



Data Article

A spatially explicit dataset of upper canopy tree species composition of public forests of the Autonomous Province of Trento, Italy



Michele Dalponte*, Davide Andreatta

Research and Innovation Centre, Fondazione Edmund Mach, via E. Mach 1, 38098 San Michele all'Adige, Italy

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ABSTRACT

This dataset provides spatially explicit information on the tree species composition of the upper canopy layer for forest management units located in public forest areas of the Autonomous Province of Trento in Italy. This area is characterized by a large variety of tree species with climatic regions ranging from sub-Mediterranean to Alpine. The data are distributed as a GeoPackage containing 121,177 polygon geometries representing forest management units derived from the provincial forest management system.

For each unit, the dataset reports the total upper canopy cover and the relative species-specific canopy cover contributing to that layer. These values originate from visual estimations by forest practitioners during the development of forest management plans. Attributes include the survey year, unit area, total upper canopy cover percentage, and the relative species-specific cover for 45 individual tree species, alongside two aggregated classes for minor broadleaved and conifer species. The dataset provides a spatially consistent representation of forest composition across about 65 % of the provincial forest area.

The dataset supports and has already been used for applications in forest management planning, forest ecology, and remote sensing products calibration and validation. Three specific applications where the dataset has already been implemented are: evaluating the impacts of extreme climatic events on different forest types, modelling species distri-

* Corresponding author.

E-mail address: michele.dalponte@fmach.it (M. Dalponte).

tribution under climate change scenarios, and benchmarking Geospatial Foundation Models.

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Specifications Table

Subject	Earth & Environmental Sciences
Specific subject area	Forest species composition and spatial distribution of tree species in managed forest ecosystems.
Type of data	Geospatial Vector (Polygon) Geopackage; Analyzed, Filtered
Data collection	Data were collected through in-situ visual estimation by professional forest practitioners during field surveys for the development of provincial forest management plans.
Data source location	Public forest areas within the Autonomous Province of Trento, Trentino-Alto Adige, Italy.
Data accessibility	Repository name: Zenodo Data identification number: https://doi.org/10.5281/zenodo.18934118 Direct URL to data: https://doi.org/10.5281/zenodo.18934118
Related research article	M. Dalponte, D. Andreatta, D. A. Coomes, L. Belelli Marchesini, D. Marinelli, L. Vescovo, D. Gianelle, "Canopy spectral responses of temperate forests to late spring frost and hot drought events assessed with Sentinel-2 NDVI time series," <i>Remote Sensing Applications: Society and Environment</i> , 40, 2025, 101,737, 10.1016/j.rsase.2025.101737 .

1. Value of the Data

- High taxonomic resolution: unlike many regional forest datasets that simplify composition into broad forest types (e.g., "coniferous" vs "deciduous"), this dataset provides species-specific canopy cover for 45 individual tree species (plus two broad aggregations), allowing for highly nuanced ecological studies.
- Spatially explicit management units: by providing data at the level of the forest management unit (121,177 polygons), the dataset bridges the gap between broad-scale vegetation maps with low spatial and taxonomic resolution and fine-scale plot data, offering a continuous map of species distribution across the public forest estate of the Autonomous Province of Trento (Italy).
- Benchmarking and remote sensing: the dataset serves as a robust ground-truth source for training and validating machine learning and deep learning classification models using for example PlanetScope, Sentinel-2, Landsat, or aerial hyperspectral data, particularly for identifying species in complex mountain terrains.
- Climate change and biodiversity research: researchers can use this data to model species distribution shifts under climate change scenarios or to explore the impact of extreme climatic events on tree species.
- Policy and management support: the data supports the evaluation of forest management histories and provides a baseline for future sustainable forest planning and carbon sequestration assessments in mountain ecosystems.

2. Background

The compilation of this dataset was motivated by the lack of detailed field data on tree species distribution over large areas. Understanding the precise spatial arrangement of forest species is critical for assessing biodiversity patterns, predicting ecosystem responses to climate

change, and guiding sustainable forest management. While forest inventory plots provide precise species information, they are typically limited to small, discrete areas and lack the continuous landscape-scale representation required for ecological modelling. Such gaps are usually filled through remote sensing estimations, which may lack ground-level accuracy. In contrast, this dataset provides direct field observations of tree species across the entire landscape, offering a spatial record that serves as a reliable baseline for both ecological research and conservation planning.

3. Data Description

The dataset contains spatially explicit information on the tree species composition of the upper canopy layer for forest management units (FMUs) located within public forest areas of the Autonomous Province of Trento (Italy). The data are distributed as a GeoPackage (.gpkg) file containing 121,177 polygon geometries representing FMUs derived from the provincial forest management planning system. The average area of each unit is 1.95 ha, ranging from a minimum of 0.01 ha to a maximum of 283 ha.

Each polygon corresponds to an FMU and includes attributes describing the inventory reference year, the unit area, and the upper canopy cover percentage expressed in fractions from 0 to 1. Additionally, the dataset reports the relative species-specific upper canopy cover; these values represent the relative species-specific upper canopy cover that summed together give 1. As an example, if the upper canopy cover of a FMU is 0.8 (80 %) and the relative *Picea abies* cover is 0.5 (50 %), it means that the absolute canopy cover for *Picea abies* in that FMU is 40 %.

The attribute table includes 45 individual tree species reported by their scientific names, alongside two aggregated classes: "Other broadleaved" and "Other conifers," which group minor species not individually represented. The upper canopy cover and the relative species-specific upper canopy cover are expressed as fractional values (ranging from 0 to 1).

The dataset structure includes the following main attributes:

- **Year:** reference year of the forest management plan used to derive species composition.
- **Area:** total area of the FMU in squared meters.
- **Upper canopy cover:** total percentage of the FMU area covered by the uppermost forest layer (expressed as fractional values ranging from 0.2 to 1).
- **Species columns:** relative species-specific upper canopy cover (expressed as fractional values ranging from 0 to 1). These columns include species typical of Alpine and sub-Alpine forest ecosystems such as *Abies alba*, *Picea abies*, *Larix decidua*, *Pinus cembra*, *Fagus sylvatica*, and several deciduous broadleaved species.

Data were collected from 2010 to 2021; the annual distribution of surveyed polygons is summarized in Figs. 1 and 2. Fig. 3 provides a histogram illustrating the distribution of upper canopy cover percentages across the study area. A comprehensive list of the tree species included in the dataset is presented in Table 1, featuring both scientific and common names. This table also specifies the frequency of each species (number of FMUs where present), the average area of the corresponding units, and the mean relative species-specific canopy cover (in %) calculated across its distribution. Figs. 4 and 5 show the spatial distribution of the FMU with the presence of each species.

4. Experimental Design, Materials and Methods

4.1. Description of the study area

The study area encompasses the Autonomous Province of Trento in Italy (Fig. 6), located in the South-Eastern Italian Alps, spanning 6212 km², of which 55 % is covered by

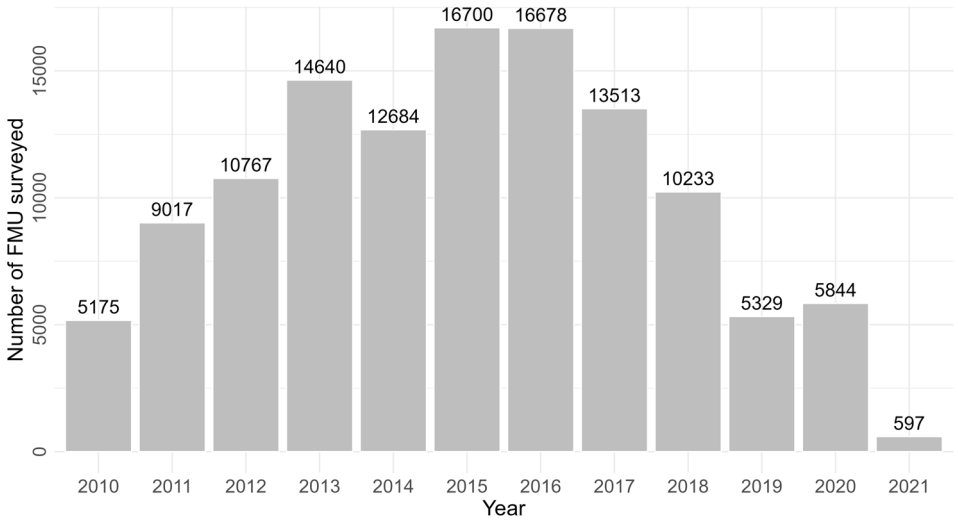


Fig. 1. Summary of the number of FMU surveyed each year.

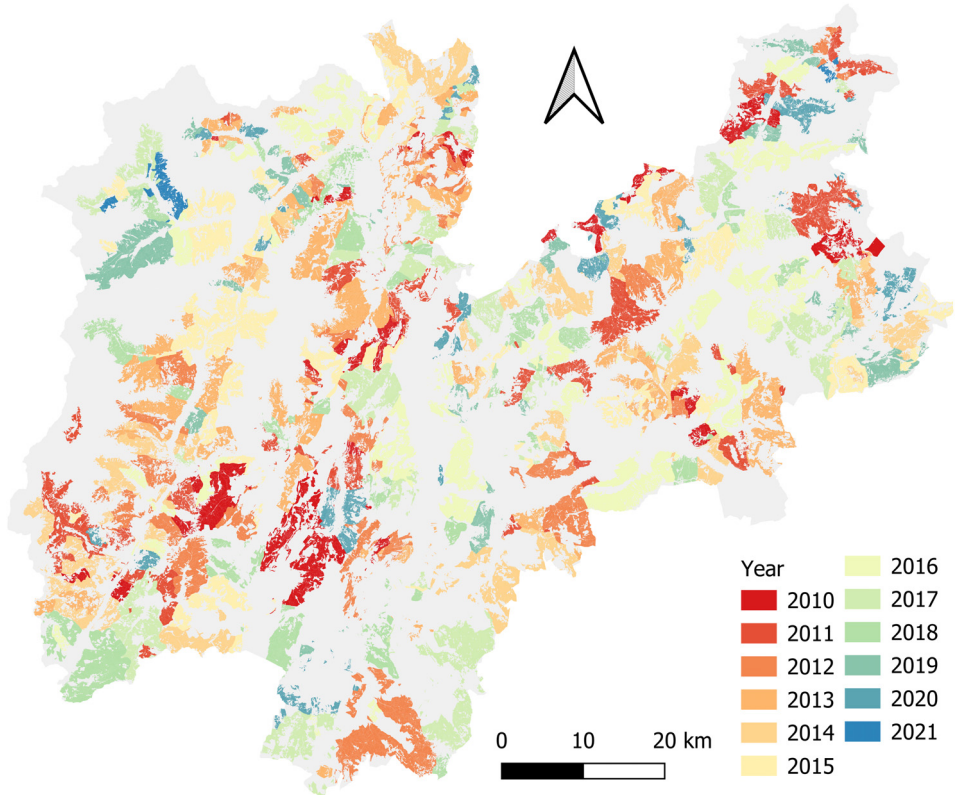


Fig. 2. Spatial distribution of the FMUs over the Autonomous Province of Trento (Italy) with the year of the survey.

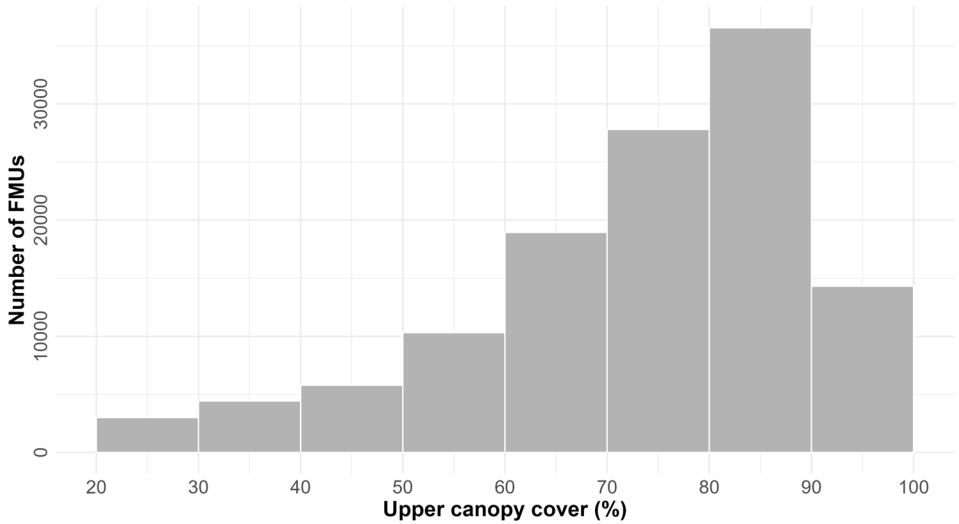


Fig. 3. Histogram of the upper canopy cover values.

forests. The terrain within this region exhibits a complex topography, with altitudes ranging from 65 m a.s.l. to 3764 m a.s.l. Conifers, such as Silver Fir (*Abies alba* Mill.), Norway Spruce (*Picea abies* (L.) Karst.), European Larch (*Larix decidua* Mill.), Austrian Pine (*Pinus nigra* J.F.Arnold), and Scots Pine (*Pinus sylvestris* L.), dominate 67 % of the forested land. The remaining 33 % comprises broadleaf forests featuring European Beech (*Fagus sylvatica* L.), Hop hornbeam (*Ostrya carpinifolia* Scop.), various Oak species (*Quercus* spp.), and Maples (*Acer* spp.).

The region's climate is characterized by a significant transition from sub-Mediterranean conditions in the southern valleys (near Lake Garda) to a typical alpine climate at higher elevations. This gradient results in a distinct vertical zonation of vegetation. Mean annual precipitation varies significantly with topography, ranging from approximately 700 mm in the inner valleys to over 1500 mm on the southern mountain fronts. These bioclimatic conditions support a transition from thermophilus broadleaved forests at lower altitudes to sub-alpine coniferous stands and, eventually, the treeline.

4.2. Data acquisition

Information on relative species-specific upper canopy cover was obtained from the forest management planning system of the Autonomous Province of Trento (Italy), which oversees public forest resources in the Trentino-Alto Adige region of Italy. Forest management plans are periodically updated for public forest properties and include detailed assessments of forest structure and species composition within defined management units.

The primary spatial unit is the forest management unit (FMU), representing a spatially homogeneous area defined for planning purposes. Total upper canopy cover values were determined by forest technicians between 2010 and 2021 through a combination of field surveys, orthoimage analysis, and LiDAR data processing. Relative species-specific canopy cover values were estimated during forest inventory activities via professional visual inspection, following standard provincial protocols [1]. Species for which the presence was extremely low were flagged as sporadic and no cover percentage was provided.



Fig. 4. Spatial distribution of the forest management units (in purple) over the Autonomous Province of Trento for the species from *Abies alba* to *Pinus nigra* (alphabetical order). The background colours represent the Digital Terrain Model of the area with grey colours moving from light grey (areas from 60 to 500 m a.s.l.) to dark grey (areas above 3000 m a.s.l.).

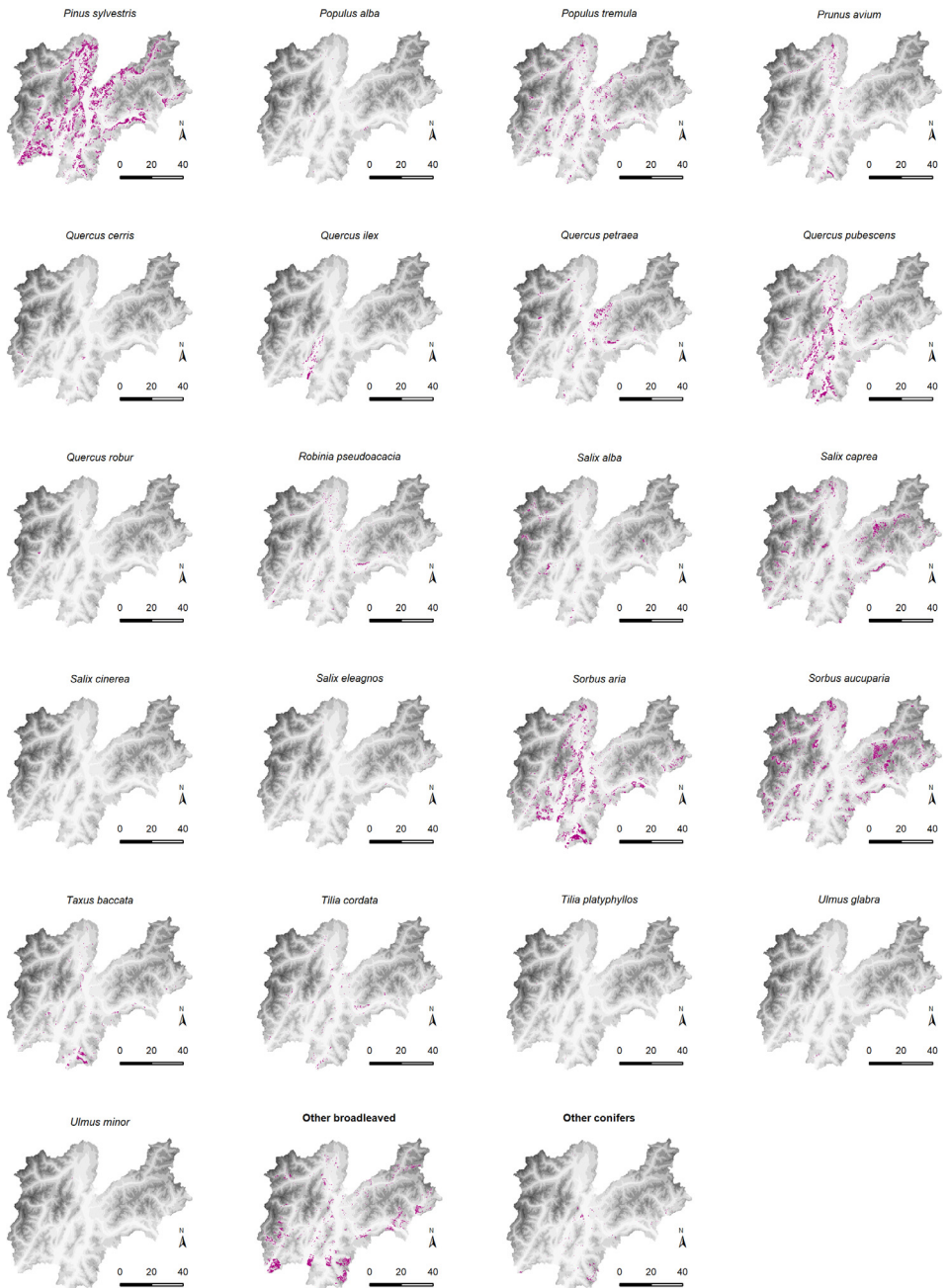


Fig. 5. Spatial distribution of the forest management units (in purple) over the Autonomous Province of Trento for the species from *Pinus sylvestris* to *Ulmus minor* (alphabetical order), plus the two aggregations. The background colours represent the Digital Terrain Model of the area with grey colours moving from light grey (areas from 60 to 500 m a.s.l.) to dark grey (areas above 3000 m a.s.l.).

Table 1

Summary statistics of the species present in the dataset.

Scientific Species Name	Common Species Name	FMU		
		Number	Average size (ha)	Average relative species-specific upper canopy cover (%)
<i>Abies alba</i> Mill.	Silver Fir	36,249	2.05	19.3
<i>Acer campestre</i> L.	Field Maple	662	1.62	3.6
<i>Acer platanoides</i> L.	Norway Maple	187	1.67	2.6
<i>Acer pseudoplatanus</i> L.	Sycamore Maple	13,215	2.2	5.2
<i>Ailanthus altissima</i> (Mill.) Swingle	Tree of Heaven	276	1.66	5.7
<i>Alnus alnobetula</i> (Ehrh.) K.Koch	Green Alder	9439	2.6	24
<i>Alnus glutinosa</i> (L.) Gaertn.	Black Alder	162	1.07	16.1
<i>Alnus incana</i> (L.) Moench	Grey Alder	2284	1.41	20
<i>Betula pendula</i> Roth	Silver Birch	10,026	2.05	4.5
<i>Carpinus betulus</i> L.	European Hornbeam	309	2.1	13
<i>Castanea sativa</i> Mill.	Sweet Chestnut	5640	1.33	9.7
<i>Celtis australis</i> L.	European Nettle Tree	42	0.86	11.3
<i>Corylus avellana</i> L.	Common Hazel	12,630	1.66	9.1
<i>Fagus sylvatica</i> L.	European Beech	56,554	2.04	27.9
<i>Fraxinus excelsior</i> L.	European Ash	3641	1.37	8
<i>Fraxinus ornus</i> L.	Manna Ash	21,532	2.09	16.1
<i>Laburnum alpinum</i> (Mill.) Bercht. & J.Presl	Alpine Laburnum	1541	1.64	5
<i>Laburnum anagyroides</i> Medik.	Common Laburnum	4084	2.47	3.2
<i>Larix decidua</i> Mill.	European Larch	81,383	2.01	20.7
<i>Ostrya carpinifolia</i> Scop.	Hop Hornbeam	21,576	2.19	19.5
<i>Picea abies</i> (L.) H. Karst.	Norway Spruce	99,570	1.92	48.5
<i>Pinus cembra</i> L.	Swiss Stone Pine	9926	2.24	15.3
<i>Pinus mugo</i> Turra	Mountain Pine	6883	3.04	43.8
<i>Pinus nigra</i> J.F. Arnold	Austrian Pine	7172	1.84	26.6
<i>Pinus sylvestris</i> L.	Scots Pine	33,121	1.84	24.3
<i>Populus alba</i> L.	White Poplar	254	1.79	6.4
<i>Populus tremula</i> L.	Aspen	7486	1.87	4.6
<i>Prunus avium</i> (L.) L.	Wild Cherry	2951	1.69	2.4
<i>Quercus cerris</i> L.	Turkey Oak	263	2.01	8
<i>Quercus ilex</i> L.	Holm Oak	807	2.91	26.1
<i>Quercus petraea</i> (Matt.) Liebl.	Sessile Oak	5275	1.2	11
<i>Quercus pubescens</i> Willd.	Pubescent Oak	9208	2.2	10.9
<i>Quercus robur</i> L.	Pedunculate Oak	56	2.24	3.4
<i>Robinia pseudacacia</i> L.	Black Locust	2907	1.04	22.3
<i>Salix alba</i> L.	White Willow	1530	2.01	5.5
<i>Salix caprea</i> L.	Goat Willow	7182	2.11	4.8
<i>Salix cinerea</i> L.	Grey Willow	13	1.26	12.3
<i>Salix eleagnos</i> Scop.	Purple Willow	164	1.35	14.2
<i>Sorbus aria</i> (L.) Crantz	Common Whitebeam	12,266	2.4	4.2
<i>Sorbus aucuparia</i> L.	Rowan	12,157	2.42	2.3
<i>Taxus baccata</i> L.	English Yew	1296	2.98	3
<i>Tilia cordata</i> Mill.	Small-leaved Lime	1631	1.53	7.6
<i>Tilia platyphyllos</i> Scop.	Large-leaved Lime	44	1.27	5.7
<i>Ulmus glabra</i> Huds.	Wych Elm	244	1.87	1.4
<i>Ulmus minor</i> Mill.	Field Elm	21	1.63	2.8
-	Other broadleaved	7271	2.73	9
-	Other conifers	703	2.42	8.9

4.3. Data processing and quality control

The raw forest management data underwent a rigorous three-step filtering and standardization process to ensure the dataset is suitable for spatial modelling and ecological analysis:

- Handling of sporadic species: in the original provincial records, certain minority species were flagged as “sporadic” without an associated numerical percentage. To maintain the represen-

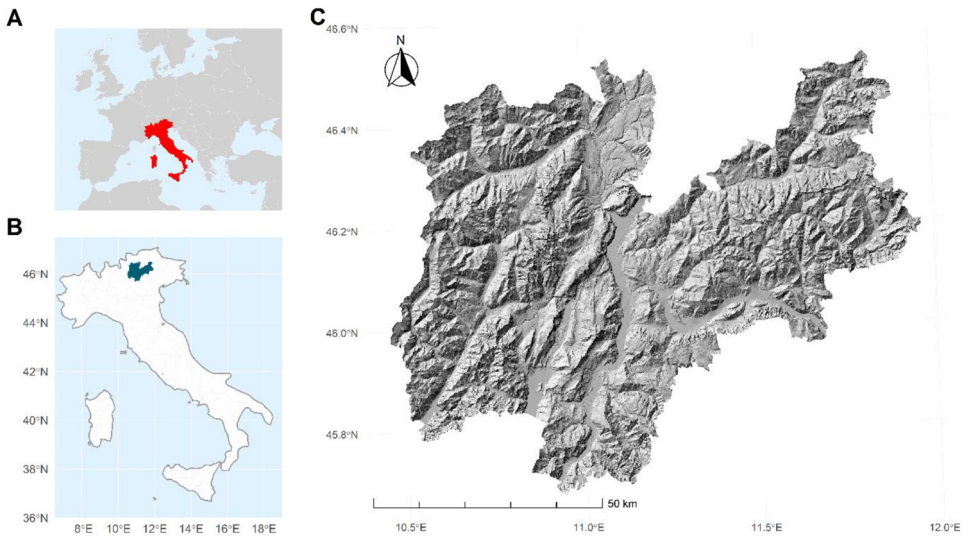


Fig. 6. Location of the study area: Italy within Europe (A), the Autonomous Province of Trento within Italy (B), and a shaded relief Digital Terrain Model (DTM) of the Autonomous Province of Trento (C), showing the complex topography of the region.

tation of biodiversity while keeping the data quantitative, these species were assigned a recognizable but format-consistent nominal forest cover value of 0.1 % (0.001 fractional value).

- Removal of FMU with low upper canopy cover: all FMU with a value of upper canopy cover below 20 % were removed from the original dataset (about 3.8 % of the total initial polygons).
- Removal of FMU with double-layered forest: all FMU classified by the forest technicians as double-layered forest were removed from the original dataset (about 4.36 % of the total initial polygons).
- Thematic consistency filtering: to ensure the reliability of the relative species-specific cover proportions data, a “sum-to-one” validation was performed. Any forest management unit where the cumulative sum of the relative species-specific cover proportions was below 99 % or above 101 % was excluded from the final dataset. This step removed units with incomplete records or significant reporting errors (0.25 % of the total initial polygons).
- Spatial filtering: to eliminate sliver polygons, derived from the intersection of the forest management units with roads, rivers, etc. and non-representative micro-units, all forest management units with an area smaller than 100 m² were removed (0.13 % of the total initial polygons).

Limitations

- Data were collected on a wide range of years (2010–2021) thus it could be that the species cover proportions changed over time. As an example, areas sampled before the Vaia storm of 2018 [2], significantly changed after that event.
- The cover proportions are estimated by visual inspection by trained forest managers, and not through full calipering of the area or other objective reproducible method, thus they should be intended as estimates rather than exact value.
- The cover proportions refer only to the upper canopy layer of the forest. While this makes it the perfect dataset for remote sensing applications, it could have limitations when studying species distribution models, as the presence of understory species is not present in the dataset.

Ethics Statement

The authors have read and follow the ethical requirements for publication in Data in Brief and confirming that the current work does not involve human subjects, animal experiments, or any data collected from social media platforms.

CRedit Author Statement

Michele Dalponte: Conceptualization, Methodology, Visualization, Formal analysis, Data Curation, Writing - Original Draft, Writing - Review & Editing, Supervision, Funding acquisition. **Daide Andreatta:** Conceptualization, Methodology, Writing - Original Draft, Writing - Review & Editing, Supervision.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used Gemini AI in order to improve language and readability. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Data Availability

[Tree species composition of the upper canopy layer of the forest management units of the Autonomous Province of Trento \(Italy\) \(Original data\) \(Zenodo\).](#)

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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- [2] G. Chirici, et al., Forest damage inventory after the "Vaia" storm in Italy, For. - Riv. Selvic. Ed Ecol. For. 16 (1) (2019) 3-9, doi:[10.3832/efor3070-016](#).