



Multi-temporal dataset of stand and canopy structural data in temperate and Mediterranean coppice forests

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Received: 6 July 2018 / Accepted: 9 July 2019 / Published online: 1 August 2019
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Abstract

• **Key message** We provided long-term stand and canopy structural data from permanent monitoring plots representative of some most diffuse temperate and Mediterranean forests, under different coppice management regimes. Periodic inventories were performed in the surveyed plots since the 1970s. Annual litterfall production and its partitioning (leaf, woody, reproductive parts) and optical canopy measurements using the LAI-2000 Plant Canopy Analyzer were performed every year in fully equipped plots since the 1990s. These data can be used for evaluating the influence of coppice management in the stand and canopy structure, the parametrization of radiative transfer models that require accurate ground truth data, and the calibration of high to medium resolution remotely sensed data. Dataset access is at <https://doi.org/10.17632/z8zm3ytkcx.2>. Associated metadata is available at <https://agroenvgeo.data.inra.fr/geonetwork/srv/eng/catalog.search#/metadata/2bd2d77f-3cf8-43da-b1b5-9f8196dc017f>.

Keywords Coppice management · Canopy gap fraction · Leaf area index · Conversion · Litterfall

1 Background

Coppices are a significant part of Europe's semi-natural forests, characterizing forest landscapes of the five EU Mediterranean countries over about 8.5 million hectares

(Forest Europe 2015). Coppices were usually used as a source of firewood until the second half of the nineteenth century (Fabbio 2016). Economic and social changes occurred in the last decades have supported both coppice abandonment and their conversion into high forest, a situation common to many

Handling Editor: Marianne Peiffer

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European countries (Cañellas et al. 2004; Cutini et al. 2015; Chianucci et al. 2016b). Given the long time needed for achieving conversion, long-term data are required to define appropriate management strategies for these forests. Accurate *in situ* quantification of both stand and canopy structural attributes is also required for the parameterization of radiative transfer models (Kuusk et al. 2014) and calibration of remotely sensed information. However, *in situ* datasets are mainly available in boreal forests (e.g., Kuusk et al. 2009; Widłowski et al. 2013) and austral forests (e.g., Woodgate et al. 2015), while comparable datasets in temperate and Mediterranean forests are scarce.

Here, we provide long-term stand and canopy structural data in forest stands representative of some most diffuse temperate and Mediterranean forest types under different coppice management regimes.

2 Methods

2.1 Study sites

The dataset is a part of a wider project (LIFE 14 ENV/IT/000514 “FutureForCoppiceS”; www.futureforcoppices.eu) aimed to demonstrate the effect of different management options on sustainable forest management (SFM) criteria and indicators (C&I) in coppice forests. In the project, different stands were surveyed in seven forest districts located in two Italian regions (Sardinia and Tuscany; Figure 1) belonging to long-term silvicultural trials established since the seventies of 1900 to monitoring the evolution of coppice stands under different management regimes. The plots were representative of three European forest types (EFT; Barbati et al. 2014): thermophilus deciduous forests dominated by Turkey oak (*Quercus cerris* L.) (EFT 8.2), mountainous beech (*Fagus sylvatica* L.) forests (7.3), evergreen broadleaved forests dominated by Holm oak (*Quercus ilex* L.) (9.1).

We included thirty-two project plots in the current database; two additional Turkey oak stands and one chestnut (*Castanea sativa* Mill.) stand (EFT 8.7) was also included from an independent field campaign. Periodic forest inventories were performed in these plots to survey dendrometric stand variables (tree density, basal area, mean diameter, mean height; Amorini et al. 1998a, b; Cutini 2002; Cutini et al. 1998; Chianucci and Cutini 2013). Litterfall production, its partitioning in leaf, woody and reproductive components, and optical canopy measurements using the LAI-2000 Plant Canopy Analyzer (LI-COR Inc. Lincoln, NE, USA) were performed every year in most of the plots since the nineties of 1900 (Cutini 2002). We classified as “fully equipped” the plots where all the dendrometric and canopy (litterfall, LAI-

2000) measurements have been performed. Table 1 lists the main characteristics of the selected plots.

2.2 Structural data

All standing trees (individuals with a stem diameter at 1.30 m \geq 3 cm) were surveyed, the species identified, and the diameter at breast height (dbh) measured. Mean dbh and basal area per hectare were then calculated from the measured diameters. When available, a sample of 30 trees was selected across the diameter range at each inventory. Dbh and height of the sampled trees were measured to calculate the height-diameter allometry. Mean height was then calculated as the height of mean diameter tree.

2.3 Litterfall data

When available, litterfall was collected from 9 to 15 litter-traps, each 0.5 \times 0.5 m in size, being systematically distributed along a grid, at 1 m above the ground level, with traps spaced 7 to 20 m apart, based on stand homogeneity and structure. Litter was periodically collected in fall-winter (usually between October and March, with the last collection completed soon after last litterfall). Litter was then sorted into its main components (leaf, woody, seed, husks, flowers), and then dried for 24 h to a constant weight in a forced-air stove at 85 °C \pm 2°. Leaf litter was also separated for each species. Litter dry mass and its partitioning were then calculated (Mg ha⁻¹) from total litter amount collected in fall-winter. We considered the reference year of sampling for litterfall as the sum of the litter collected in October–December of the current year and the litter collected in the January–March of the subsequent year. During this period, the sampled deciduous trees are in nonvegetative stage, and therefore, the litterfall collected refers to the previous vegetation period.

2.4 Optical canopy data

When available, optical canopy measurements were performed every year in each plot usually in summer (Jun–Aug), just after dawn or close to sunset and under uniform sky conditions using the LAI-2000 Plant Canopy Analyzer. The optics of LAI-2000 consists of a fisheye lens (148° field of view) divided into five concentric rings (with central zenith angle of 7°, 23°, 38°, 53°, and 68°, respectively). Each ring simultaneously integrates incoming radiation in the 320–490 nm wavelength range (blue light) over the complete range of azimuth angle. Five view caps are provided with the instrument to reduce the azimuthal view of the optical sensor: 270°, 180°, 90°, 45°, and 10°.

One above-canopy reference measurement for each plot was recorded in clearings near each study area. The fisheye lens of the instrument was covered by a 90° view

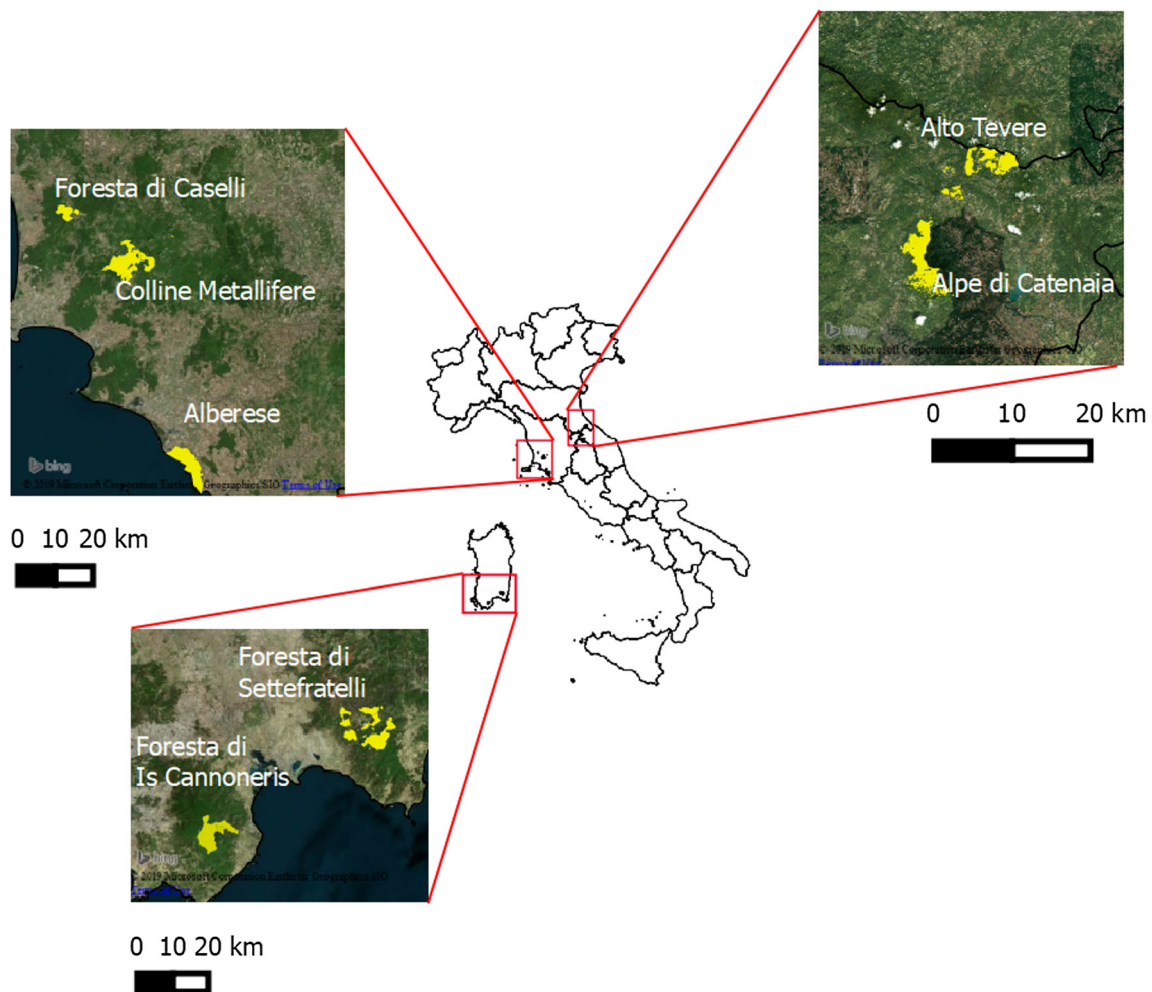


Fig. 1 Forest districts considered in the LIFE FutureForCoppiceS project

cap to avoid the influence of surrounding trees on the reference measurements. Nine to 15 below-canopy measurements were recorded within each plot at the same grid points used for photography, using the same 90° view cap. Gap fraction was estimated as the fraction of below- to above-canopy readings. Optical variables were then inferred from gap fraction using the FV2200 software version 1.2 (LI-COR Inc. Lincoln, NE, USA), which allowed to estimate effective leaf area index and leaf area index corrected for apparent clumping (see Ryu et al. 2010 for details) using Miller's (1967) theorem. Alternative leaf area index methods calculated from the software include Lang's interpolating method (1987), the Ellipsoidal method (Campbell 1986), and the constrained least square method (Perry et al. 1988).

3 Access to data and metadata description

The dataset can be downloaded using the following reference and doi: Chianucci F, Ferrara C, Bertini G, Fabbio

G, Tattoni C, Rocchini D, Corona P, Cutini A (2018). Multi-temporal dataset of stand and canopy structural data in temperate and Mediterranean coppice forests. Mendeley Data, v2, [dataset], <https://doi.org/10.17632/z8zm3ytkcx.2> under the Creative Commons Attribution—NonCommercial 4.0 License. The repository URL contains a descriptive table (“Tbl_description”) with information about the plots and four data tables (“Tbl_Inventory,” “Tbl_LAI-2000,” “Tbl_Leaf_Seed_Litter,” and “Tbl_Woody_Litter”). Illustrative images of the plots are also available as a compressed file (“Images.rar”). Associated metadata are available at <https://agroenvgeo.data.inra.fr/geonetwork/srv/eng/catalog.search#/metadata/2bd2d77f-3cf8-43da-b1b5-9f8196dc017f>. The metadata include (i) documentation on data provision and discovery, (ii) information on the data protocol in use, origin, and context, and (iii) technical documentation describing all the provided variables provided along with the data structure. All the data are provided without georeferenced information; georeferenced data are however available from the authors upon request.

Table 1 General description of the database plots. Asterisks indicate the plots not belonging to the LIFE FutureForCoppiceS Project

| N | ID_plot | Region | Forest district | European forest type (EFT) | Management option | Fully-equipped |
|----|-------------|----------|--------------------------|----------------------------|---|----------------|
| 1 | qiA2isc | Sardinia | Foresta di Is Cannoneris | 9.1 | Active conversion through periodic thinning | No |
| 2 | qiA3isc | Sardinia | Foresta di Is Cannoneris | 9.1 | Active conversion through periodic thinning | No |
| 3 | qiAisc | Sardinia | Foresta di Is Cannoneris | 9.1 | Active conversion through periodic thinning | Yes |
| 4 | qiB2isc | Sardinia | Foresta di Is Cannoneris | 9.1 | Active conversion through periodic thinning | No |
| 5 | qiB3isc | Sardinia | Foresta di Is Cannoneris | 9.1 | Active conversion through periodic thinning | No |
| 6 | qiBisc | Sardinia | Foresta di Is Cannoneris | 9.1 | Active conversion through periodic thinning | Yes |
| 7 | qiT2isc | Sardinia | Foresta di Is Cannoneris | 9.1 | Natural evolution (unthinned control) | No |
| 8 | qiT3isc | Sardinia | Foresta di Is Cannoneris | 9.1 | Natural evolution (unthinned control) | No |
| 9 | qiTisc | Sardinia | Foresta di Is Cannoneris | 9.1 | Natural evolution (unthinned control) | Yes |
| 10 | qiA1acq | Sardinia | Foresta di Settefratelli | 9.1 | Active conversion through periodic thinning | Yes |
| 11 | qiA2acq | Sardinia | Foresta di Settefratelli | 9.1 | Active conversion through periodic thinning | Yes |
| 12 | csAVVcate* | Tuscany | Alpe di Catenai | 8.7 | Active conversion through periodic thinning | Yes |
| 13 | fsCEDcolt1 | Tuscany | Alpe di Catenai | 7.3 | Traditional coppice | No |
| 14 | fsCEDcolt2 | Tuscany | Alpe di Catenai | 7.3 | Traditional coppice | No |
| 15 | fsCEDgeom1 | Tuscany | Alpe di Catenai | 7.3 | Traditional coppice | No |
| 16 | fsCEDgeom2 | Tuscany | Alpe di Catenai | 7.3 | Traditional coppice | No |
| 17 | fsCONTRcate | Tuscany | Alpe di Catenai | 7.3 | Active conversion through periodic thinning | Yes |
| 18 | fsDIR3cate | Tuscany | Alpe di Catenai | 7.3 | Active conversion through periodic thinning | No |
| 19 | fsDIR4cate | Tuscany | Alpe di Catenai | 7.3 | Active conversion through periodic thinning | No |
| 20 | fsDIR5cate | Tuscany | Alpe di Catenai | 7.3 | Active conversion through periodic thinning | No |
| 21 | fsDIRcate | Tuscany | Alpe di Catenai | 7.3 | Active conversion through periodic thinning | Yes |
| 22 | fsTESTcate | Tuscany | Alpe di Catenai | 7.3 | Natural evolution (unthinned control) | Yes |
| 23 | fsTScate | Tuscany | Alpe di Catenai | 7.3 | Anticipated seed cutting | Yes |
| 24 | qcAVVcate* | Tuscany | Alpe di Catenai | 8.2 | Active conversion through periodic thinning | Yes |
| 25 | qcDvals | Tuscany | Alto Tevere | T8.2 | Active conversion through periodic thinning | Yes |
| 26 | qcTvals | Tuscany | Alto Tevere | 8.2 | Natural evolution (unthinned control) | Yes |
| 27 | qc112mass | Tuscany | Colline Metallifere | 8.2 | Natural evolution (unthinned control) | Yes |
| 28 | qc1324mass | Tuscany | Colline Metallifere | 8.2 | Traditional coppice | Yes |
| 29 | qc2536mass | Tuscany | Colline Metallifere | 8.2 | Active conversion through periodic thinning | Yes |
| 30 | qc3748mass* | Tuscany | Colline Metallifere | 8.2 | Active conversion through periodic thinning | Yes |
| 31 | qcCEDmass | Tuscany | Colline Metallifere | 8.2 | Traditional coppice | No |
| 32 | qcD1case | Tuscany | Foresta di Caselli | 8.2 | Active conversion through periodic thinning | Yes |
| 33 | qcD3case | Tuscany | Foresta di Caselli | 8.2 | Active conversion through periodic thinning | Yes |
| 34 | qcT1case | Tuscany | Foresta di Caselli | 8.2 | Natural evolution (unthinned control) | Yes |
| 35 | qcT3case | Tuscany | Foresta di Caselli | 8.2 | Natural evolution (unthinned control) | Yes |

4 Technical validation

The dataset includes four data tables (“Tbl_Inventory,” “Tbl_LAI-2000,” “Tbl_Leaf_Seed_Litter,” and “Tbl_Woody_Litter”) comprising respectively 136, 1399, 951, and 378 records, for a total of 2864 measurements (records) associated with the 35 plots. Field inventory and litterfall collection have been conducted by four expert foresters. For leaf litter, identification of species has been performed in the laboratory by one expert botanist. The adopted nomenclature of leaf litter was set according to the UNECE/ICP species code (available at: <http://icp-forests.net/page/expert-panel-on-biodiversity>). Optical measurements using the LAI-2000 were conducted by one expert in optical canopy analyses.

Data cleansing have been performed to check for data quality. Data inconsistency originating by errors in user entry (e.g., typographical errors), data type storage, and field measurements have been checked by two independent expert users. Example of data quality analysis included data type constraints (e.g., values in a field must meet the desired data type), range constraints (minimum and maximum values allowed for numerical variables), and numeric constraints (e.g., tree height must not decrease through time).

5 Reuse potential and limits

The dataset allows characterizing the structure of forest stands which are representative of most diffuse European forest types, along with its variation over time. Forest inventory yielded traditional stand variables, while periodic repetition allows the examination of changes in stand structure due to mortality, growth, regeneration, and management.

Litterfall is a key descriptor of stand vitality, soil nutrient status, and forest ecosystem productivity, while its temporal distribution provides information about the influence of environmental factors and natural/anthropogenic disturbances on ecosystem dynamics. In addition, while most litterfall datasets are mainly limited to leaf litter, the current dataset provides also data on seed production, which can be used to either evaluate the influence of climate on mast seeding (Vacchiano et al. 2017) and assess the influence of masting on pulsed-resource consumers like wild boar (Bisi et al. 2018).

Leaf area index and other optical attributes are useful for multiple purposes, including (i) evaluating the influence of climate and management on forest canopy structure; (ii) monitoring stand vitality and productivity; (iii) parametrizing ecological and processed-based canopy photosynthesis models. New algorithms can be tested

using the gap fraction data (columns “AVGTRANS”) to improve estimation of canopy attributes like leaf area index (e.g., Gonsamo et al. 2018) and clumping index (e.g., Chianucci et al. 2019).

Other applications from the available data include the parameterization of radiative transfer models that require accurate ground truth data (Kuusk et al. 2014; Nilson 1999), as well as the calibration of remotely sensed information. The plot size is suitable for comparison with high to medium resolution aerial and satellite products and unmanned aerial vehicles (Chianucci et al. 2016a).

Although the data have been limited to relatively few plots, the temporal resolution allows a long-term assessment of the management influence within each stand, which is representative of the most widespread temperate and Mediterranean forest types. In addition, the selected variables and used experimental designs were in accordance with those of other studies specifically addressing forest dynamics (e.g., Genet et al. 2010; Meier and Leuschner 2008) and long-term forest monitoring programs such as UNECE/ICP (icp-forests.net), allowing large-scale comparison with other datasets and studies.

Finally, we foresee to periodically replicate measurements, so we plan to include new measurements in the dataset once they will be made available in future field campaigns.

Acknowledgments We thank the anonymous Reviewer and the handling Editor Marianne Peiffer for the constructive comments, which improved the original version of the manuscript. We are grateful for all technicians of CREA, who contributed to field data collection, with particular reference to Maurizio Piovosi, Luca Marchino, Tessa Giannini, Umberto di Salvatore, Leonardo Tonveronachi, Valter Cresti, Eligio Buchioni, Umberto Cerofolini, and Luigi Mencacci.

Funding The dataset has partly been compiled within the LIFE 14 ENV/IT/000514 “Shaping future forestry for sustainable coppices in southern Europe: the legacy of past management trials”—FutureForCoppiceS (www.futureforcoppices.eu).

Data availability statement The data are available under the Creative Commons Attribution—Non Commercial 4.0.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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