Scientific report

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The impact of urban environment on tree growth

Visit to Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, Zurich, Switzerland

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Summary

State of the art

Urban green areas, and trees in particular, play a crucial role in limiting the negative impact related to environmental and climatic characteristics in the urban context. On the other hand, typically urban factors such as air quality, rising and persistent temperatures (heat island effect), and anthropogenic activities affect urban vegetation. Trees are often affected by exposure to adverse growing conditions, such as pest or disease, water stress and air pollution. In addition, many urban areas are characterized by site-specific conditions (above and below ground) that can influence the rate of tree growth, such as anthropic activities, poor soil or excessive heat. Tree growth patterns usually reflect environmental conditions.

Although these aspects are important to understand the relationships existing within the urban environment, there is a lack of knowledge concerning urban trees due to the complexity of this research topic. Analysis of urban tree growth must be related to a very large number of factors that can have either a positive or negative effect on the rate of tree growth. Furthermore, there could be an additive effect of different factors (i.e., soil compaction by treading and drought).

During a Short Term Scientific Mission from June to November 2013, funded by the COST Action FP1204, Dr. Giuseppe Colangelo, research assistant at the University of Bari, visited the Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf (Switzerland).

The purpose of the visiting period was to provide preliminary evidence that urban tree growth can effectively represent urban environmental conditions and variations. A large number of scientific papers describe the advantages of using trees as a passive sampler in biomonitoring of the urban environment, which is useful to describe the interactions of urban trees with their immediate environment.

Traffic pollution was considered as a relevant anthropogenic factor that can impact tree sensitivity to urban climatic conditions.

Materials and methods

Study area

The study area consists of an urban park located in the northern part of the metropolitan area of Milan (45◦53'71"N, 9◦20'97"E). Parco Nord (PNM) extends to more than 600 hectares: 16% (approx. 100 ha) is covered by forest trees; the remaining part is covered by green spaces, recreational facilities and agricultural areas. In terms of forest vegetation, the area is classified according to the Querco-Carpinetum boreoitalicum alliance (Pignatti, 1998). This vegetation type is reflected in the variety of species that were used in PNM upon its establishment (1983), such as: *Acer* spp., *Carpinus betulus*, *Fraxinus* spp., *Prunus avium*, *Quercus cerris*, *Q. robur*, *Tilia* spp. and *Ulmus* spp. In addition, coniferous species were introduced, such as *Pinus sylvestris* and *P. wallichiana*. Understory species were not part of the initial plan but were introduced through secondary successions or plantations of species, such as *Sambucus nigra*, *Crataegus monogyna, Cornus sanguinea, Viburnum lantana* and *Corylus avellana*.

Broadleaved and coniferous species were planted at a distance of about 3 m (1110 trees/ha). After 1983, other trees were planted using different plantation schemes, plantation density (up to 3000 trees/ha), and vegetation types (with the introduction of shrubs).

Sampling

Field data collection was performed over three areas within a transect from the outer to inner zones of the park. Each area is located at an increasing distance (respectively 10, 350 and 700 m) from a heavily polluted urban road (Fig. 1). Five oaks (for a total of 15 samples) per each experimental area were sampled in June 2013. Three cores were taken from each specimen with a 5-mm borer (Suunto, Finland) at a height of 1 m.

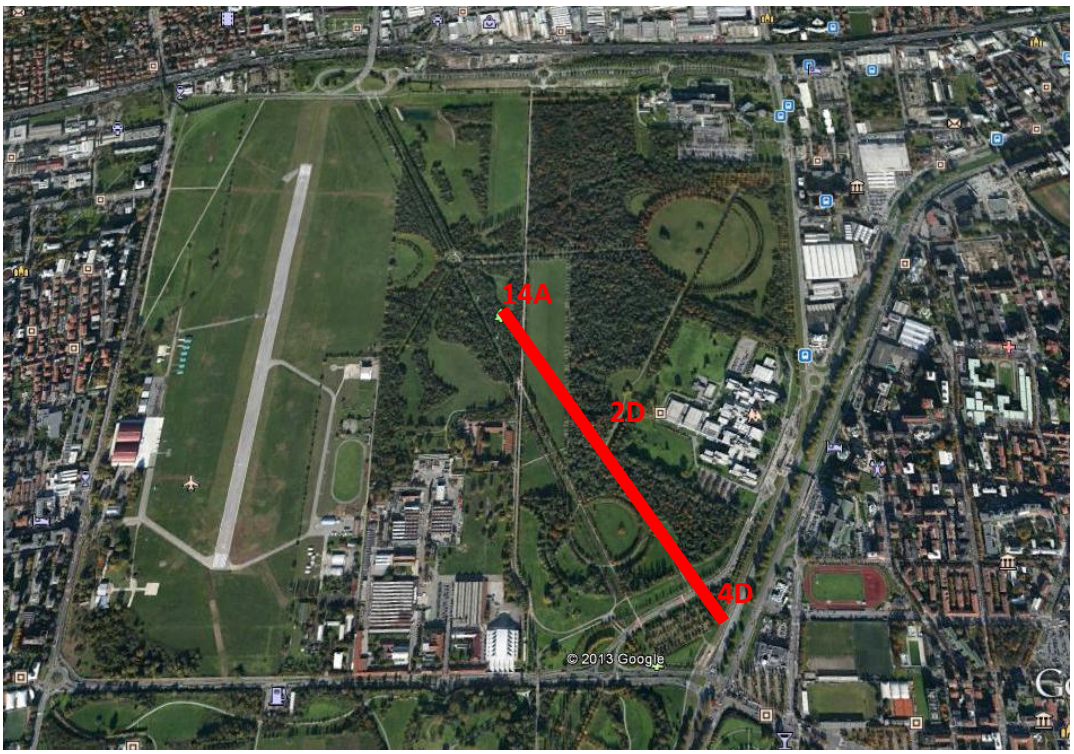

Figure 1: Experimental areas for sampling of wood cores

Sample preparation and analyses

Increment cores were treated with a special microtome (designed from WSL) for surface preparation of samples. Each annual ring was identified with a Leica MS5 stereoscope (Leica Microsystem, Germany). Rings were previously referred to the annual table according to the list method proposed by Yamaguchi (1991). Each wood corer was dated and measured from bark to pith with the Leica MS5 stereoscope. Ring-width measurements were taken with a 0.01-mm resolution using the TSAP (Time Series Analysis and Presentation) software package (Frank Rinn, Heidelberg, Germany).

The ring-width measurements of each sample were compared with the other two cores of the same tree to obtain averaged series per tree.

Single chronologies were grouped in a series related to each experimental area.

Due to tree age (not more than 30 years) it was not possible to verify the statistical agreement among the series using the COFECHA quality-control program (Holmes, 1992) or ARSTAN software (Cook and Holmes, 1984).

After the ring-width measurements were completed cores were dissected, separated per year and collected in Eppendorf tubes. Samples were pooled together in a centrifugal mill (Retsch, Germany) for each year, resulting in a single wood sample per year. This step was necessary to obtain material for subsequent chemical analysis.

For ^{13}C and ^{14}C isotope analysis, samples were further grouped per period (1990-2000; 2001-2006; 2007-2010) according to the differences of heavy metal concentration in relation to the change of fuel composition.

Preliminary results

The major part of analysis activities will be completed in the next months.

Preliminary statistical analysis shows that all sampled trees crossdated well, indicating an homogeneous common influence of environmental factors on tree growth. The chronologies, for example, show the positive effect that silvicoltural treatments can have on tree growth.