

NbS for Urban Ecosystem Restoration: Integrating Soil-Plant-Atmosphere Indicators for Multifunctional Landscapes

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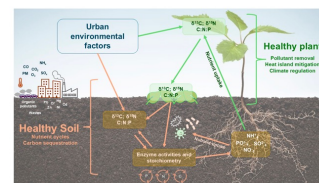
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Introduction

The **soil-plant-atmosphere system** plays a crucial role in ensuring the effectiveness of **Nature-based solutions (NbS)**, especially in **urban areas**. In this study, we assessed the **soil ecoenzymatic stoichiometry** and **isotope signature**, **plant functional traits** and **air quality** as indicators of **soil-plant-atmosphere system** in several NbS in the **municipality of Firenze (Italy)**.



Methodology

Six NbS have been chosen based on:

- the **gradient of green area size and fragmentation** (Dondina et al., 2024)
- the **categorization of air monitoring stations** (D.Lgs 155/2010)

Fortezza da Basso (19th century)

Gradient	B2
Station	Traffic
NbS	Garden/Park

Giardino Niccolò Galli – Campo di Marte (19th century)

Gradient	C2
Station	Urban background
NbS	Garden

Parco di San Bartolo a Cintoia (2017)

Gradient	C3
Station	Urban background
NbS	Urban forestry

Parco del Mensola (2019)

Gradient	D3
Station	Suburban background
NbS	Stormwater rain park

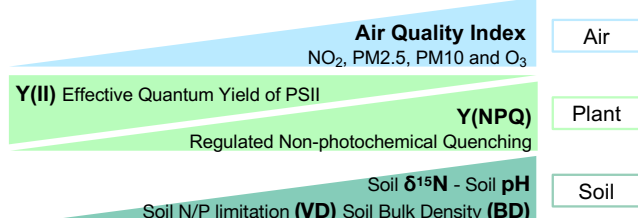
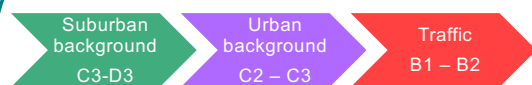
Parco delle Cascine (16th century)

Gradient	C3
Station	Suburban background
NbS	Park

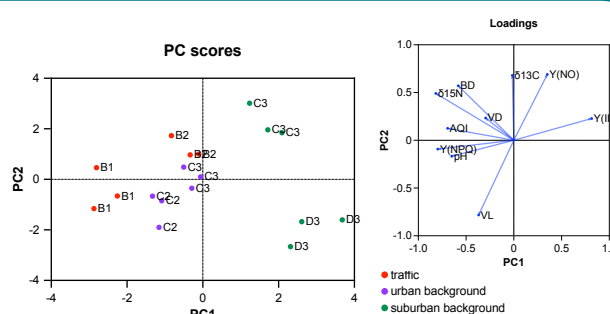
Piazza Beccaria (19th century)

Gradient	B1
Station	Traffic area
NbS	Street trees

Results and Conclusions



Building on the results obtained in Firenze, the study is now being expanded to other metropolitan cities across Italy. This national-scale extension aims to validate and refine the proposed indicators in diverse urban contexts, fostering a comparative understanding of NbS performance and promoting scalable restoration strategies.



Indicators related to the soil-plant-atmosphere system provided **important insights** into how the NbS functions across the **range of green area sizes and their fragmentation**, as well as the **various classifications of air monitoring stations**.

Dondina, O. et al., (2024). Spatial and habitat determinants of small-mammal biodiversity in urban green areas: Lessons for nature-based solutions. *Urban Forestry & Urban Greening*, 128641. EPA-454/B-24-002 - Technical Assistance Document for the Reporting of Daily Air Quality – the Air Quality Index (AQI).
Macci, C., Vannucchi, F., Scartazza, A., Masciandaro, G., Doni, S., Peruzzi, E., 2025. Soil-Plant Indicators for Assessing Nutrient Cycling and Ecosystem Functionality in Urban Forestry. *Urban Science* 9, 82. doi:10.3390/urbansci9030082