

Carlo Calfapietra

Acting Director

R-IRET, Research Institute on Terrestrial Ecosystems, Porano, Montelibretti, Napoli, Firenze, Pisa, Sassari

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



INCREASED ATTENTION TOWARDS <u>CO2 REDUCTION</u> THROUGH URBAN FORESTRY

<u>2008</u> - The <u>European Commission</u> launched the <u>Covenant of Mayors</u> to oblige European cities to establish an Action Plan to reduce their CO2 emissions by over 20% through activities and practices including the addition of more plants in urban areas and the sustainable *management* of the *green* Espaces onger Focus on Carbon mitigation

<u>2015</u> - Even stronger Focus on Carbon mitigation potential at urban level after







Urban plant physiology: adaptation-mitigation strategies under permanent stress

Carlo Calfapietra^{1,2}, Josep Peñuelas^{3,4}, and Ülo Niinemets^{5,6}

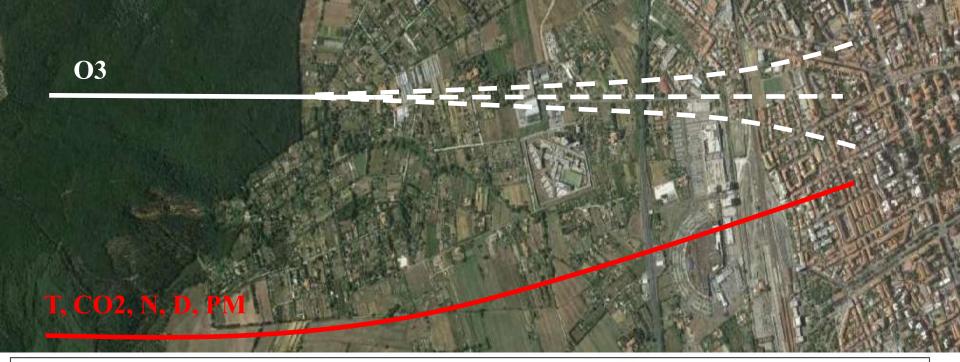
¹Institute of Agro-Environmental and Forest Biology (IBAF), National Research Council (CNR), Viale Marconi 2, Porano (TR), Italy ²Czechglobe, Global Change Research Centre, Academy of Sciences of the Czech Republic, v.v.i., Bělidla 986/4a, 603 00 Brno, Czech Republic

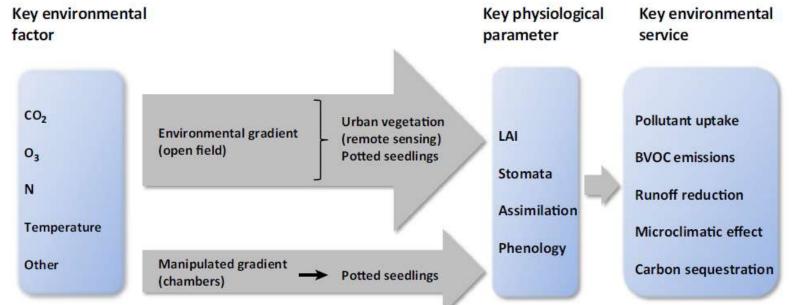
³CSIC, Global ecology Unit CREAF-CSIC-UAB, Bellaterra 08193, Catalonia, Spain

⁴CREAF, Bellaterra 08193, Catalonia, Spain

⁵Estonian University of Life Sciences, Kreutzwaldi 1, 51014 Tartu, Estonia

⁶Estonian Academy of Sciences, Kohtu 6, 10130 Tallinn, Estonia





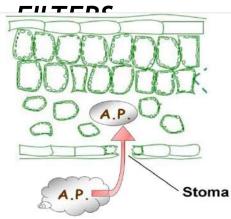
TRENDS in Plant Science

Urban Trees: ACTIVE and PASSIVE natural AIR

Atmospheric Pollutants Mitigation

- Stomatal uptake (NOx; SO₂; O₃; CO)
- Capture dry deposition (PM)

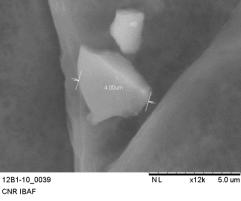






Pollutant: <u>Particulate Matter</u> (PM 10; 2.5)

> - **Diffused** Airborne particles in 10 μm and 2.5 μm



Highly diffused Dangerous

Assessing interactions between air pollutants uptake by urban forests (mainly O3, NOx and PM) and possible role of BVOCs

Big cuvette measurements of leaf gas exchange

campaign using eddy covariance technique



Laboratory

Application and validation of models

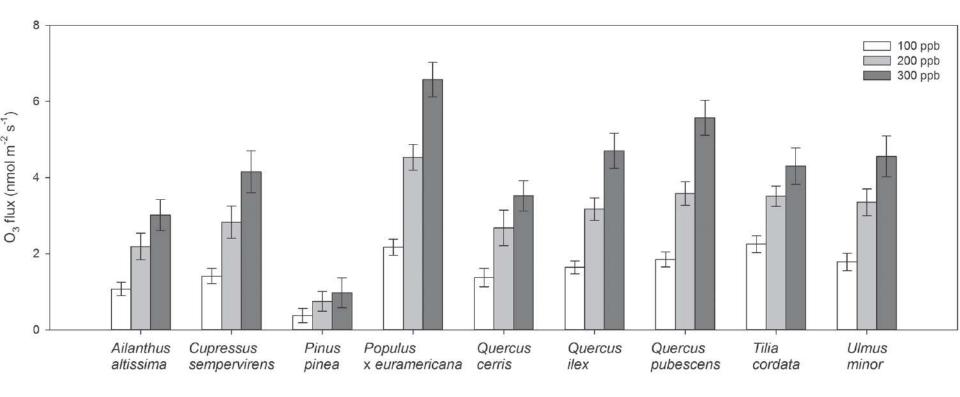


GIS+Modelling



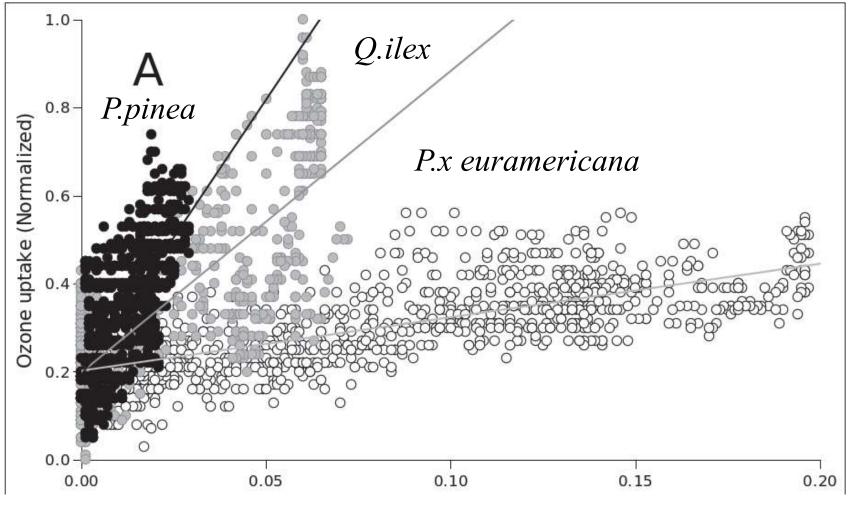
Field

Laboratory cuvette results



Calfapietra et al. 2016

Laboratory cuvette results



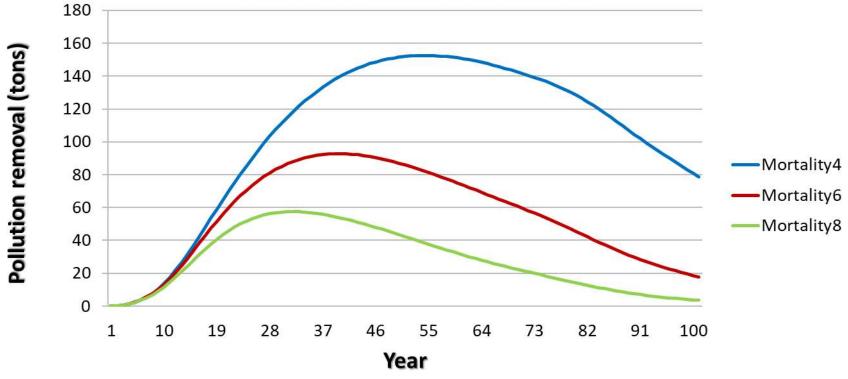
Stomatal conductance (mol m-2s-1)

Calfapietra et al. 2016

Applying UFORE Population Projector in New York



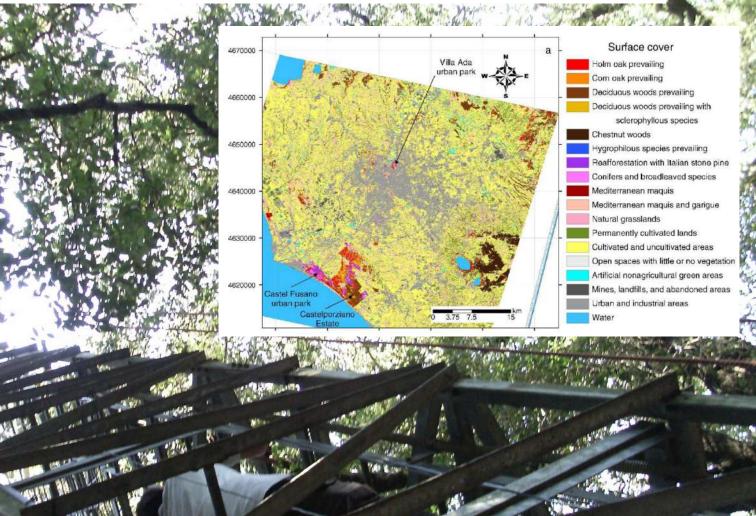
Annual Pollution Removal

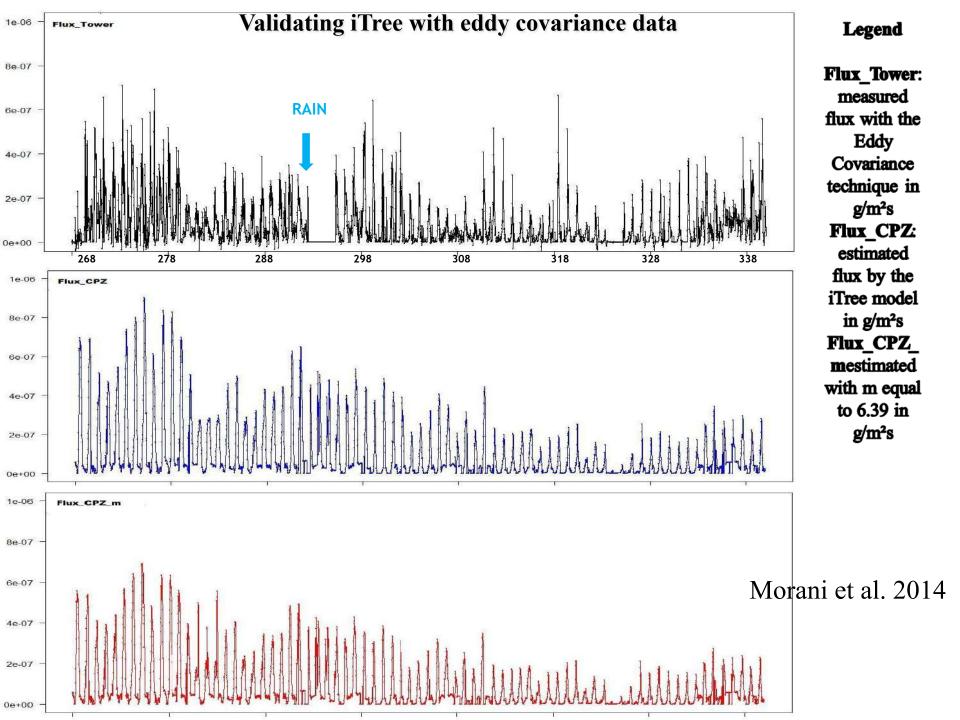


Peak values : 152.6, 92.8, 57.5 (tons/year)

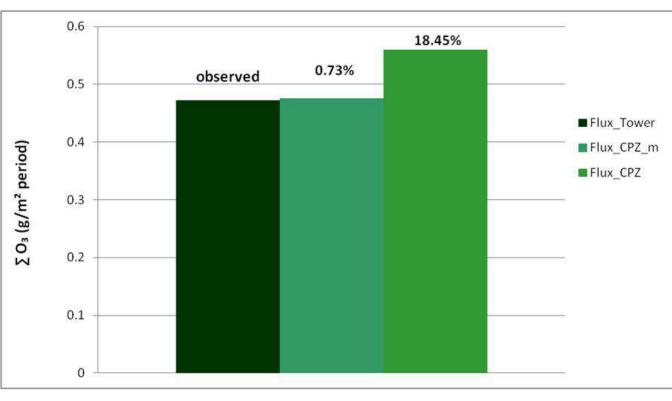
Morani et al. 2011

Validating iTree with eddy covariance data





Validating iTree with eddy covariance data



Cumulative flux over the entire period

The original model (CPZ) overestimates the ozone flux measured by the tower by 18.4% while the modified model (CPZ_m) overestimates the observed ozone flux by only 0.7%.

Morani et al. 2014

PM deposition - Study Area: the city of TERNI

BORGO RIVO

<u>WHERE / WHY</u>: <u>Terni</u>

-Industrial city: Steel/Chemical factories -Factories into the urban environment -Geo morphological characteristics



ThyssenKrupp 🌘



Flat plain valley surrounded by mountains

HIGH ATMOSPHERIC POLLUTANTS CONCENTRATIONS

E U limits for PM10: 50 μ g/m³ for maximum 35 days in one year 2012: 68 overlay recorded



Sampling Campaigns 2012:

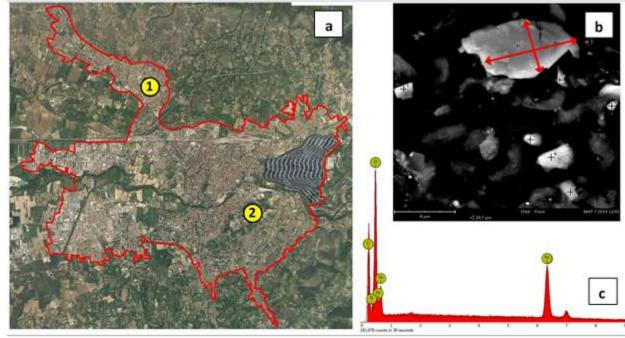
LE GRAZIE

CARRARA

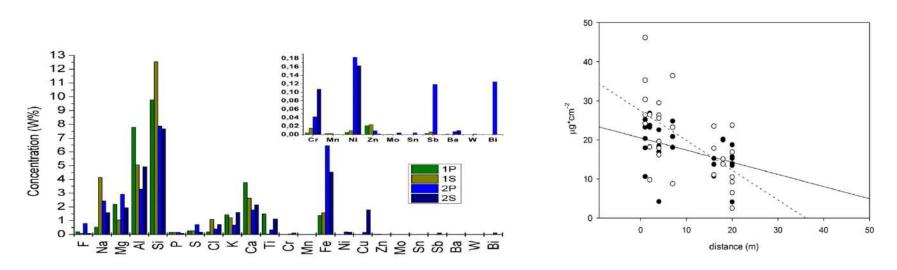
VERGA

4 Environmental **Control Stations** 12 trees Upper and Lower Crown January and August 2012

PM deposition - Study Area: the city of TERNI



SEM microscopy coupled with EDX



Sgrigna et al. 2015; 2016

Strong focus on air quality mitigation capacity of urban trees by media (particularly for PM)

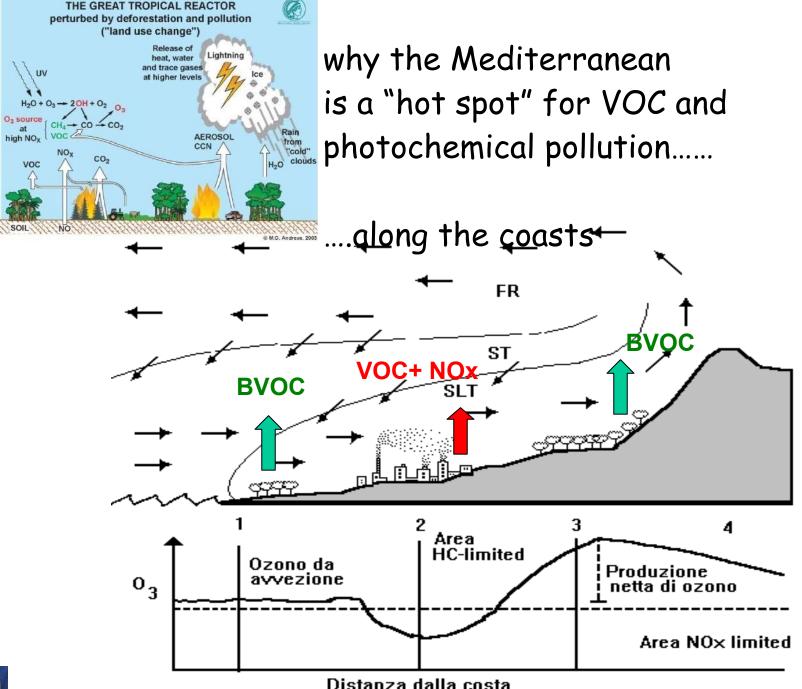


Così gli alberi salveranno le città



3 Nov 2016

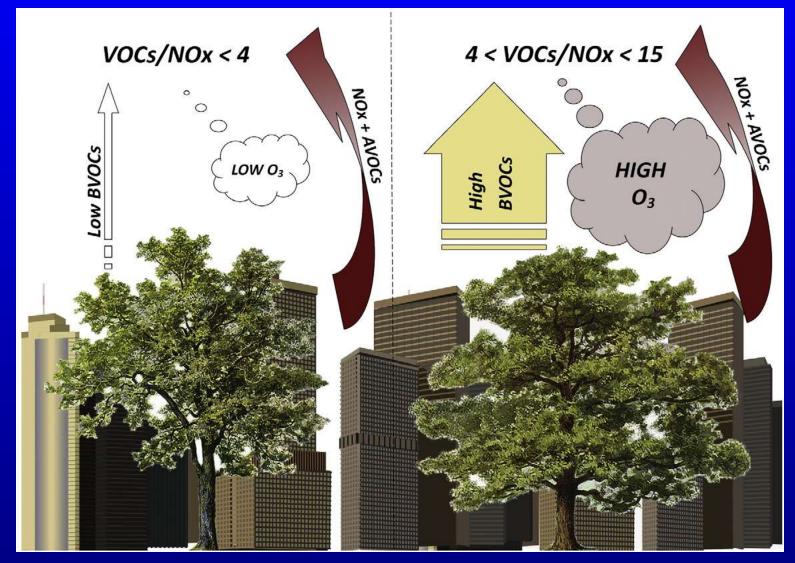




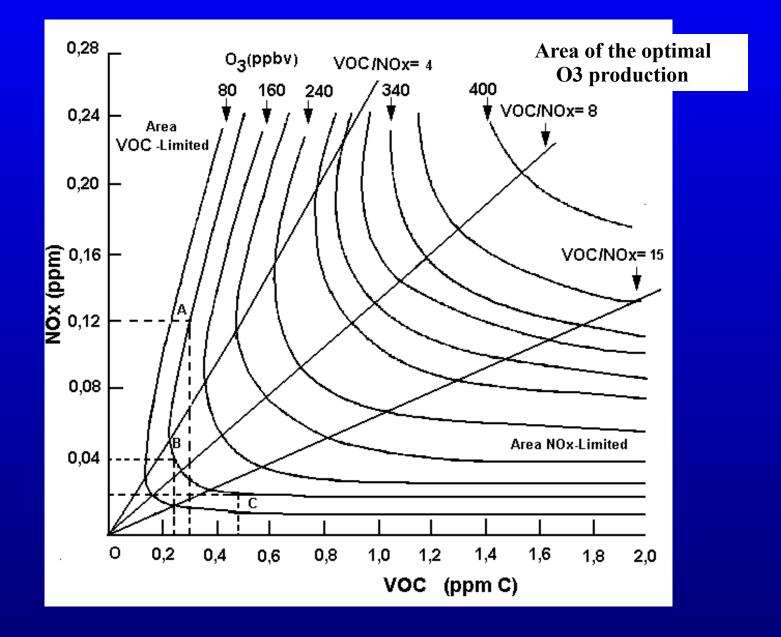


Distanza dalla costa

Low BVOC emitting species in urban environment are recommended



(Calfapietra et al. 2013)



High BVOC-emitters



Quercus spp.



Platanus spp



Populus spp



Salix spp.



Reeds (Phragmites, Arundo....)



Eucalyptus spp.

Is it higher the O_3 removal by trees or the O_3 induced by BVOC emission of those trees?

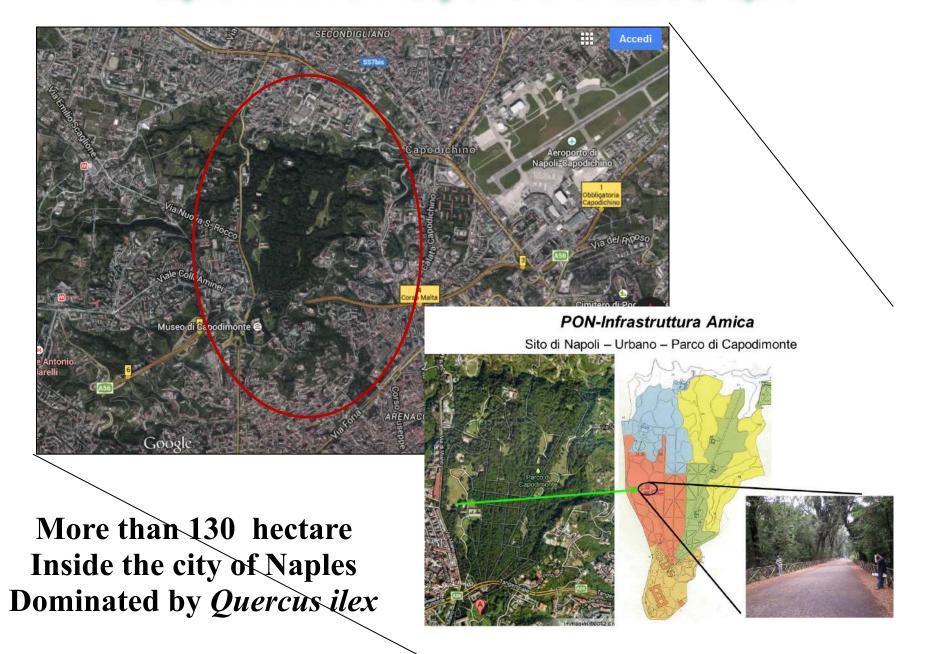
Table 3

Ozone removed and total VOC emitted in a year (g/tree) in two UFORE case studies in Italy: Milan (Porta Venezia gardens; Siena and Buffoni, 2007) and a tramway under construction in Florence (Line 1 and 3; Paoletti, unpublished).

Milan			Florence		
Species	O3 removal	VOC emission	Species	O3 removal	VOC emission
Acer platanoides	45	86	Acacia dealbata	603	1103
Aesculus hippocastanum	71	135	Acer campestre	26	354
llex aquifolium	26	135	Acer negundo	137	442
Magnolia sp.	60	179	Aesculus hippocastanum	257	372
Taxus baccata	70	143	Ailanthus altissima	174	320
Tilia sp.	84	83	Catalpa bignonioides	43	407
Quercus robur	45	345	Cedrus atlantica	924	213
			Cedrus deodara	644	173
			Celtis australis	230	348
			Cercis siliquastrum	0	62
			Chamaecyparis lawsoniana	52	42
			Crataegus sp.	44	279
			Cupressus sempervirens	260	313
			Fraxinus sp.	280	224
			Laurus nobilis	296	249
			Ligustrum lucidum	54	435
			Liquidambar styraciflua	13	688
			Magnolia sp.	85	318
			Olea europaea	35	200
			Paulownia tomentosa	125	853
			Pinus pinea	179	385
			Platanus acerifolia	140	276
			Populus alba	193	467
			Populus nigra	353	327
			Prunus armeniaca	14	698
			Prunus cerasifera	52	311
			Quercus ilex	112	341
			Quercus rubra	65	312
			Robinia pseudacacia	30	320
			Tilia cordata	193	332
			Ulmus sp.	216	307

Paoletti et al. 2009

Capodimonte Park eddy covariance station, Naples





EDDY COVARIANCE TOWER

Li-COR LI-7200

Li-COR LI-7700

- CO₂ / H₂O
- Methane
- Particulate matter
- NO_x
- N₂O
- Ozone

- N₂O analyzer Thermo 46i Dasibi 1108 slow analyzer Sextant fast ozone analyzer
- PTR-TOF-MS 8000

Acetaldehyde, benzene, toluene, monoterpen

isoprene, methanol, many others

- Gill Windmaster Pro Anemometer
- ARG100 Precipitation Sensor

Ecophysics CLD 88 Yp NO_x analyzer

Apogee Instruments SP-110 Pyranometer Sensor

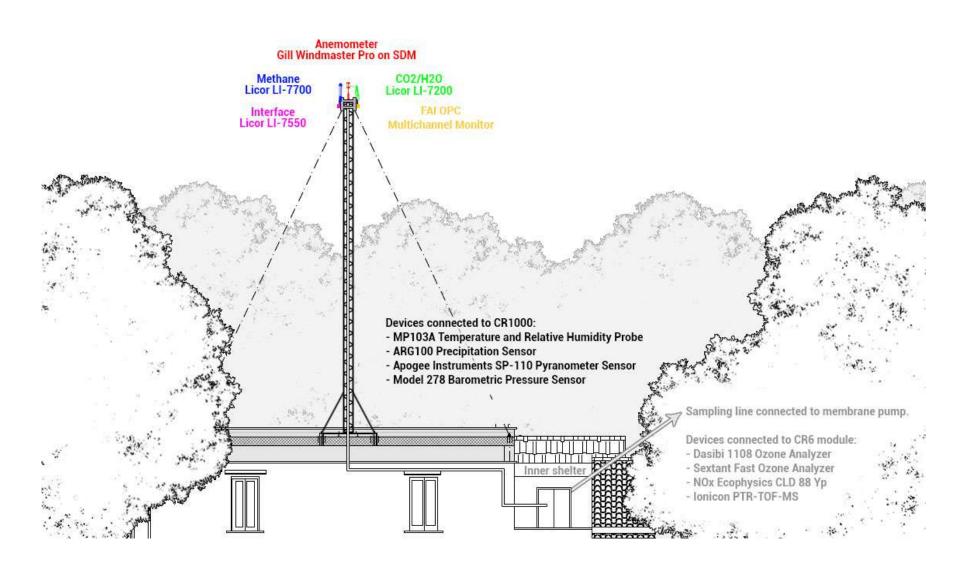
FAI OPC Multichannel Monitor

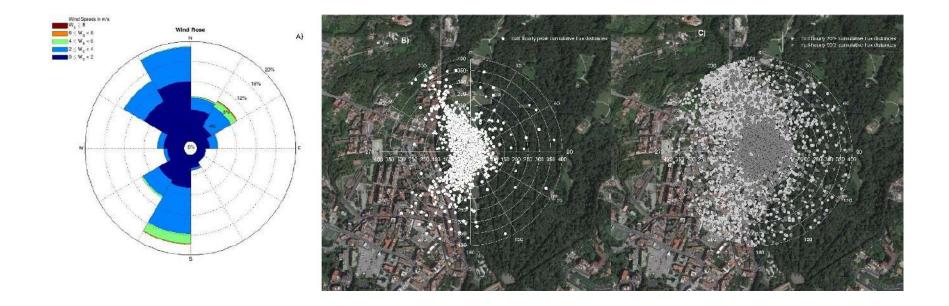
- Model 278 Barometric Pressure Sensor
- MP103A Temperature and Relative humidity Probe



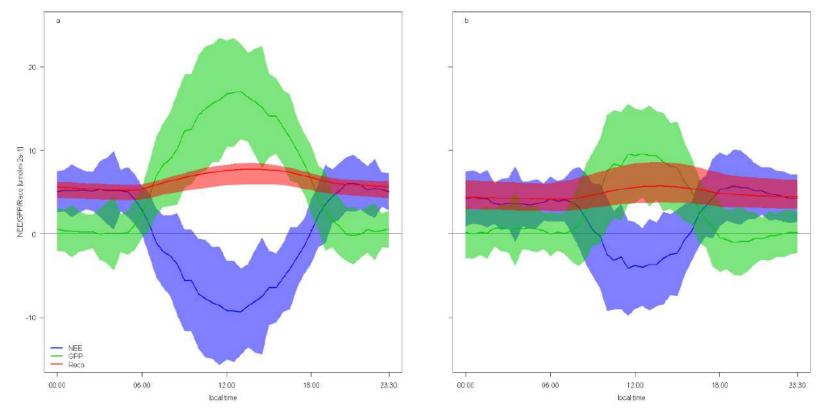
MAIN INFO on INSTRUMENTATION

Analyzer	Datalogger	Signal	Freq
		SDM	
Anemometer Gill Windmaster Pro on SDM	CR6	Digital	10 Hz
"	LI7550		10 Hz
CO ₂ /H ₂ O LI-7200	LI7550		10 Hz
Methane LI-7700	LI7550		10 Hz
FAI OPC MULTICHANNEL MONITOR	Hard Disk	Digital	4 Hz
Dasibi 1108 Ozone Analyzer	CR6	Analog	0.5 Hz
Sextant Fast Ozone Analyzer	CR6	Analog	10 Hz
N ₂ O analyzer Thermo 46i	CR6		1 Hz
NO _x Ecophysics CLD 88 Yp	CR6	Analog	1 Hz
\rightarrow		Serial	8 Hz
PTR-TOF-MS	Hard Disk	Digital	10 Hz
			30 min.
ARG100 Precipitation Sensor	CR1000	Analog	avg.
An arrea lastrona anta CD 440 Dimensiona tan Canada	CD4000	Anglen	30 min.
Apogee Instruments SP-110 Pyranometer Sensor	CR1000	Analog	avg.
Model 278 Barometric Pressure Sensor	CR1000	Analog	30 min.
MP103A Temperature and Relative Humidity	CITIOUU	Analog	avg. 30 min.
			50 mm.





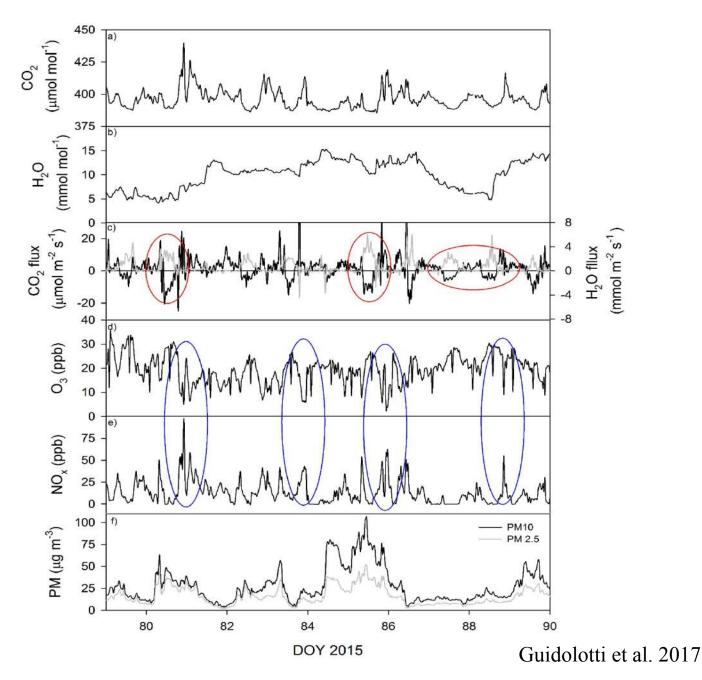
Wind distribution for the period March 2015 – April 2016 (panel a). Half hourly cumulative fluxes distances representing the peak (white circles) (panel b), 70% (dark grey circles) and 90% (light grey circles) (panel c) for the period March 2015 – April 2016. Cumulative fluxes distances were calculated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



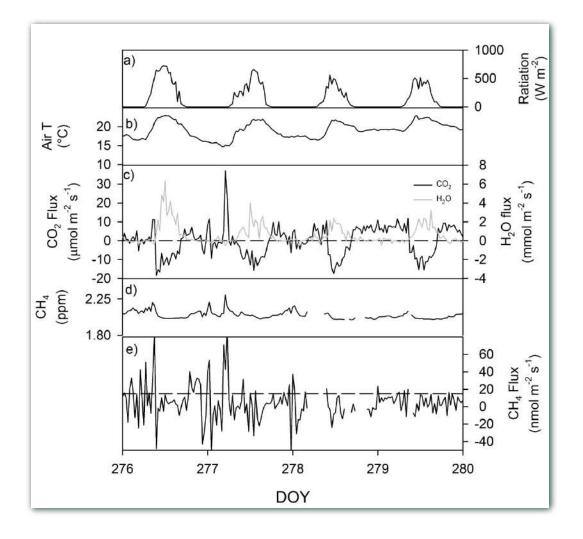
Diurnal patterns of NEE (blue), GPP (green) and RECO (red) for the summer period (panel a, April-September) and the winter period (panel b, October-March). The solid lines and shaded bands represent the average and standard deviation of the half-hour flux, respectively.

Guidolotti et al. 2017

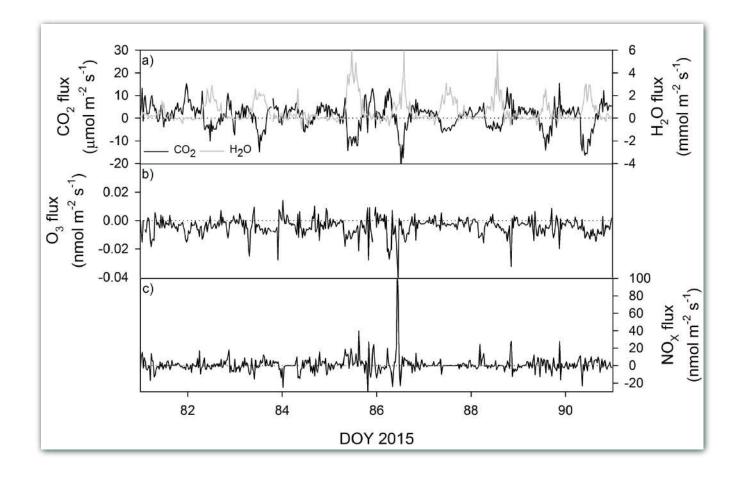
Concentrations and fluxes at the end of March 2015



GHG concentrations and fluxes at the end of the summer 2015

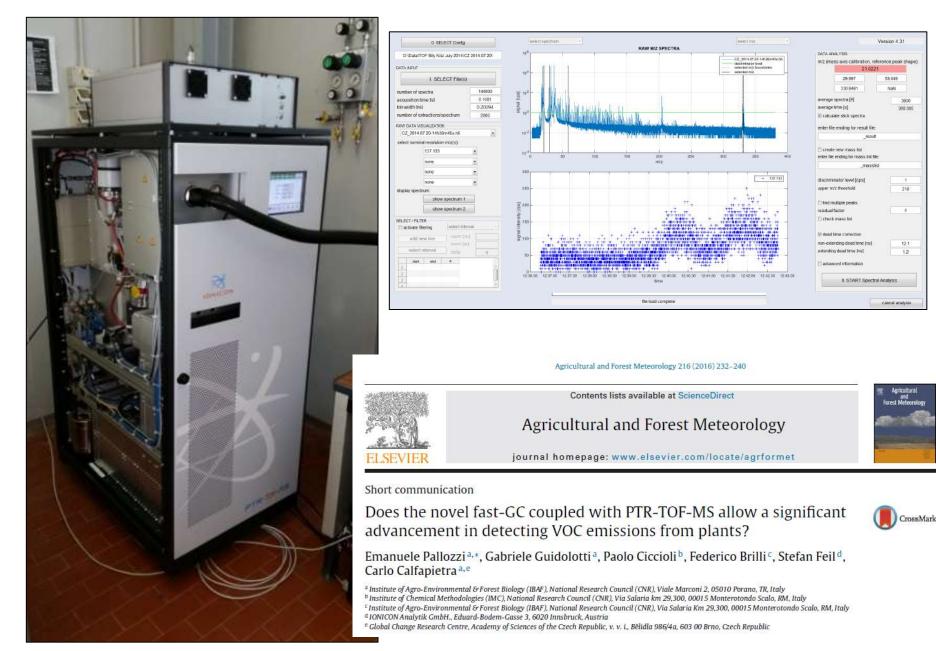


Guidolotti et al. 2017



Guidolotti et al. 2017

PTR-TOF Mass Spectrometer coupled with Fast-GC



Need of establishing a net of such innovative urban park sites because of:

 Interest in accounting C sink capacity of urban forests to be accounted in carbon credits strategy

 Interest in understanding interactions between anthropogenic and biogenic compounds in urban environments

 Interest in understanding pollutant mitigation potential by urban forests

... INTEGRATED CARBON SYSTEM

STATION

Castelporziano2 Borgo Cioffi Renon Pramaggiore ECO Monte Bondone ECO Capodimonte ECO Arca di Noè Bosco Fontana ECO Torgnon Collelongo Bonis Beano Monte Cimone ATM Lampedusa ATM Plateau Rosa Potenza Lamezia terme ATM Lecce Monte Curcio ATM Capo Granitola ATM

Ny Alesund Miramare Paloma

E2M3A Cardin W1M3A Bozzano

Lampedusa

ECO ECO ECO Class 2 Class 2 Associated ECO Associated ECO ECO ECO ECO Class 1 ATM Class 2 ATM Associated ATM Associated Associated

ATM

OCE

OCE

OCE

OCE

OCE

Class 1 Silvano Fares Class 1 Enzo Magliulo Class 2 Leonardo Montag Andrea Pitacco Damiano Giannelle Carlo Calfapietra Associated Donatella Spano Giacomo Gerosa Edoardo Cremone Associated Giorgio Matteucci Associated Giorgio Matteucc Associated Alessandro Peress Associated Paolo Cristofanelli Giorgio di Sarra Class 1 Francesco Apadula Class 1 Lucia Mona Claudia Calidonna Associated Daniele Contini Francesca Sprovieri Angela Marinoni

CLASS

PI

TYPE

Associated

Class

Class

Class

Class



ICOS

Vanessa More sites hopefully implemented with the 14M€ Robertoproject PROICOS_MED

ICOS Italia

da definire Associated

Vito Vitale Michele Giani

Anna Luchetta



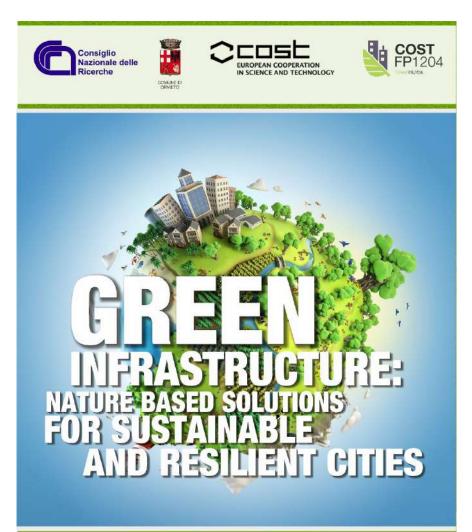
69

countries involved

35 COST countries 4 Neighbour countries 2 non-COST countries FAO About 200 people involved so far



www.greeninurbs.com









European Commission Environment Nature & Biodiversity

EUROPEAN COMMISSION

Environment

Home | Who's who | Policies | Integration | Funding | Law | Resources | News & Developments



EU Biodiversity Policy

 EU Nature Legislation
 I

 Natura 2000 Network
 I

 Species protection
 I

 Green Infrastructure
 I

 Invasive Alien Species
 I

 Climate Change
 I

 Partnerships
 I

 Knowledge Base
 I

 Information
 I

 EU Biodiversity Policy
 I

 EU Nature Legislation
 Natura 2000 Network

 Species protection
 I

 Green Infrastructure
 I

 Invasive Alien Species
 I

Illustrations of the Green Infrastructure concept

What is Green Infrastructure?

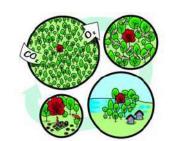
Green bridges and eco-ducts re-connect natural areas that have been artificially divided, by roads or railway lines for example. They reduce accidents involving wild animals and cars – which in France alone, for example, caused damages of about 150 mio. EUR in total. Green bridges also allow animals to move easily and safely from one area to another, and help plant species to spread. This gives animals more space to find food and shelter, and allows populations of the same species to interact, improving the overall resilience of the species.

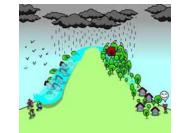
Developments have to be made in a way that does not destroy the future potential of a site. With the right kind of planning, different needs can be taken into account, and the right balance can be kept. Investments can be made in every kind of environment – even in densely populated urban areas – in a way that is beneficial for people and the economy, while still leaving room for nature.















une 2010

EN

Nature

Green infrastructure

Europe's landscape has faced more habitat loss and fragmentation than any other continent. This is a major problem for biodiversity.

Although core nature areas are now largely protected under the Natura 2000 Network, species still need to be able to move between these areas if they are to survive in the long term.

A green infrastructure will help reconnect existing nature areas and improve the overall ecological quality of the broader countryside.

A green infrastructure will also help maintain healthy ecosystems so that they can continue to deliver valuable services to society such as clean air and fresh water.

Investing in a green infrastructure makes economic sense: maintaining nature's capacity, for instance in mitigaining against the negative affects of climate change, is far more cost-effective than having to replace these lost services with much more costly man-made technological solutions.

A green infrastructure is best achieved through an integrated approach to land management and careful strategic spatial planning.

All land users and policy sectors should be engaged early on in the process of developing a green infrastructure and apportioned a share of the responsibility in its delivery.

The European Commission is developing a strategy for an EU-wide Green Infrastructure as part of its post-2010 biodiversity policy.

environment

conference called Green Infrastructure Implementation.

"Green Infrastructure serves the interests of both people and nature. <u>It can</u> <u>be defined as a strategically planned network of high quality green</u> <u>spaces and other environmental features</u>......Green Infrastructure includes natural and semi-natural areas, features and green spaces in rural and urban, terrestrial, freshwater, coastal and marine areas."

On 6 May 2013

The Commission has adopted a Green Infrastructure Strategy, 'to promote the deployment of green infrastructure in the EU in urban and rural areas'.



COST GreenInUrbs structure and responsible people

- Chair: Carlo Calfapietra, IT; Vice-Chair: David Pearlmutter, IL
- WG1 Environmental services of GI and UF and implications of climate change (R. Samson, B)
- WG2 Social/cultural services of GI and UF (Liz O' Brien, UK)
- WG3 Governance of UF in a GI approach (S. Krajter Ostoic, HR)
- WG4 Task Force on Integration and Dissemination to stakeholders (G. Sanesi, IT)
- STSM Coordinator: Rocio Alonso, ES (funded more than 40 STSMs so far)



Workshops



CHAIRS AND SPEAKERS



Deta Sallagaine a recercher at the Italian National Research Council (ONR), Istibute of Agne Selvicommutal 6 honst. Bology (BAP) and Loster in a Usaan Fonetry at University of Tuccia. His main intensis are the biosphre-almosphere internation and the effects of grobal charge and an pollulants on these with a particular focus on the biogenic VCC emission birth in utana and runit environments. Dr. Galqueta has publiched abuit 70 research papers on International je unrelationate or three taples of School so 30%. He has Member at the Editoria Board of tower a journals, Member of the Scientific Committee Life, Environmental and Becode oct of Science Europe, Chair of the (CST Action HP1304 "Breakingthe" and member of the Omitre of Excellence Czechglobe for the study of climate charge



Ecology deals with (1) urban ecophysiciogram/plantathrospheninteactions (2) plantbased portraited on urban is coastion and (3) urban ecology. at bornneining of urban ar position and (b) unan scoopy, at aspectatis from an apportunity and incident approaches. Moreaver, the tas table recommon findem software and many approximation and a strand strangent capport. The aethy of these Strangent apports, the strateging strangent active of these Strangent and Strateging and Strateging and Strateging and Strateging and Strategy and environmental count and strateging and Strategy and environmental count and strateging and Strategy and environmental counts and strateging and Strategy and environmental counts and strateging and strategy and environmental counts and strateging and strategy and



people gain train engagement with tracs wo xelands and error spaces it a variety of different levels of practice from frands on engagement, such as valanteering, to using which level and works. This sequent of the workforcase uring earliering in woodwels. This separat of the workforcing patholarity on health and relations in ite most physical and metrial health, and also an autoper discussion and learning patholary thready the Frends Store of approach to ensuing U.2 houses an engagement and well doing across the unamened not a continuum. Theis internets in innow the bendts's people gain any patholary theorement and in innow the bendts's people gain any patholary theorement constraint.

Final the second second



povernance and a Rester in Public Adrianstration from the University of Washington Evens School of Rubic Policy and Seventhered in storus or under usificiatelity



In description of users in Press. The Socialities again term for Strationing totals of the Stration of Strations and Stratic Stration of Strations and Stratic Strations and Strations and Stratic strate viewers. The same strate is the Stratic National inclusion for inclusion and Steatons, and and strate strate strate strate strate strate and strate strate strate strate strate strate strategies in the Strate Strate strate strate strate distance strate strate strate strate strate strate strategies and strate strate. The strate strate strate strategies and strates. Landscase end op of the international Union of Forest Research Organizations (UEPR). Number of the Scillaria Board of the Union Research Union Grouping (Deal of) and Later Journal of Research Moartain Reviewments Autoon of 170 calcellite.

Central Progetice is Deputy Head in the Unit of Sastistication management of material resources which is responsible for invariantly with nation and satural hortboor for environmental, social and economic sastisticatify and real-invariant part of these interface and an anon-

We have a set of the s Part of the social calling is on 2 minutes of the social calling is on 2 minutes of the social calling is one of the social calling





the UN international Law commission to paper the funct Artista on the used Transsourced Apatient. An important appet of the work has been on scientific and pails-related uses som unitiggio underator governing and governation is pailsoftnes when has also some as when of autous international journals. Glisboration and research interests: when some and another govername and soon



See 2012, the two devices the decisive of unclease junction (as in thread safe of de-parency from overal last use strategies to detailed design-anisticals is currently usering on the sound press of feature from a fars. Strategi, in columnon with the real relation is theorer and the location of the design of the theory of the location of the sound press of feature transmission will increase junction to the location of beaution and sound interaction are architely as the location at invariant rate rate of their parts and the location and interaction the location and the location at invariant rate of the instance and interaction and and the location and the matures are instance rate of their sound and the location rate of the invariant set instance rate of the sound and the location rate of the invariant set instance rate of the sound set of the location of the location of the invariant set instance rate of the sound location rate of the sound location and the location of the sound location rate of the sound location and the location of the sound location and location rate of the sound location and location and sound location and so



have a first set of the set of th



We have a set of the s



experience includes various architectural projects as well as four and insistemental planing for the public and private exclosion in Israel. Mid/id-opiani, unrowing Heng Mid/ Major project in the last lan yaas in Israel insiste Racter Plan Maker projects in the lacker yake in track react that the Maker Pro-for the Merconstitution was not the David Set of Showa), and maky other shit hydrach yaker. Live has been invited to tak shout her protection interval on its workshill used in shit her Shoulding of of Columbic Reader, UC Davis, UK Berkeley, mid U of New





Name Restor PCO, addition, is un Accode Infestor in the Schole Schole Weeks and Schole Schole Schole Schole Weekshole Schole Schole Schole Schole Weekshole Schole Arthlotis, His researce equions state of megration between open and ball spaces, and intenti and utam environments, spannen form inno teritorialization to small abecates. Plauno's princes and writings have been wildly published in bodies and pormas (porms, Antang Geastatis, AH), Taroston, Architecture Australia arrong offend, enhibited and auentical anticology and internationally and presentatic dominenciciand approals.



where the second second



renget i noro 200 to 301 th even torns part of the 50A (being county) and the torns part of the 50A (being county) and the torns part of the 50A (being county) and the description of the second second second second second second second second description of the second second



action of the hyperbalance in the second sec

materiants, the contrabute to the existent memory target with a here to believe targetory and the TBI is it. Contrable nature reserves, and to the approval of a new former CLV Ran, chickness on tests and to green and a significant and must and contening docters of new public Prints its rescard areas native targets and contening docters of targets the innum as a Magoor, 12000, these were plands only in chargets the innum as a Magoor, 12000, these were plands only in an intriperio Reservent Prince Research Letter Studies.



Freedo Saget, activo da el accuze fessore: la profecco 24 el faso fessore: la profección de la profección far a del bana, aureite a una fessore: la profección de la profección faso 160 "Prese Meteodar o la profección de la profección por Meno 255 aureito 40", la decida in Galigue Metodor 11 actosore: la faso fessore de la profección de la profección profección de la pro





REVIEWS REVIEWS REVIEWS

Functional traits of urban trees: air pollution mitigation potential

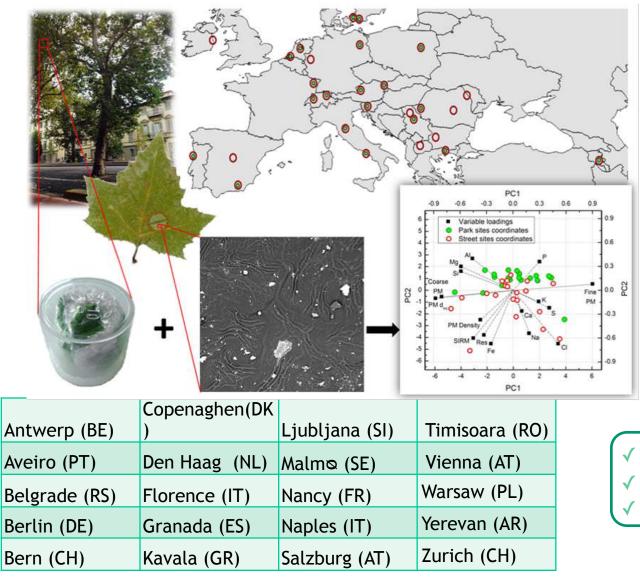
Rüdiger Grote^{1*}, Roeland Samson², Rocio Alonso³, Jorge Humberto Amorim⁴, Paloma Cariñanos⁵, Galina Churkina⁶, Silvano Fares⁷, Didier Le Thiec⁸, Ülo Niinemets⁹, Teis Norgaard Mikkelsen¹⁰, Elena Paoletti¹¹, Abhishek Tiwary¹², and Carlo Calfapietra^{13,14}

In an increasingly urbanized world, air pollution mitigation is considered one of most important issues in city planning. Urban trees help to improve air quality by facilitating widespread deposition of various gases and particles through the provision of large surface areas as well as through their influence on microclimate and air turbulence. However, many of these trees produce wind-dispersed pollen (a known allergen) and emit a range of gaseous substances that take part in photochemical reactions – all of which can negatively affect air quality. The degree to which these air-quality impacts are manifested depends on species-specific tree properties: that is, their "traits". We summarize and discuss the current knowledge on how such traits affect urban air pollution. We also present aggregated traits of some of the most common tree species in Europe, which can be used as a decision-support tool for city planning and for improving urban air-quality models.

Front Ecol Environ 2016; 14(10): 543-550, doi:10.1002/fee.1426



Participation to the sampling campaign on PM deposition on plane trees across Europe



SIRM (Saturation isothermal remanent magnetization)+ SEM-EDX analysis

17 Countries

20 Cities

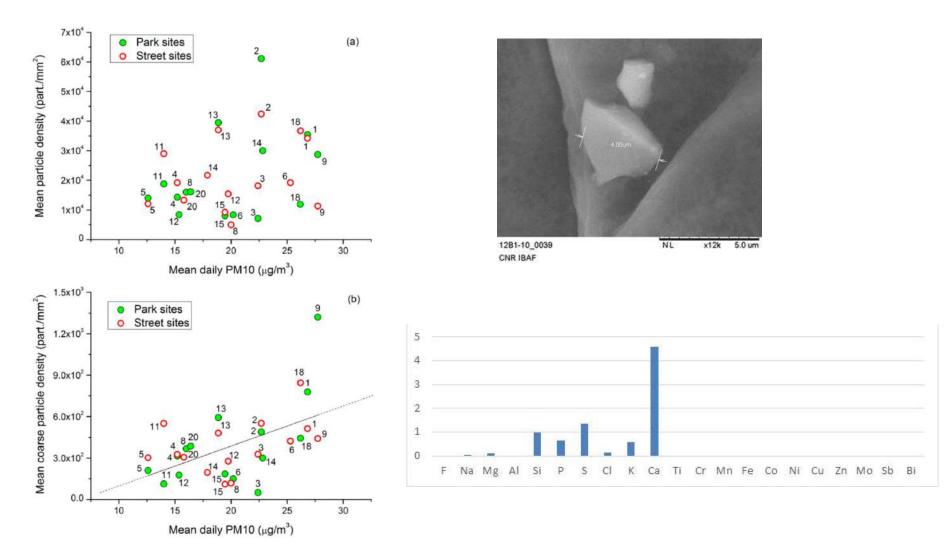
25/08/14 - 15/09/14

Baldacchini et al, 2017, Environmental Science & Technology



Common European Sampling Campaign

SEM-EDX analyses



Baldacchini et al, 2017, Environmental Science & Technology



Image: state s

The Urban Forest and Ecosystem Services – Tree, Street and City Scale

Guest editors: Dr Stephen Livesley (The University of Melbourne, AUS) <u>sjlive@unimelb.edu.au</u> Dr Carlo Calfapietra (National Research Council, ITA) <u>carlo.calfapietra@ibaf.cnr.it</u> Dr Greg McPherson (USDA Forest Service, USA) <u>egmcpherson@ucdavis.edu</u>

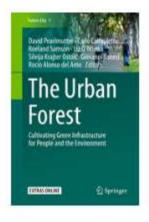
JEVQAA 45(1)1-375(2016)

January-February 2016 - Volume 45 - Number

FP1204 GreenInUrbs	Der Springer						
	Search					Q	
	Home	Subjects	Services	Products	Springer Shop	About us	

» Earth Sciences & Geography

Future City



^{© 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.)

5

20

Provides the first comprehensive catalog of tree species that is cross-correlated with the ecosystem services they provide in different regions of Europe

» see more benefits

COST Guideline GreenInUrbs for practitioners and policy makers

ESTABLISHING AN INTERDISCIPLINARY APPROACH

- 11. Munanion the Urban Forest as part of Green Infrastructure requires the input of many disciplines. There are key roles for arborists, tree officers, foresters and green space planners. These professions understand the technical and sustainable management of the Ilrhan Forest. Where foresters are managing the breader wooded ecceystern, arberists deal with the care of individual trees (cultivation, tree surgery, tree diseases) in practice (as consultant, or as a civil servant) A tree officer is a civil servant who is responsible for tree management at the local authority, he/she is responsible for granting permits for planting and removing trees or parts of trees. A green space planner is looking for opportunities to develop the Green Infrastructure further.
- 12. However, in the context of Green Infrastructure, the professional canvass is much wider then the forest and tree management; urban planners, landscape architects, orgineers, community work sustainable development and climate change specialists as well as staff and volunteers in NGOs and the community have important contributions to make to urban forestry discussions. For example, in the planning process roundtable discussion can draw on the many disciplines to help draw up policies and find creative ways of funding Urban Forest management.
- 10. As the contributions of the Urban Forest are multiple and situated within a variety of domains, a clase collaboration between different disciplines is needed: urban planners should involve green space planners when designing new developments, and arborists and foresters should be involved to check the technical feasibility of the planned establishment and management of the new creen space. Climate change experts, arborists and planners should look for nature based solitions in an interdisciplinary way The role of the Urban Forest advocates is crucial in coordinating the cooperation between different disciplines.

SOVERNANCE

14. Citizens interact with the Urban Forest daily and in many ways, and consequently governance considerations are important. In respect of Green Infrastructure channeling critzen interest into urban forestry is a tractical vehicle for direct engagement and is generally more easily achieved than with other Green Intrastructure elements (such as green roots or green walls). Citizens should he involved in all stages of the Liban Forest planning process including the drafting, approval and delivery of Urban Forest management

plans or Strategic Green Initastructure plans and be offered training support. Citizens can siso be involved directly in growing the Urban Forest through, for example, citizen science projects, common nurseries, tree planting schemes, monitoring tree health or planning new facilities such as forest trails. Co-designing and co-managing the Urban Forest should be a commo thread in Green Infrastructure governance



15. At the political and legal levels municipalities and other governmental bodies, should have in pla-

ce ordinances that can protect the Urban Forest from the individual tree through to whole forests. 16. It is normally local authorities in partnership with their agencies



The union forest cells the scene for important recreational areas such as the be in private ownership. Through isas Qual, Burich, Switzerland, PHOTO CREDIT; Navrai Zuniver legal instruments and devolument planning the municipality

- and its partners can exert significant influence on the privately-owned elements. The private sector has a key role. There are benefits to companies and property owners in the Urban Forest since it can help reduce energy costs, add to property values, general amenity and improve the appearance of business to visitors and the public. Co-establishing the Unian Forest is a profitable investment for both the public and the private sector, not recessarily monetary, but the overall economic and societa return on investment is enormous
- 17. The role of NGOs in urban forestry is significant in some countries. NGOs are skilled at attracting externalresources net available to public bodies. NGOs are efficient in engaging otizens in Urban Forest planning, establishment, management and monitoring.
- 18. An Urban Forest forum in a territory may be appropriate in some situations to bring together stakeholdens into an urban forestry stakeholder collaboration.

RESOURCES

- 19. Resources needed for the Urban Forest and Green Infrastructure include staff, plans and budgets. The costs of these resources may be clear in a numicipal budget, but the (monetary) benefits generated by the Urban Forest are less well documented. There are well known valuation methods in place to establish a monetary value on a territories Urban Forest. The evidence generated by this can be used to justify the resources needed to manage the Urban Forest.
- 20. Continuing professional development is needed for those engaged in urban forestry and exchange of knowledge and techniques across the continent sought. Staff should be encouraged to become part of national and international union forestry networks such as the European Forum or Urban Forestry (EFUF) and to avail themselves of a vast, existing body of knowledge, extensive array of online Urban Forest strategic and management plan examples as well as informative webirars.
- 21. Strong consideration should be given to the creation and subsequent sustemance of the post of Uban Forester. It is almost unthinkable that other areas of urban infrastructure would be without a key oversight person. An Urban Forester (or a team of people in large territories) can work in planning and delivery, engage with citizens, oversee good management of the Urban Forest resource and ensure it is sligned and highly preforming in respect of Urban Green Infrastructure in the territory.

SUSTAINABLE MANAGEMENT OBJECTIVES

- ainability planning and baving long-range territorial objectives is essential. There are two orucial questions that need to be answered by green space managers. Firstly, what do we want to know, and ascondly how will that information be in used in respect of the entire Urban Forest resource. The answers should then inform local standards and protocols and determine BMPs. Central to the information needs is a ground-based Urban Forest inventory followed by the implementation of a valuation methodology to determine the economic value of the ecrevatern service benefits the Urban Forest is providing, and could provide into the future. This can nost readily be incorporated in the planning and decision-making process in order to prioritize different project proposals and justify the relative allocation of funds for urban greening.
- 23. Territorial auklelines are strungly advocated, directed towards the needs of traditioners and contractors and linked to Strategic Green Space (Green infrastructure) Plans. The content can be tallored to the local and biogeographic situation. Suggested content includes planting sol specifications, tree selection protocols including genetic diversity, provenance requirements, site preparation procedures and planting protocols, establishment period criteria, e.g. watering and the development of a contract growing standard to facilitate diversity of species and quality of stock for public infrastructure projects.

INFORMATION ABOUT GREENINURBS

24. COST Action FF1204, entitled Green Infrastructure approach: Inking environmental with social aspects is studying and managing Urban Forests (GreenInUrbs) started in February 2013 funded by the European Commission through the European Cooperation in Science and Technology (COST) which is one of the longest-supping European frameworks which encourages and supports come ration among different communities across Europe. Led by Dr. Carlo Califapietra of the Institute of Agro-Environmental and Forest Biology (BAF) of the National Research Council (CNR), Italy, GreeninUrbs is a collaborative effort between scientists, practitioners and policy makers engaged with the erwironmental, accio-cultural, governance and economic aspects of Urban Forests within a broader Green Infrastructure perspective.

ENDTLICD INCODMATION

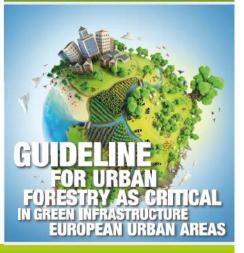
25. Web links to further reading on Green Infrastructure and Lithen Ecceptry can be found at the European Forum on Urban Forestry website www.etuf.org

UTHOR CREDITS

re Davles, Mars Beetrice Andreux), Naomi Zurcher, Pik De Vreese, Andrej Yerlië, Siovenn sei, Andreas Bernseconi, Carlo Calfoplare.









SPECIFIND: Choose the Best TREE SPECIES for Your City

Specifind

rch Species		
Height at Maturity	Min Max	Locality Nation Locality select
Benefits * Pollutant Removal Overall Rate	Overall O Specific O (select)	Report Estimate Values per Area Unit Generate Report per Specie Genus
Low VOC Emissions Low Allergenicity Carbon Storage	0 (select) ✓ 0 (select) ✓ 0 (select) ✓	Show All In the report you will get a list of the most used tree species for urban greenery, arranged according to a score (rank) expressing the degree of compliance with chased requirements.
Air Temperature Reduction Select All Show in Report	0 (select) V	Climatic and site requirements are measured (if you specify the location), the correspondence to the possible required height and the value of the potential environmental benefits of species, weighted according to the specified scale of importance from 0 to 10 (*).



Towards an EU Research and Innovation policy agenda for

Nature-Based Solutions & Re-Naturing Cities

Final Report of the Horizon 2020 Expert Group on 'Nature-Based Solutions and Re-Naturing Cities' (full version)



"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



European Commission leader in NBS and environmental protection







European Commission



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

We are now able to quantify ES e DES provided by UF and NBS and this should emerge in all plans and projects

An impact evaluation framework to support planning and evaluation of nature-based solutions projects

An EKLIPSE Expert Working Group report





ProGIReg

«Productive Green Infrastructure for post-industrial urban regeneration»



2018-2023 11M€

Bando PRIN 2017 2019-2022

Ministere dell'Istruciene dell'Università e della Pierra

Dipartimento per la formazione superiore e per la Ricerca Direzione Generale per il Coordinamento, la promozione e la valorizzazione della Ricerca

PRIN: PROGETTI DI RICERCA DI RILEVANTE INTERESSE NAZIONALE – Bando 2017 Prot. 20173RRN2S

PART A

1. Action line

Main line/Linea Principale

2. Research project title

Establishing Urban FORest based solutions In Changing Cities (EUFORICC)

CNR-IRET: Coordinator Unimolise UniBari UniTuscia UniFirenze UniRoma3

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

Calfapietra Lab

Chiara Baldacchini, Researcher Giovanni de Simoni, Technician Sara Di Giovanni, master student Raffaela Esposito, phD Olga Gavrichkova, Researcher Gabriele Guidolotti, Researcher Ilaria Lusini, postdoc Michele Mattioni, engineer Mauro Medori, phD Enrica Nestola, phD Emanuele Pallozzi, Technologist Gaspare Perconti, master student Federica Revoltella, phD Andrea Scartazza, Researcher Gregorio Sgrigna, postdoc Claudia Tarmati, master student