Urban park effects on Naples air quality

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1. INTRODUCTION
   • Introduction on Urban Forests and Parks
   • Objectives

2. MATERIAL & METHODS
   • The Royal Forest of Capodimonte in Naples
   • Eddy Covariance in Capodimonte

3. RESULTS
   • Source area (footprint analysis)
   • CO₂ fluxes
   • PM concentration, fluxes and composition

4. CONCLUSIONS
INTRODUCTION
Urban Park

CH₄, H₂O, CO₂
(Nowak et al., 2008)

(VOC, O₃, NOₓ, PM)
(Paoletti 2009; Manes 2012)

ENVIRONMENTAL SERVICES
AFFECTING URBAN AIR QUALITY
(Nowak et al., 2016)
INTRODUCTION
Urban Park

CH$_4$, H$_2$O, CO$_2$
(Nowak et al., 2008)

(VOC, O$_3$, NO$_x$, PM)
(Paoletti 2009; Manes 2012)

ENVIRONMENTAL SERVICES

AFFECTING URBAN AIR QUALITY
(Nowak et al., 2016)

MODELS are often used to estimate air pollutants removal capacity
(Escobedo and Nowak, 2009; Alonso et al., 2011; Barò et al., 2014; Kim et al., 2014, Guidolotti et al. 2016).
INTRODUCTION
Objectives

WE ESTABLISHED AN EDDY COVARIANCE URBAN FOREST STATION:

TO DIRECT MEASURE TRACE GASES FLUXES IN URBAN PARK ECOSYSTEMS

TO UNDERSTAND ENVIRONMENTAL EFFECTS OF URBAN PARK ON URBAN AIR QUALITY AND QUALITY OF LIFE OF CITIZEN
MATERIALS & METHODS

The Royal Forest of Capodimonte in Naples

The Real Bosco di Capodimonte, a green area of 125 ha located inside the urban area of Naples

16.3 °C  Mean annual temperature
8.4 °C  Mean Temperature of coldest month
24.7 °C  Mean Temperature of warmest month
855 mm  Mean annual precipitation

Mixed Mediterranean forest dominated by:
• *Quercus ilex* (22 m mean height)
• *Pinus pinea*

Meadows: *Trifolium* and *Medicago*.

Several autochthonous and exotic tree species
EDDY COVARIANCE...

- a micro-meteorological technique, based on the turbulent air movement (EDDIES) transporting masses (gases, PM)
- It is a reliable method to assess exchange of masses between biosphere and atmosphere

• The flux tower (25 m) is above a small building
• Equipped with instruments to measure concentrations/exchanges of: \( \text{CO}_2 \), \( \text{H}_2\text{O} \), \( \text{CH}_4 \), \( \text{O}_3 \), PM, \( \text{NO}_x \) and VOCs

(from Burba et al. 2008)

(from Guidolotti et al. 2017)
RESULTS
Footprint Analysis
(from March 2015 to September 2017)

• White border represents up to 80% of accumulated flux footprint
• The distance of 80% of accumulated footprint was about 100 m around the tower

• Land Cover Contribution
• 41 % from the mixed forest
• 13 % from the meadow
• 46 % from the buildings
RESULTS
Average Diurnal Pattern
(from March 2015 to September 2017)

- Sensible Heat (H) is dominant with a maximum average of about 200 W m$^{-2}$

- Net CH$_4$ emission detected without any diurnal trend

- CO$_2$ fluxes averages ranged from – 5 to +5 µmol CO$_2$ m$^{-2}$ s$^{-1}$
RESULTS
Interannual Variability of CO₂ fluxes (from June to September)

CO₂ and Energy Fluxes were gap-filled by the REddyProcWeb on-line tool (Max Planck Institute for Biogeochemistry)

Pallozzi et al., «Urban park effects on Naples air quality»
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<th>Month</th>
<th>2015</th>
<th>2016</th>
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<td>September</td>
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Pallozzi et al., «Urban park effects on Naples air quality»
RESULTS
Interannual Variability of CO$_2$ fluxes
(from June to September)

CO$_2$ and Energy Fluxes were gap-filled by the REddyProcWeb on-line tool (Max Planck Institute for Biogeochemistry)
RESULTS
Carbon Balance 2016

NET LOSS OF 2400 g m\(^{-2}\) year\(^{-1}\)
RESULTS
Particulate Matter (PM) Concentration (from June 2017 to September 2017)

- Highest concentration between 7 and 8
- Lowest concentration between 14 and 15
RESULTS
Particulate Matter (PM) Fluxes
(from June 2017 to September 2017)

• PM10 fluxes did not pass QC

• Not clear daily trend for PM 2.5 fluxes

• Peak of deposition of PM 1 around noon
RESULTS
Particulate Matter (PM) Fluxes
(from June 2017 to September 2017)

Particulate Matter (PM) Fluxes

Hour
0 6 12 18 24
PM1 flux (winter)
february 2018

Hour
0 6 12 18 24
PM1 flux (summer)
may september 2017

Stomatal Mechanism?
(Burkhardt 2010; Fares et al. 2016)
RESULTS

Particulate Matter (PM) Composition

- Locations 2 and 4: Highest levels of **Iron**, 11% and 15% with and Mg, Mn, Ca and P.
- Locations 1, 5 and 7: Associated with **Na, Cl** (sea elements) and K.
- Locations 6 and 3: Associated with **Al, Si** (earth based elements).

**SEM/EDX**

- SEM imaging: particle size (volume Vi)
- EDX analysis: particle elemental composition (elemental concentration per particle)
RESULTS
Particulate Matter (PM) Composition

01/01/2016
h. 00:00

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RESULTS
Particulate Matter (PM) Composition

01/01/2016
h. 00:00 - 02:00
Peak of PM concentration and resuspension

→ SEM/EDX Analysis
one month later (end January)

Typical FIREWORKS Component

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<thead>
<tr>
<th>Component</th>
<th>Magnesium</th>
<th>Titanium</th>
<th>Barium</th>
<th>Copper</th>
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RESULTS
Particulate Matter (PM) Composition

• The vegetation of the Capodimonte park can only offset city carbon losses (deeper analysis of footprint required)

• Summer CO$_2$ uptake is driven by precipitation

• A clear deposition for PM1 during the central hours of the day (stomata?)

• Composition of PM deposed on leaves it depends on wind direction

• Don’t do fireworks!!!
RESULTS
Particulate Matter (PM) Composition

- The vegetation of the Capodimonte park can only offset city carbon losses (deeper analysis of footprint required)
- Summer CO\textsubscript{2} uptake is driven by precipitation
- A clear deposition for PM\textsubscript{1} during the central hours of the day (stomata?)
- Composition of PM deposed on leaves it depends on wind direction
- Don’t do fireworks!!!