Data Article

Traditional and TLS-based forest inventories of beech and pine forests located in Sila National Park: A dataset

Nicola Puletti a, Mirko Grotti b, Carlotta Ferrara a, Stefano Scalercio a

a Research Centre for Forestry and Wood, CREA, viale Santa Margherita 80, Arezzo, Italy
b Department of Architecture and Design, Sapienza University of Rome, Piazza Borghese 9, Rome, Italy

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ABSTRACT

Vegetation structure is a key determinant of species distribution and diversity. Compared to traditional methods, the use of Terrestrial Laser Scanning (TLS) has allowed massive amounts of point cloud data collected for quantifying three-dimensional habitat properties at increasing spatial and temporal scales. We used TLS to characterize the forest plots across a broad range of forest structural diversity, located in the Sila National Park, South Italy. The dataset reports data collected in 24 15-m-radius circular plots, 12 of which were dominated by beech (Fagus sylvatica L.) and 12, by black pine (Pinus nigra subsp. laricio). In detail, this work provides dataset of i) plot-level attributes calculated from raw data, such as the number of trees, ii) tree-level data, comprising a total of 1709 trees, with information related to field-based forest inventory such as the diameter at breast height (DBH), and iii) plot-level information related to the time for conducting both traditional field- and TLS-based forest inventories. Compared to traditional methods, the use of TLS allows a very high-resolution quantification of the 3D forest structural properties, also reducing the time for conducting forest inventories.

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## Specifications Table

| Subject | Agricultural and Biological Sciences |
|---------|--------------------------------------|
| Specific subject area | Forestry |
| Type of data | Table, Point cloud (LAS format), Georeferenced sample plots (shapefile and KMZ format) |
| How data was acquired | Data were collected from August 25th to August 30th, 2019. Our inventory consisted of twenty-four plots of 15 m radius (707 m²) each within the Sila National Park (Southern Italy). Plots were randomly located and stratified between the two main forest tree species in the Park: black pine and European beech. We measured the diameter of all the trees with DBH ≥ 3 cm found within the plots with a calliper at 1.30 m taken from the base of the tree and collected health status (i.e. alive, dead or snag). Each tree was marked with red spray paint where the DHB was measured. A total of 1709 trees were measured. TLS data were acquired using a GeoSLAM ZEB-REVO mobile time-of-flight scanner. We scanned each plot in a circular pattern at about 15 and 7.5 m from the centre respectively, starting and ending at the centre. |
| Data format | Raw |
| Parameters for data collection | Data collection considered GPS position, all trees of DBH ≥ 3 cm and TLS point clouds within 24 plots. |
| Description of data collection | Data were collected as part of the Agridigit project funded by the Italian Ministry of Agricultural, Food, and Forestry Policies in southern Italy. The dataset comprises plot georeferenced position, all trees with DBH ≥ 3 cm and all TLS point cloud for each of the twenty-four-plot area. |
| Data source location | Sila National Park in Calabria, Italy. Sampling plot names: ID_PXXX: Black pine forest, from 001 to 012; ID_FXXX: European beech forests, from 001 to 012. |
| Data accessibility | Repository name: Mendeley data |
| Direct URL to data | http://dx.doi.org/10.17632/k6mmr6ytvf.1 |
| Related research article | Puletti N.; Gotti M.; Ferrara C.; Chianucci C. | Lidar-based estimates of aboveground biomass through ground, aerial, and satellite observation: a case study in a Mediterranean forest. J. of Applied Remote Sensing, 14(4), 044501 (2020). | https://doi.org/10.1117/1.JRS.14.044501 |

## Value of the Data

- The data provide information useful for estimating forest carbon storage in beech and pine forests in Southern Italy (see for example [1]).
- Shared TLS data can be used to create species-specific allometry models (see for example [2]).
- Data can be exploited to analyse structural characteristics of considered forests, providing information to implement local conservation policies.
- This dataset may assist forest researchers to combine and extend their data for further meta-analysis in the same biogeographic area.
- Data can provide useful information to compare the pros and cons on the adoption of mobile TLS in forest inventories.
- A simultaneous acquisition of both DBH and TLS measurements is useful to evaluate the pros and cons of Field- and TLS-based forest inventories.

## 1. Dataset Description

The dataset presents the results of a forest inventory conducted in a Mediterranean forest located in the Sila National Park, Southern Italy (39.4° N, 16.5° E; Fig. 1). The dataset consists of three tables: plot-level data (Table 1), tree-level data with information related to field-based
Fig. 1. Study area and sampling plot distribution. The white line depicts the Sila National Park boundaries.

Table 1
List of sampling plots with their geographical location and number of trees registered. In the online version, we uploaded the shapefile of plot centres.

| ID plot | Dominant species | Latitude     | Longitude     | N. of trees |
|---------|------------------|--------------|---------------|-------------|
| ID_P001 | Black pine       | 39.0786141083 N | 16.5735212244 E | 17          |
| ID_P002 | Black pine       | 39.0840337522 N | 16.5748482777 E | 27          |
| ID_P003 | Black pine       | 39.0859809136 N | 16.5779477189 E | 28          |
| ID_P004 | Black pine       | 39.0829139671 N | 16.5809598645 E | 100         |
| ID_P005 | Black pine       | 39.0814667143 N | 16.5852189074 E | 30          |
| ID_P006 | Black pine       | 39.0786141083 N | 16.5735212244 E | 17          |
| ID_P012 | Black pine       | 39.0707102766 N | 16.5913812203 E | 25          |
| ID_P007 | Black pine       | 39.0707102766 N | 16.5926242830 E | 67          |
| ID_P008 | Black pine       | 39.0680117525 N | 16.5949533534 E | 54          |
| ID_P009 | Black pine       | 39.0653250512 N | 16.5861507606 E | 22          |
| ID_P010 | Black pine       | 39.0906694910 N | 16.5864054250 E | 28          |
| ID_P011 | Black pine       | 39.1027589857 N | 16.6196679544 E | 121         |
| ID_P012 | Beech            | 39.1106409347 N | 16.6063941305 E | 61          |
| ID_P013 | Beech            | 39.1325413418 N | 16.5650174068 E | 61          |
| ID_P004 | Beech            | 39.1175803220 N | 16.6019309515 E | 36          |
| ID_P005 | Beech            | 39.1166786865 N | 16.6002999343 E | 62          |
| ID_P006 | Beech            | 39.1170979625 N | 16.5958293660 E | 33          |
| ID_P007 | Beech            | 39.1216671472 N | 16.5969088712 E | 203         |
| ID_P008 | Beech            | 39.1200267111 N | 16.5918490960 E | 112         |
| ID_P009 | Beech            | 39.1278265765 N | 16.5811928951 E | 265         |
| ID_P010 | Beech            | 39.1291099017 N | 16.5727152185 E | 92          |
| ID_P011 | Beech            | 39.1310926576 N | 16.5708270382 E | 95          |
| ID_P012 | Beech            | 39.1275562293 N | 16.5673577557 E | 76          |
Table 2
Example of the field inventory database for the first 10 rows only. ID_plot is the sampling-plot identification code; Tree_id is the identification number assigned to each measured tree; Subidentity_id is the identification code assigned to each measured shoot (only for broadleaves); the last two columns are tree species (spp) and diameter at breast height (diam_cm) of each measured tree/shoot. A column for notes about tree conditions (vitality or position) was also added.

| ID_plot | Tree_id | Subidentity_id | spp               | diam_cm | Note |
|---------|---------|----------------|-------------------|---------|------|
| ID_P001 | 1       | a              | Pinus nigra subsp. laricio | 46      |      |
| ID_P001 | 2       | a              | Pinus nigra subsp. laricio | 51      |      |
| ID_P001 | 3       | a              | Pinus nigra subsp. laricio | 7       |      |
| ID_P001 | 4       | a              | Pinus nigra subsp. laricio | 62      |      |
| ID_P001 | 5       | a              | Pinus nigra subsp. laricio | 15      |      |
| ID_P001 | 6       | a              | Pinus nigra subsp. laricio | 43      |      |
| ID_P001 | 7       | a              | Pinus nigra subsp. laricio | 52      |      |
| ID_P001 | 8       | a              | Pinus nigra subsp. laricio | 66      |      |
| ID_P001 | 9       | a              | Pinus nigra subsp. laricio | 4       |      |
| ID_P001 | 10      | a              | Pinus nigra subsp. laricio | 57      |      |

Table 3
Plot-level information related to both traditional and TLS-based time forest inventory (in minutes).

| id_plot | Time from car to sampling plot | Traditional inventory | TLS-based inventory |
|---------|--------------------------------|-----------------------|---------------------|
|         | Preparatory actions | Field works | Preparatory actions | Field works |
| ID_P001 | 5 | 3 | 3 | 4 | 10 |
| ID_P002 | 3 | 3 | 3 | 10 | 8 |
| ID_P003 | 2 | 2 | 3 | 4 | 10 |
| ID_P004 | 1 | 3 | 3 | 23 | 15 |
| ID_P005 | 3 | 2 | 3 | 9 | 11 |
| ID_P006 | 13 | 2 | 3 | 9 | 11 |
| ID_P007 | 2 | 3 | 3 | 14 | 8 |
| ID_P008 | 3 | 5 | 3 | 9 | 17 |
| ID_P009 | 4 | 6 | 3 | 3 | 9 |
| ID_P010 | 12 | 5 | 3 | 9 | 9 |
| ID_P011 | 4 | 2 | 3 | 8 | 7 |
| ID_P012 | 4 | 1 | 3 | 11 | 12 |
| ID_F001 | 4 | 5 | 3 | 19 | 11 |
| ID_F002 | 4 | 4 | 3 | 12 | 16 |
| ID_F003 | 6 | 4 | 3 | 15 | 11 |
| ID_F004 | 4 | 6 | 3 | 6 | 13 |
| ID_F005 | 5 | 5 | 3 | 10 | 9 |
| ID_F006 | 1 | 7 | 3 | 13 | 6 |
| ID_F007 | 5 | 2 | 3 | 26 | 15 |
| ID_F008 | 7 | 2 | 3 | 13 | 11 |
| ID_F009 | 5 | 2 | 3 | 26 | 13 |
| ID_F010 | 2 | 2 | 3 | 13 | 10 |
| ID_F011 | 1 | 3 | 3 | 8 | 9 |
| ID_F012 | 2 | 6 | 3 | 9 | 9 |

forest inventory (Table 2), plot-level information related to both field-based and TLS-based forest inventories (Table 3).

2. Experimental Design, Materials and Methods

The study site was a 40 km² area located in the Sila National Park, Italy (approx. lat.: 39° 6’ N, long.: 16° 35’ E; elevation between 1,200 and 1,600 m above sea level).

Field measurements were performed from 25 to 30 August 2019 during leaf-on conditions in 24 circular plots of 15 m radius each (Table 1); 12 plots dominated by European beech (7.3 of European Forest Types; [3]) and 12 plots by black pine (10.2 of European Forest Types; [3]).
Global Navigation Satellite Systems (GNSS) static observations were recorded at the centres of each sampling plot with a Trimble Juno 5 GPS (Trimble Inc., Sunnyvale, California, US) during a 10 minutes observation time to assure that GNSS errors do not lead to significant mismatches between the field and the laser scanning datasets [4].

2.1. Field-based forest inventory

Diameters-at-breast-height were recorded as averages of two perpendicular calliper measures, while tree height was measured using a Vertex IV ultrasound instrument (Vertex IV, Haglöf, Långsele Sweden). Every tree within the circular plot was surveyed, except those with a diameter-at-breast-height lower than 3 cm. In the meantime, species, and health status (i.e. living, dead, snag) have been collected (Table 2).

2.2. TLS-based forest inventory

For TLS data acquisition we used a GeoSLAM ZEB-REVO (GeoSLAM Ltd, Ruddington, England) lightweight mobile laser scanner. This device features a rotating 2D scanning device and an IMU in the handle. The system acquires three-dimensional information of the surrounding area at 905 nm wavelength but does not store the backscattered laser intensity information. Outdoors data acquisitions are performed within the range 0.60-15 m, with a measurement rate of 40,000 points per second. The relative points accuracy is 2-3 cm [5]. To improve the positioning accuracy, this technology requires that the starting and ending points of the scan process coincide and some overlaps are done during the scan-path. No additional supports (i.e. targets) are needed. In this work, we define a specific scan-path that starts from and ends at the field plot centre (Fig. 2).
The operator can divert from this theoretical path because of forest floor obstacles (rocks, deadwood, etc). For each plot, the scan process required from 10 to 15 min, depending on stand complexity and ground asperity (see par. 2.3 and Table 2 for more details).

2.3. Work times

For each plot, we recorded times from car to sampling plot, useful to calculate plot accessibility, times for preparatory actions for and the time for field works for both traditional and TLS-based inventories.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have or could be perceived to have influenced the work reported in this article.

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