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Urban tree responses to climate and pollution: implications for environmental monitoring and management

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INTRODUCTION & AIM

Trees are increasingly used as tools to create healthier and more comfortable urban environments. The extent of their impact on urban settings is tied to their physiological health, growth, and vitality

This study aims to assess the physiological responses of urban trees to key urban stressors: heat, drought, traffic emissions, and pollutants. Tree ring width, stable isotopes ($\delta^{13}C$, $\delta^{18}O$, $\delta^{15}N$), and heavy metal accumulation in tree rings were investigated across two urban settings in Firenze and Pisa, Italy.: Periurban parks (FI-PU and PI-PU) and heavily trafficked roads (FI-TR and PI-TR).

Picture: TREES FOR LIFE Master Plan for Barcelona's Trees 2017 - 2037

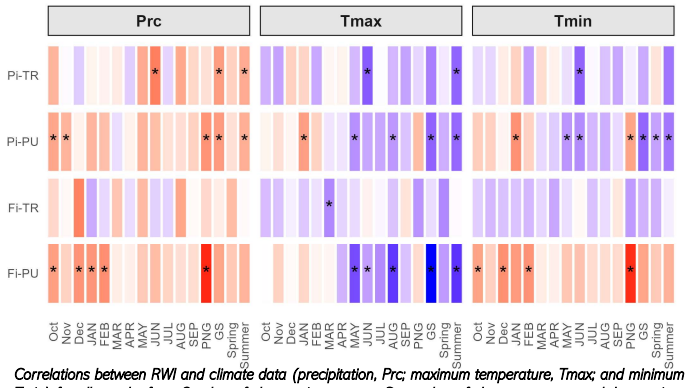
METHOD

Dendrochronological analysis. Ring width was measured and cross-dated using Skippy, CooRecorder, TSAP-Win and COFECHA; ring-width data were detrended using a 30-year smoothing spline in R.

Isotope analysis. $\delta^{13}C$ and $\delta^{18}O$ analyses were performed after thermal conversion to CO at 1420° on a deltaXP isotope-ratio mass-spectrometer (Thermo, Bremen, Germany). $\delta^{15}N$ values were determined after combustion under excess of oxygen at 1020° C and reduction with copper at 600° C to N2 followed by isotope analysis (HS2022, Sercon, Crewe, UK).

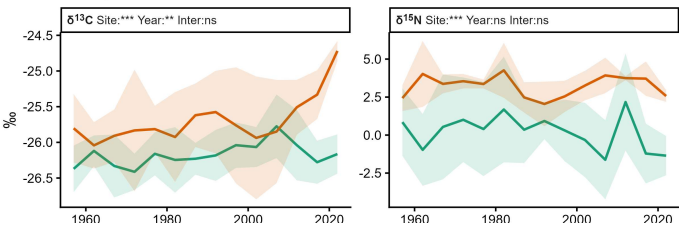
Heavy metals analysis was performed using high-resolution laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS)

PRELIMINARY RESULTS & DISCUSSION



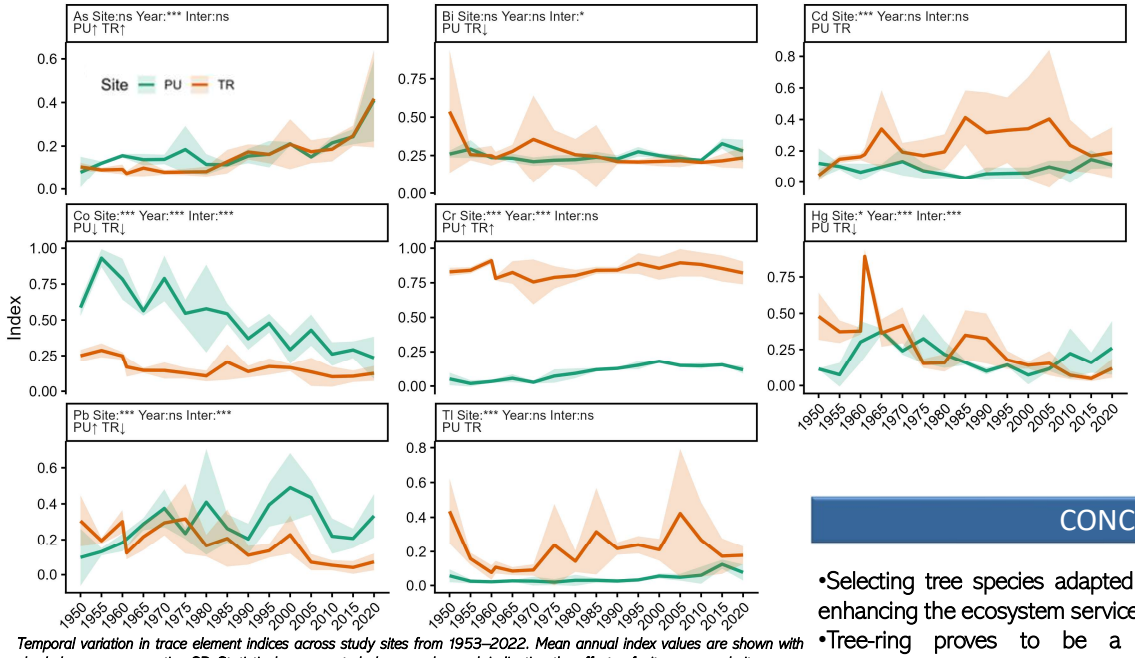
Correlations between RWI and climate data (precipitation, Prc; maximum temperature, Tmax; and minimum temperature, Tmin) for all months from October of the previous year to September of the current year and the previous non-growing season, growing season, spring, and summer in the three different settings for each city. Significant correlations are indicated with "". Cell colour corresponds to the R-value scale.*

- In PU sites, RWI showed significant positive correlations with precipitation in the PNG and negative correlations with maximum summer temperatures (Tmax). In contrast, in TR sites, RWI was influenced by different climate factors at each site, with no consistent response across locations.



Temporal trends in stable isotope composition ($\delta^{13}C$ and $\delta^{15}N$) across study sites from 1958–2022. Mean annual values are shown for the two sites (orange and green lines), with shaded areas representing SD

- $\delta^{13}C$ showed a significant site and year effect, whereas no significant effects of site × year interaction were detected. $\delta^{15}N$ showed a significant site effect



Temporal variation in trace element indices across study sites from 1953–2022. Mean annual index values are shown with shaded areas representing SD. Statistical are reported above each panel, indicating the effects of site, year, and site × year interaction. Arrows indicate overall temporal trends (TR): increasing (↑) or decreasing (↓) concentrations through time in each site.

- Significant differences between sites were observed for most elements, with generally higher values of Cd, Cr, Hg, and Tl at the TR site, and higher Co and Pb values at the PU site. Through time, As and Cr increased, whereas Bi, Co, and Hg showed decreasing trends. Pb displayed contrasting temporal trajectories between sites, resulting in a significant interaction effect, while Cd and Tl remained relatively stable over the study period. Next steps will investigate if the heavy metals accumulation in tree rings influences tree growth in the current and/or in the following years.

CONCLUSION

- Selecting tree species adapted to urban stressors is crucial for enhancing the ecosystem services
- Tree-ring proves to be a powerful tool for monitoring environmental quality and the long-term impacts of urbanization