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Dataset paper

Mapped tree dataset of public green areas in the Municipality of Arezzo, Tuscany (Italy)

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ABSTRACT The dataset reports data from more than 9,000 trees, which were sampled in 2024-2025 to create a first urban tree inventory of public green areas in the Municipality of Arezzo. For each tree, spatial position, species, diameter were sampled in different public green space types. Data are available as table and spatial vector layer. Data can support urban planners and managers for assessing the state-of-the-art of urban greening, supporting tree management practices and monitoring, feeding urban tree models and calibrating remotely-sensed information. Non-spatial and spatial metrics can be derived to assess the diversity of urban tree spaces to implement sustainable urban greening practices.

KEYWORDS: Tree dataset, urban tree inventory, public green areas, Arezzo.

Introduction

Urban trees are essential for providing key ecosystem services in the cities. These include mitigating climate (Grote et al. 2016), removing air pollution (Fares et al. 2020), reducing urban heat island effect (Wang et al. 2021), providing habitat for urban-dwelling fauna (Jensen et al. 2023) and sequestering carbon dioxide (Sharma et al. 2024). Additionally, urban trees play a key role in enhancing the quality of life, by providing significant socio-economic benefits, improving mental well-being, reducing stress, and fostering a sense of community and connection to nature in cities (Tyrväinen et al. 2005, Mensah et al. 2016).

Several studies indicated that variation in species composition significantly influences the ability of trees to deliver these ecosystem services and benefits (Chinchilla et al. 2021, Krischke et al. 2025, Manes et al. 2012, Schillé et al. 2025). Furthermore, having precise data on urban tree composition allows to objectively evaluate the structural and specific diversity of urban green spaces and potentially analyze its correlation with other environmental variables (birds and insects frequentations, attenuation of acoustic and thermal impact). Indeed, previous studies confirmed the relationship between tree diversity and the provision of urban ecosystem services such as land surface temperature (Chinchilla et al. 2021), and the role or tree diversity in the perceived urban diversity (Muratet et al. 2015) and human well-being (Barona et al. 2022, Krischke et al. 2025).

Urban tree species diversity enhances ecosystem services such as air purification, temperature regulation, and stormwater management (Bartoli et al. 2021, Tang et al. 2024). Finally, measuring compositional diversity aligns with the Green City Accord's goals for sustainable urban planning and biodiversity conservation (Lepczyk et al. 2017).

Therefore, mapping urban tree species is essential for assessing the diversity of green spaces and effective urban tree planning and monitoring.

Existing methods to map urban tree species can be divided into field surveys and those based on remotely-sensed information (Nielsen et al. 2014, Yang et al. 2022, Velasquez-Camacho et al. 2021). While remotely-sensed methods are cost-effective and suitable for large scale applications, they are hindered in urban environments by the complexity to classify the potentially-high number of tree species, along with their fine-grain spatial variability (Wang et al. 2018). Additionally, spatial resolution coarser than 1-5 meters are often not suited to capture isolated, sparse trees (Fassnacht et al. 2016, Myint et al. 2011). Therefore, field methods, although being more costly and time-consuming, can provide real information on species and other attributes such as age class and dimension at the tree level (Li et al. 2019). The disadvantage of such methods is that field measurements are often restricted to public areas.

The dataset reported here was compiled within the framework of the Green City Accord, a European initiative to make cities greener, cleaner, and healthier (European Commission. Directorate General for Environment 2020). Within this context, we collected data from more than 9,000 trees growing in public green spaces (mainly urban parks) in the Municipality of Arezzo, Tuscany (Italy), who joined the GCA in 2021.

Material and Methods

Study area

The dataset was collected in the Municipality of Arezzo, the easternmost capital among the 10 provinces of the Tuscany region. The population of the province lives in the plains, especially in the capital, with a population size of about 100,000 inhabitants. The Municipality of Arezzo extends over 385 km^2, mostly represented by hills and moun-

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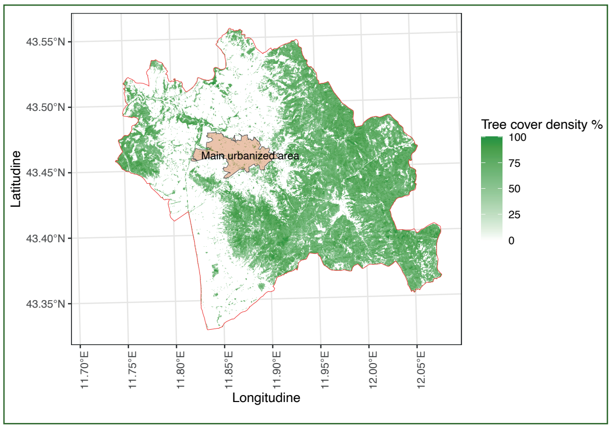
tains covered by forests, which represents about half the total surface (European Environment Agency and European Environment Agency 2024, 2020).

Figure 1 - Study area. Green colour reports the tree cover according to Copernicus's Tree Cover Density Layer 2018 (European Environment Agency and European Environment Agency (2024)). The red border highlights the Arezzo city Municipality limits and the brown area the main urbanized area perimeter.



Tree data have been collected in the main urbanized area of the Municipality[1], which includes the capital medieval center, and its surrounding areas (Fig. 1). We collected data on accessible public green spaces, mainly consisting of parks, tree-shaded squares, and other green infrastructures. These spaces are typically identified by signs (Fig. 2), indicating their public nature, and are often furnished by amenities such as fountains, benches, tables, trash cans, and playgrounds.

Figure 2 - Public green areas of the Municipality of Arezzo have brown signs indicating public space type and its regulations.

Non-disposable areas, such as single tree-lined boulevards or other public green areas not suitable for public use, were not included in the dataset.

Data collection

Tree data were collected using a smartphone, with Android operating system. A field mapping app (Fig. 3) was created using QField (https://qfield.org). Tree positioning was aided by two supporting layers, Google Satellite Imagery (https://www.google.com/maps) and Openstreetmap (https://www.openstreetmap.org). The coordinate reference system of the app is the spherical-Mercator projection (EPSG:3857), which is the one required by both supporting layers. An input mask was created to record tree attributes like species ("Specie") and diameter ("Diametro"; Fig. 3). To speed-up species name insertion and reduce imputation errors, species names were made available from a drop-down list of 280 woody species, which was compiled from a lists of European tree species (http://www.euforgen.org/species) and a dataset of tree woody species measured in parks, gardens and forests in Europe (Chianucci et al. 2018). In case of a tree species was not included in the list, a 'Not available' option can be selected, and the species can be reported in the notes.

Figure 3 - The graphic interface of the QField Project.

Tree data were collected during leaf-on period, to ease species identification. Species was determined by two forestry experts. In case of doubts, species was also checked using PlantNet (https://plantnet.rbgsyd.nsw.gov.au) and by a third plant botanist expert. Plane and lime trees were reported respectively as *Platanus* spp. and *Tilia* spp., as we

1 https://opendata.comune.arezzo.it/datasets/ru_urb_vigente

found high tree hybridization in both genuses, which complicated species-level identification based on morphological features only.

A minimum diameter of 7 cm, and a minimum height of 1.3 m were considered as threshold values for selecting the tree, as this is the minimum diameter considered for selected tree plant materials in the Municipality. Tree diameter was measured at breast height (1.3 m), except for some trees, in which measurement at this height was not possible (e.g. some variety such as common cypress *var. pyramidalis* or pedunculate oak *var. fastigiata*); in such a case, the trees were measured at the base, and this detail was reported in notes.

Dataset access and content

The dataset is available using the following reference and doi: Chianucci et al. 2025. Mapped tree dataset of green areas in the Municipality of Arezzo, Tuscany (Italy)", Mendeley Data, V1, [Dataset] doi: 10.17632/x9bxmpbk8h.1, under the Creative Commons Attribution—Non Commercial 4.0 License. The repository contains three tables, consisting of the dataset, summary statistics on tree species occurrence ("summary_dataset_en_2025-06-18.xlsx") and the metadata description table ("metadata.xlsx"), which reports information about data coverage and access, protocols used for data collection, and technical description of all tables, variables, and fields available from the dataset content.

The dataset is reported as both table ("dataset_en_2025-06-18.xlsx") and point vector layer (ESRI shape file; in the sub-folder "shape file"). Each record consists of a tree, as uniquely defined by its number (field "uid"). Additional fields report the name of the green area sampled ("area"), the tipology of green area ("type"), the relative number of the tree in the area ("id"), the plant species ("species") and diameter ("diameter"). Additional comments are optionally reported in "notes" field.

Additionally, the sub-folder "QField Project" reports the QField app used for field data collection ("QField_Arezzo_v5.0.zip") and an R (CRAN Development Team) script ("QField.R"), which can be used to convert and export the shape file compiled using the QField app into WGS84 (EPSG:4326) coordinate reference system.

Example applications

To illustrate the utility of mapped tree information in urban greening, we showed calculation of diversity metrics, considering the public parks surveyed in the dataset. These include taxonomic diversity indices like species abundance and diversity (richness), which allow to objectively quantify and compare the diversity of public parks. Additionally, two spatial-diversity indices were calculated to provide complementary information on tree diversity distribution in terms of species spatial admixture and size. The species mingling index M_i (Aguirre et al. 2003) was calculated as:

$$M_i = \frac{1}{n}\sum_{j=1}^{n} v_{i,j} \qquad \text{(eq. 1)}$$

where n is the number of nearest neighbors (up to 4) considered for tree *i*, $v_{i,j}$ a binary variable defined as 0 if neighbor j is of the same species, 1 if it is of different species.

Another spatial index considered is the diameter differentiation:

$$t(m_i, m_j) = 1 - \frac{\min(m_i, m_j)}{\max(m_i, m_j)} \qquad \text{(eq. 2)}$$

where m_i,m_j are the pairs of *j* neighbor (up to 4 trees) and the *i*-th reference tree, using diameter as quantitative variable. Mean indices were calculated by summing the values calculated for all tree pairs divided by the number of total trees in each park. These spatial-diversity metrics were calculated using the R package 'treespat' (Chianucci et al. 2023).

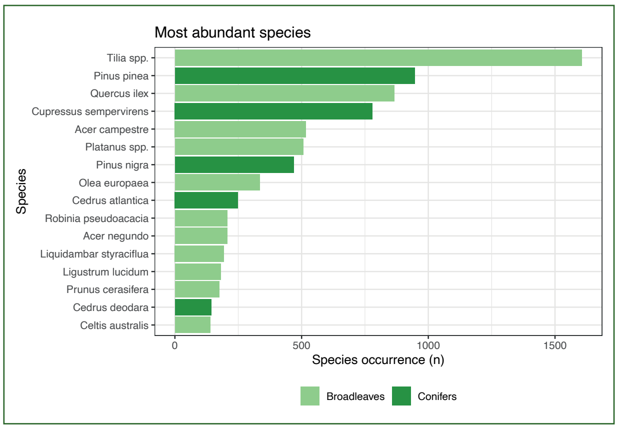
Results

Main tree data attributes

We surveyed 82 public green areas in the main urbanized area of the Municipality of Arezzo, of which about 2/3 consists of public parks. A total number of 9,307 trees were collected, representing 114 different woody species.

The most common tree species were limes (*Tilia* spp.), followed by stone pine (*Pinus pinea* L.), holm oak (*Quercus ilex* L..), common cypress (*Cupressus sempervirens* L.), field maple (*Acer campestre* L.), planes (*Platanus* spp.) and European black pine (*Pinus nigra* J. F. Arnold), which comprises more than 60% of the total number of species recorded. About two-thirds of the trees were broadleaved species.

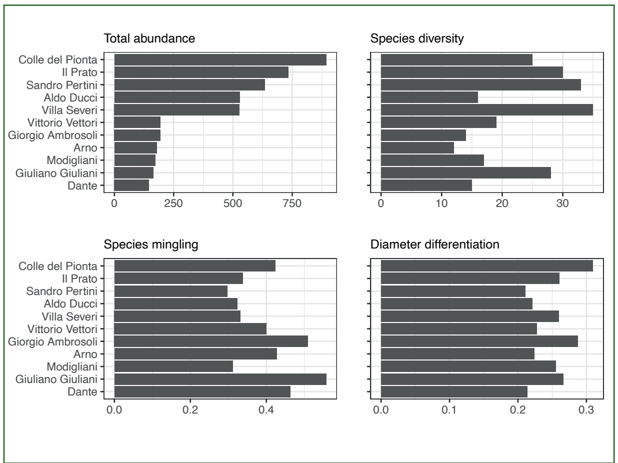
Figure 4 - Most diffuse species in the Municipality. We showed only species with > 100 tree occurrences.



Diversity in public parks of the Municipality

For illustrative purposes, we calculated four diversity metrics in the public park of the Municipality of Arezzo (Fig. 5). The five largest parks (in terms of number of trees) where in descending order "*Colle del Pionta*", "*Il Prato*", "*Sandro Pertini*", "*Aldo Ducci*" and "*Villa Severi*". This gradient also aligned with those of the oldest green areas in the city. With the exception of "*Aldo Ducci*", these parks have also largest species richness. By contrast, "*Giuliano Giuliani*" park, which is the most recently established park in the Municipality, have both high species richness and high species mingling, a result of tree species planted close to other different species. Interestingly, "*Giorgio Ambrosoli*" park, which contains relatively few trees and species — primarily old pines — displays a high level of spatial mingling and size differentiation. This is due to the alternating presence of few large, old cedars and many recently planted small, shrub-form privets, which increase the tree spatial variability. These results demonstrated that mapped tree data can allows to calculate both non-spatial and spatial metrics, which can support designing diverse urban tree spaces.

Figure 5 -Tree diversity in the public parks of the Municipality of Arezzo (we showed only parks with > 100 trees). Top-left: species abundance Top-right: Species richness. Bottom-left: species mingling. Bottom-right: diameter differentiation index.



Discussion

The mapped tree dataset provides baseline information on the tree species composition and size in public green areas at Municipality level. Such information can support effective tree management, e.g. by defining a set of periodic tree monitoring and pruning practices. Additionally, accessibility to tree species and its position can support more effective pest monitoring, management and control, particularly for tree host-specific pests and pathogens (e.g. pine processionary moths, Xylella fastidiosa, and Platypus quercivorus (Augustinus et al. 2024)).

Information on tree species composition and size can be used to inform processed-based models to assess the tree contribution to urban ecosystem services like carbon sequestration, air pollution removal, temperature buffering, climate mitigation (Fares et al. 2020). Tree species composition can be used to evaluate the contribution of tree diversity to overall urban biodiversity (e.g. contribution of trees to pollinator communities, saproxylic insects, nesting birds; (Lundquist et al. 2022; Sandström et al. 2006; Somme et al. 2016)). Additionally, the dataset can be used to identify areas with a higher concentration of species known for their allergenic potential, providing useful insights for urban planning and public health. The tree data from public green areas can be further integrated with additional tree layers such as street trees (e.g. https://doi.org/10.2909/205691b3-7ae9-41dd-abf1-1fbf60d72c8c)

Mapped tree data can be used to calibrate and validate tree species classification (Wallace et al. 2021) and other information available from remotely-sensed data (Parmehr et al. 2016). Tree data, and associated indices calculated from them, can be integrated with other measurements performed in the Municipality such as acoustic, weather, and pollution mapping and monitoring (Hao et al. 2021, Benocci et al. 2022).

Use of a standardized acquisition protocol and data structure allows to integrate existing mapped tree data information available from other cities like Florence, in the same Tuscany Region (https://www.dati.toscana.it/dataset/42cd1073-521f-4040-9491-e993d03663a4), and international urban tree datasets like Opentrees (https://opentrees.org). The dataset can be further integrated with other measurements, e.g. extending the tree inventory to private areas, school gardens, and other green areas which have not been included in the current dataset. In this line, the availability of a mapping app can support reliable and straightforward data collection, which can also be used to enhance citizen-science initiative for partecipatory tree data collection.

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