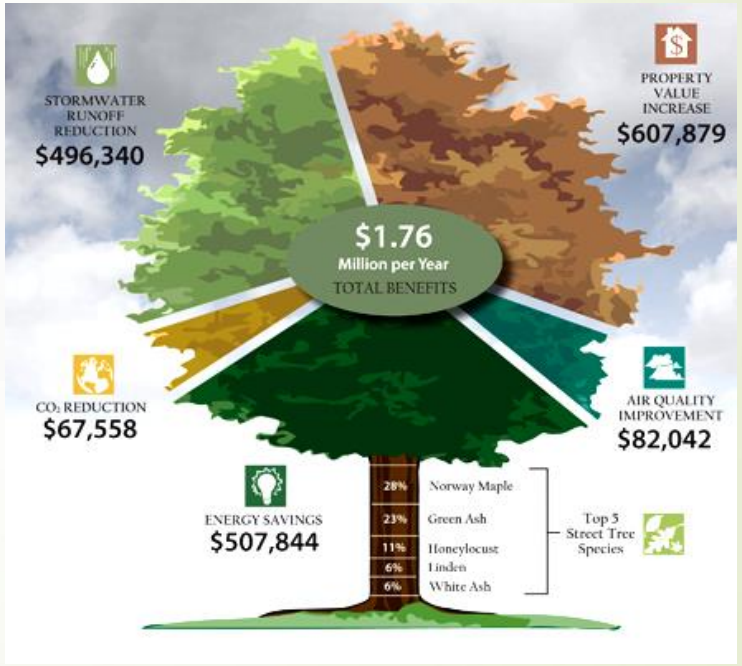
Raymond, C.M., Frantzeskaki, N., Kabisch, N., Berry, P., Breil, M., Razvan Nita, M., Geneletti, D., Calfapietra, C. (2017). A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environmental Science and Policy.* 77:15-24.

IMPACT ASSESSMENT FRAMEWORK

Raymond, C.M., Frantzeskaki, N., Kabisch, N., Berry, P., Breil, M., Razvan Nita, M., Geneletti, D., Calfapietra, C. (2017). A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas. *Environmental Science and Policy.* 77:15-24.

10: Economic Opportunities/Green Jobs

- increase in mean land/property price
- new jobs created, gross economic value added
- food/other goods production
- energy saving
- evironmental benefits



Estimated economic benefits provided by street trees in the Green Bay Metro Area (Wisconsin, USA)

www.itreetools.org/resources/reports/WDNR_GreenBay_Metro.pdf

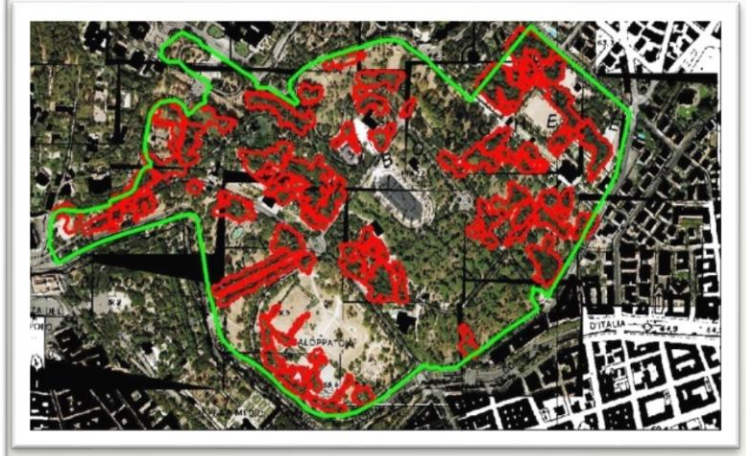
NBS *Assessment Plan*

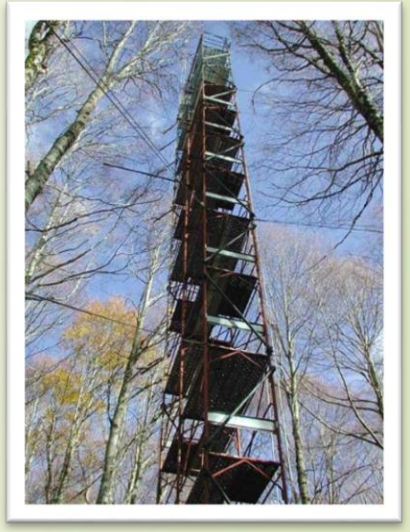
in ProGIReg

proGIreg

B - SOPARC	Number of users and type of physical activity for a specific NBS	Survey performed by using the "System for Observing Play and Recreation in Communities"[7], in a pre-post design (**1 PM** per implementation, under the guidance of ISGLOBAL)
C - Economic and labour impact questionnaire	Economic impact indicators of a specific NBS	Survey about economic parameters to be submitted to the organisation in charge of NBS implementation as well as to the organisation in charge of long-term management (**1 PM** per FRC, under the supervision of SL)
D – Carbon impact	Carbon storage; saved carbon dioxide emissions	Mathematical models applied to a specific NBS, based on either environmental, GIS or economic data. (timing depends on the NBS)
E - Air quality	Ozone (O_3) and nitrogen dioxide (NO_2) concentrations	Discontinuous concentration measure-ments by passive diffusion tubes in the proximity of the NBS and in a control site, repeated before the implementation and two times after. For each monitoring site, 36 passive diffusion tubes are needed (3 tubes x 2 gases x 3 years = 18 passive tube samples for both sample and control sites). Samples should be placed onsite, removed after three weeks, and sent for analysis. FRC will be incharge of installing, removing and sending the sensors (**6 working days** in three years) and buying sensors for the two post implementation campaigns. CNR will be in charge of pur-chasing and installing the sensors for the pre implementation campaign
F - Air temperature	Air temperature	Continuous measurement of air tempera-ture inside an NBS and in a control site over three years. For each monitoring site, 6 temperature sensors are needed (3 for the site and 3 for the control site). The sensors should be checked monthly for data download and battery (**9 working**

→ *Research* Levels of investigation

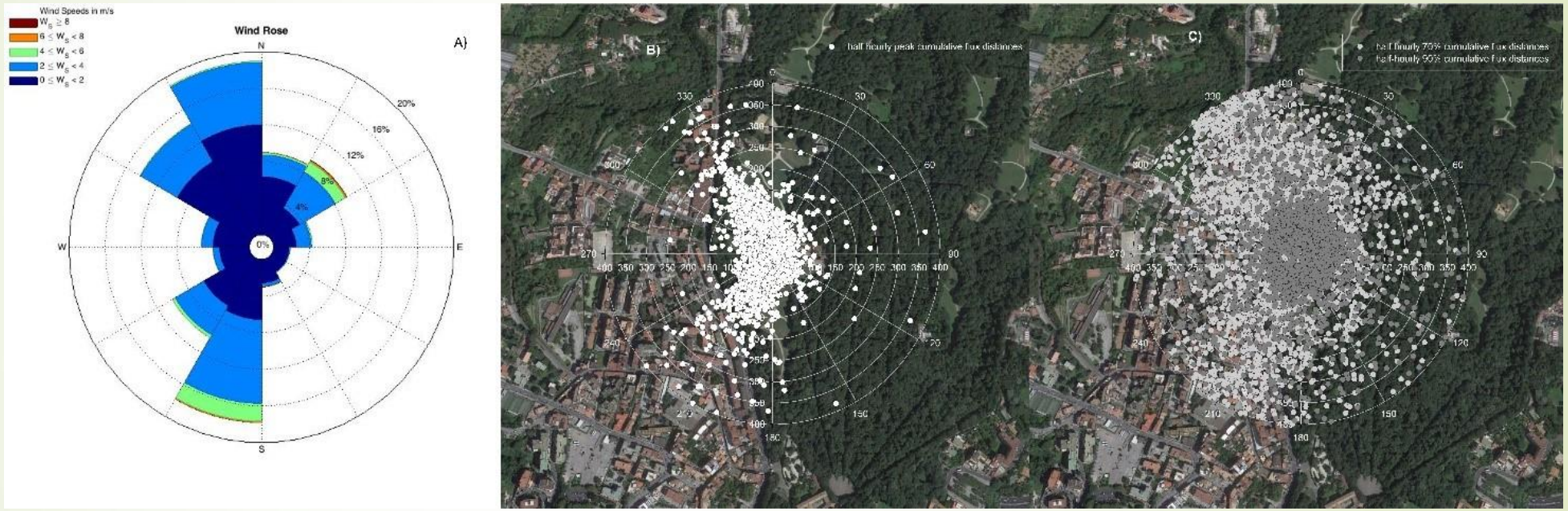




Laboratory → Modelling → Field

Promoting the potential of flux-measuring stations in urban parks: An innovative case study in Naples, Italy

Guidolotti et al. 2017, Agricolture and Forest Meteorology



Wind distribution for the period March 2015 – April 2016 (panel a). Half hourly cumulative fluxes distances representing the peak (white circles) (panel b), 70% (dark grey circles) and 90% (light grey circles) (panel c) for the period March 2015 – April 2016. Cumulative fluxes distances were calculated using the footprint model of Kljun et al. (2004).

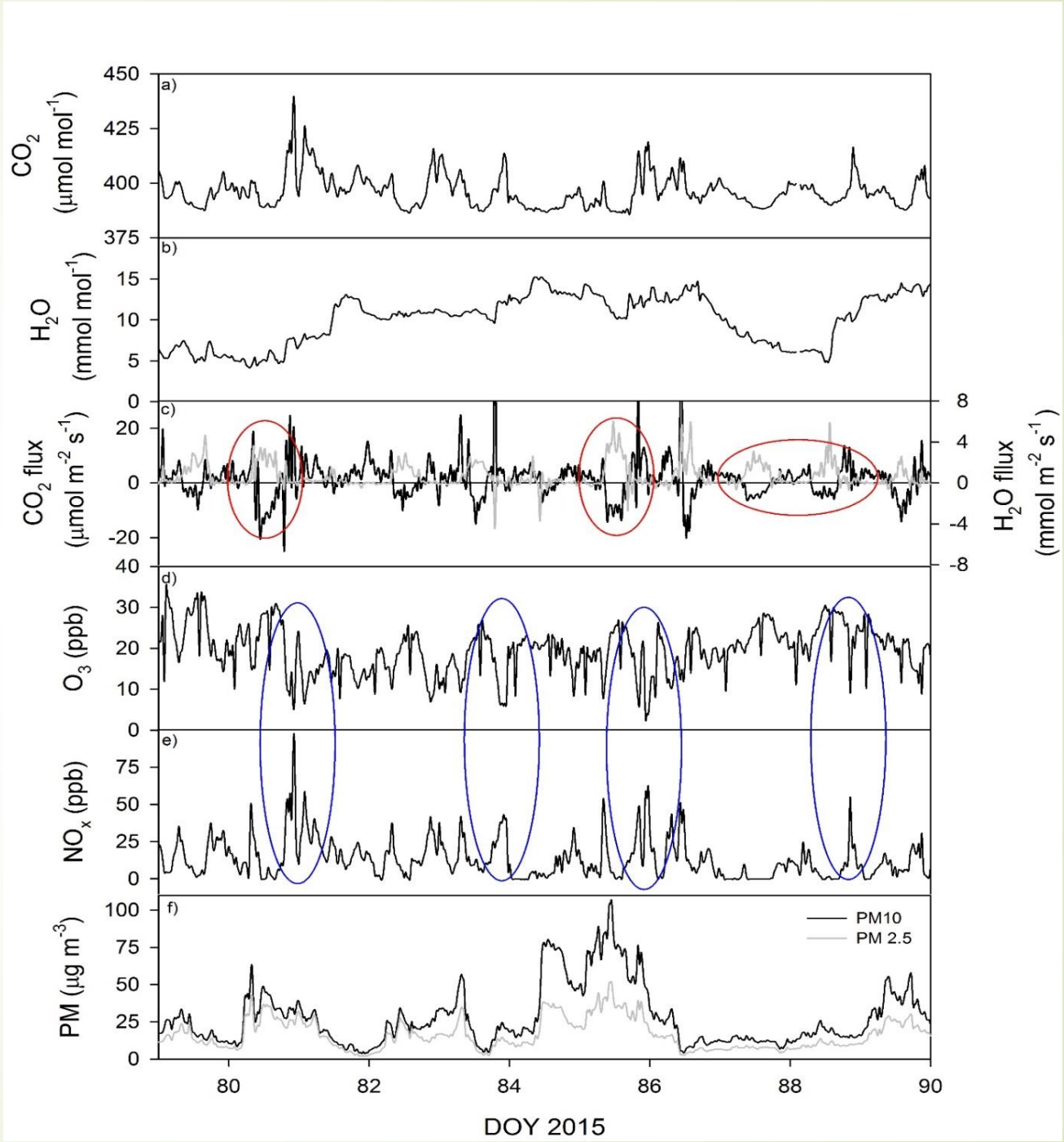
Concentrations

and **fluxes**

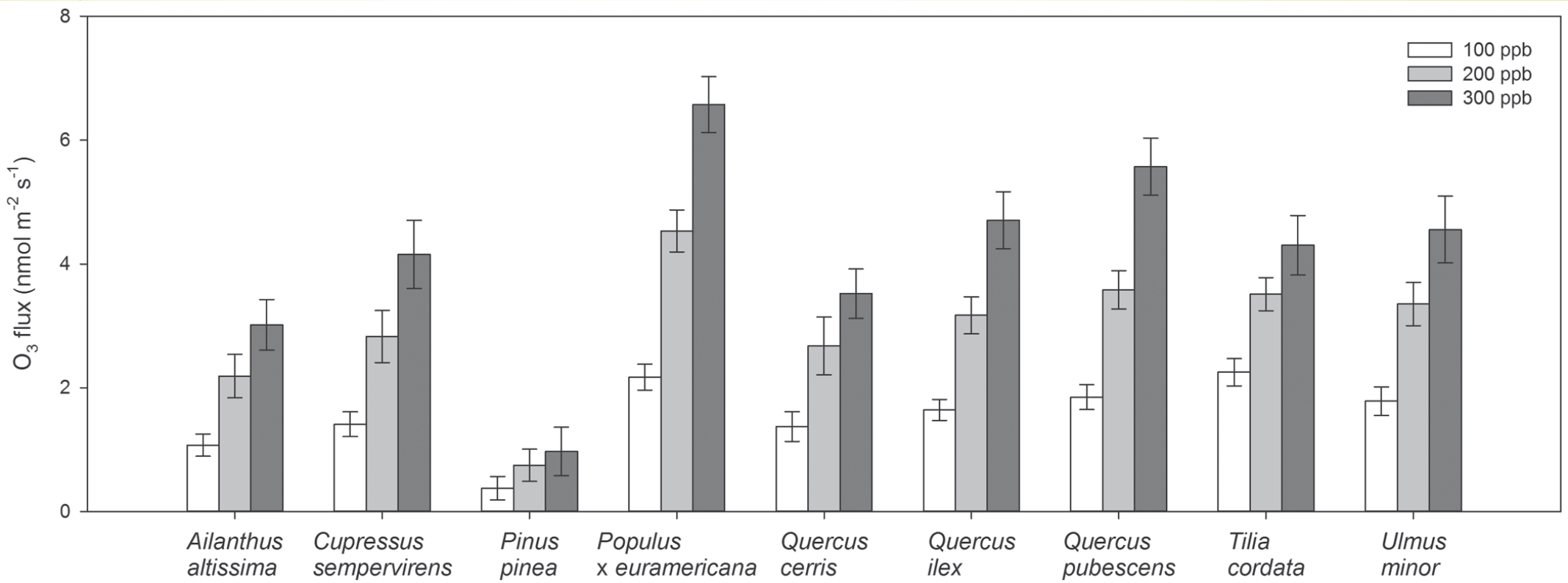
at the end

of March 2015

(Guidolotti et al. 2017)



Laboratory *cuvette results*



Calfapietra et al. 2016

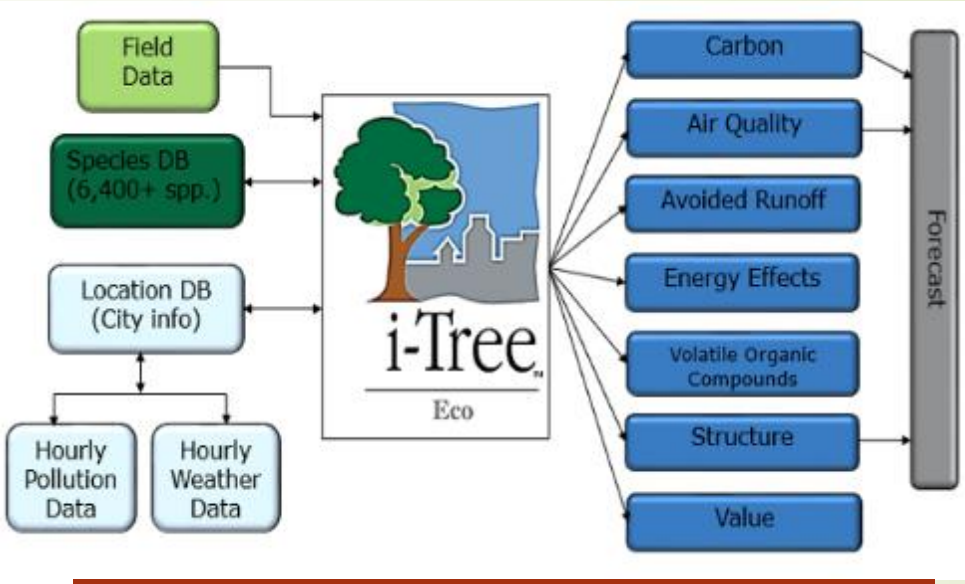
1. To quantify benefits provided by urban trees
2. To maximize their contribution to the improvement of quality life (species selection, trees management)
3. To help city managers and policy makers (planning)

Why do we need to model ecosystem services?

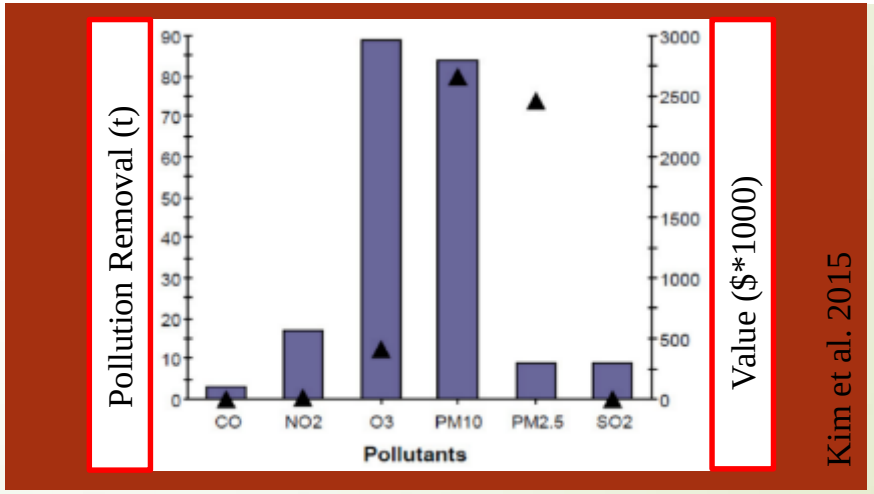
i-Tree Eco model

i-Tree is a model developed by the USDA:

- To quantify urban forest structure
- To estimate urban forest's benefits
- To calculate energy and emission savings



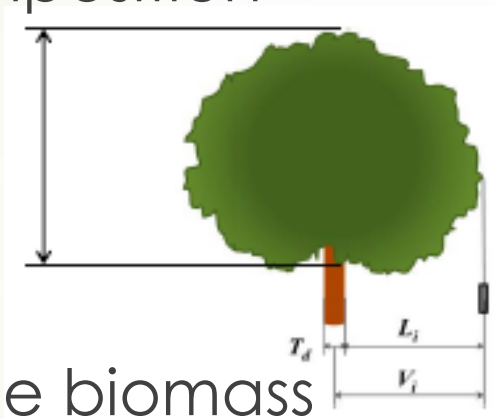
International projects



i-Tree Eco - modules

A: Anatomy of the Urban Forest

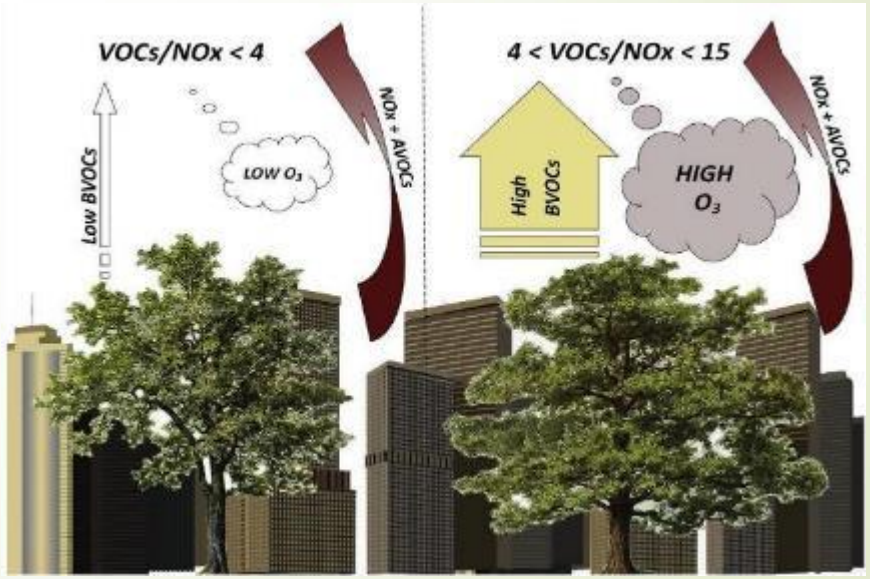
- Species composition
- Tree density
- Tree health
- Leaf Area
- Leaf and tree biomass



- **C: Carbon Storage and Sequestration**
- Total stored carbon
- Carbon sequestered annually

B: Biogenic Volatile Organic Compound (BVOC) Emission

- BVOC emissions (isoprene, monoterpenes)

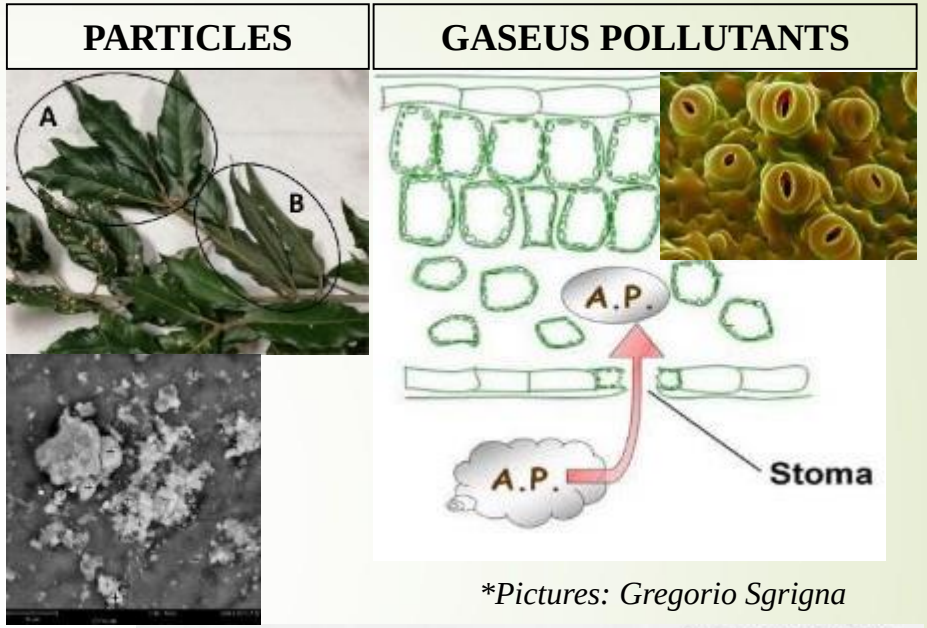


Calfapietra et al. 2013

i-Tree Eco - modules

D: Dry Deposition of Air Pollution

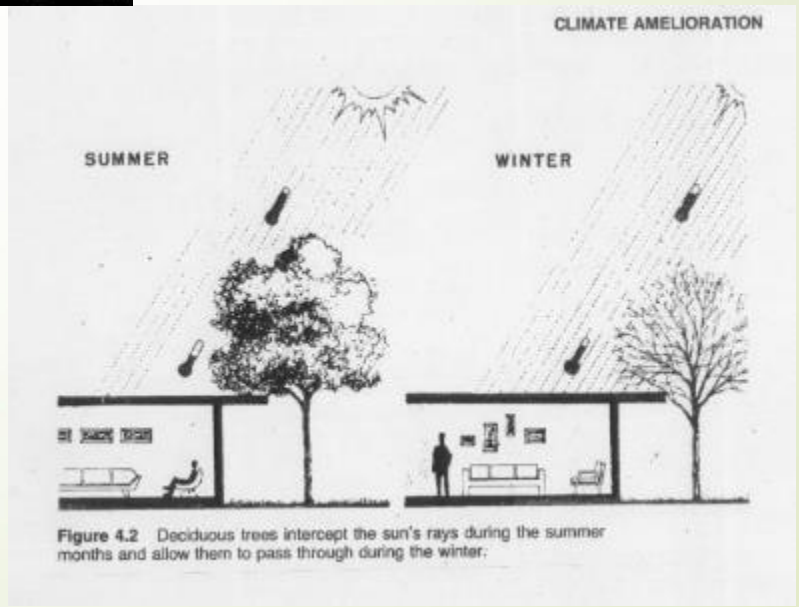
- Pollution removed by trees (O_3, SO_2, NO_2, CO and $PM_{2.5}$)
- Percent improvement in air quality throughout a year



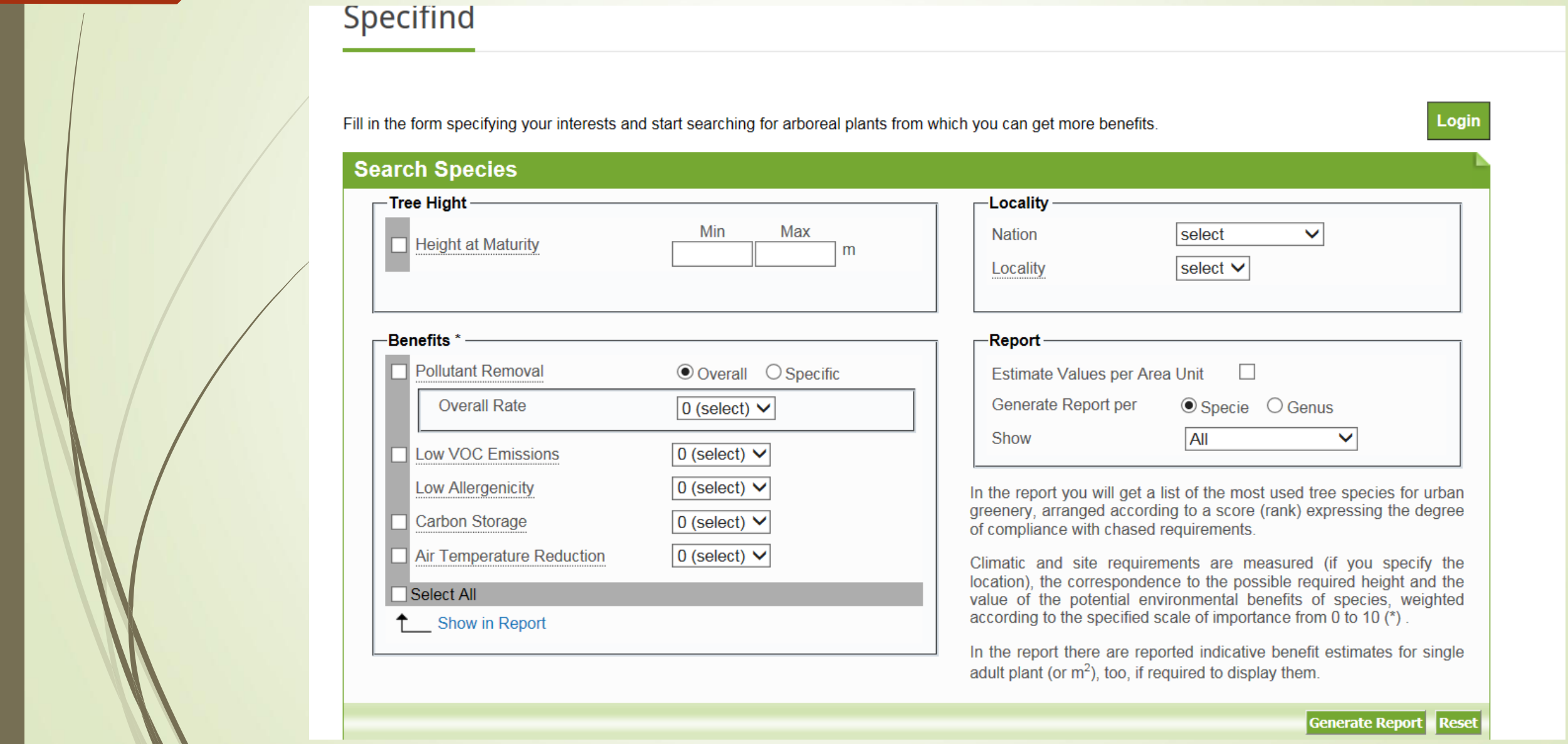
*Pictures: Gregorio Sgrigna

E: Energy Conservation

- Carbon emissions avoided due to the energy savings (trees close to buildings)
- Heat island effect

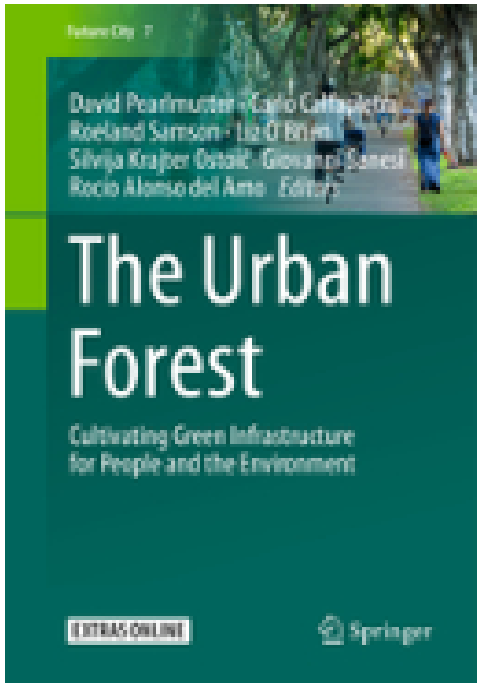


SPECIFIND: find the best tree species in your city



Translating and transferring science → into applications

- COST Action GREENINURBS – **www.greeninurbs.com**

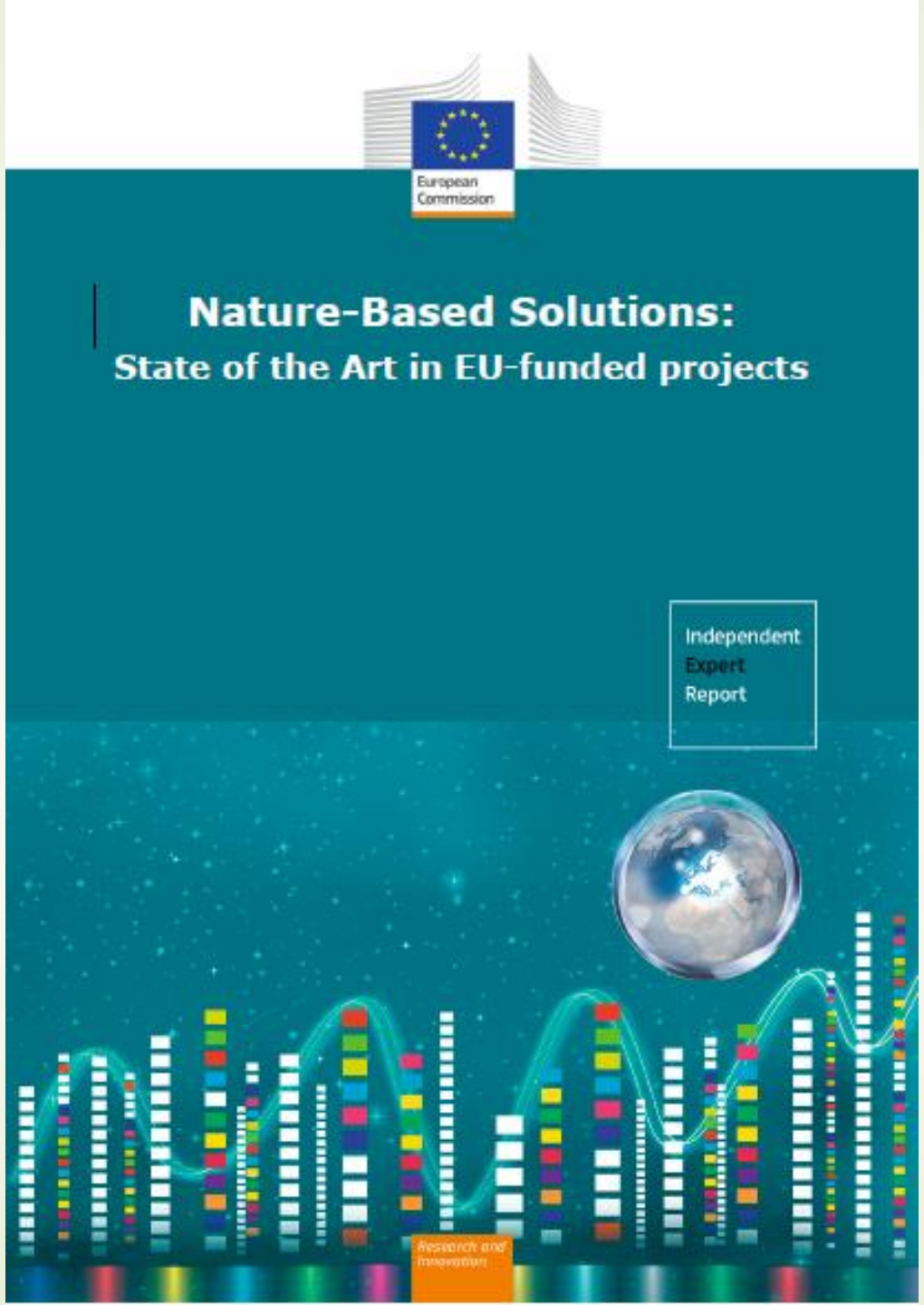


© 2017

The Urban Forest

Cultivating Green Infrastructure for People and the Environment

Editors: **Pearlmutter**, D., **Calfapietra**, C., **Samson**, R., **O'Brien**, L., **Krajter Ostoić**, S., **Sanesi**, G., **Alonso del Amo**, R. (Eds.)


European Commission
Nature-Based Solutions:
State of the Art in EU-funded projects
Independent
Expert
Report
Research and Innovation

European Commission
Nature-based Solutions for microclimate regulation and air quality
Analysis of EU-funded projects
Independent Expert Report
Research and Innovation

Conclusions

- **Decision-support tools** for planning green space and improving citizens' quality of life
- **Maximizing ecosystem services** of urban green spaces:
  - Species selection
  - Planting priority index
  - Management and monitoring of trees and urban forests
  - Evaluation of costs and externalities
- **Validation** and **integration** of models with **experimental results** (research)

Calfapietra Lab

carlo.calfapietra@cnr.it
www.carlocalfapietra.com

Rocco Pace, Post-doc
Chiara Baldacchini, Researcher
Giovanni de Simoni, Technician
Arianna Calabresi, master student
Martina Ristorini, phD
Olga Gavrichkova, Researcher
Gabriele Guidolotti, Researcher
Loredana Caccavale, Technician
Michele Mattioni, engineer
Thais Huarancca Reyes, postdoc
Enrica Nestola, postdoc
Emanuele Pallozzi, Technologist
Maaz Hasmi, phD
Federica Revoltella, phD
Andrea Scartazza, Researcher
Gregorio Sgrigna, postdoc
Lucia Cherubini, project manager

European Commission

IRET CNR

Consiglio Nazionale delle Ricerche