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DATA PAPER Open Access

A dendroarchaeological tree-ring dataset of *Abies alba* Mill. from historic buildings in the French Pyrenees

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Key message
This article presents ring width chronologies derived from samples extracted from historical timber buildings in the French central Pyrenees. Two chronologies for fir (*Abies alba* Mill.) were dated for two periods: 1446–1655 and 1679–1952 AD. These chronologies are suitable for dendroarchaeological and paleoenvironmental studies, or for reconstructing past climates. Dataset access is at https://doi.org/10.48579/PRO/KH6HPC and associated metadata at https://metadata-afs.nancy.inra.fr/geonetwork/srv/fre/catalog.search#/metadata/edba546e-3769-4f06-959b-f0d8db7fbcdb.

Keywords Dendrochronology, Silver fir, Ancient and mature forests, French Pyrenees, Wooden buildings in mountain, Early and late modern period

1 Background

The BENDYS French project (ANR-19-CE03-0010) aims at improving our understanding of the Holocene trajectories of six ancient and mature forests (AMF) located in the French Pyrenees, in order to improve their management and conservation (Py-Saragaglia et al. 2020). The dendroarchaeological approach was implemented to better characterize local timber harvesting strategies and forest dynamics in the past. These historical data indicate the widespread use of fir in stands of various ages in local Pyrenean construction, as well as the occasional use of other species. The archaeological survey have focused on the northern slopes of the Pyrenees which led to the acquisition of 393 tree-ring series from historic timbers of silver fir (*Abies alba* Mill.), deciduous oak (deciduous *Quercus*), beech (*Fagus sylvatica* L.), pine (*Pinus* sp.), and poplar (*Populus* sp.). The samples were extracted from 24 building timbers (Fig. 1) located in the immediate vicinity of current old-growth fir-beech forests (Sabatini et al. 2018, 2021, Larrieu et al. 2023). We successfully crossdated 57 series from fir trees. Sixty-seven short series (less than 50 rings) were also dated but not included in the chronology (see, for example, Bridge 2020). The other 269 series remain undated.

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2 Methods

2.1 Site selection

The dendroarchaeological approach carried out in the framework of the BENDYS project aimed at characterizing the past management of the studied old-growth forests, we therefore selected buildings located in the vicinity of these forests.

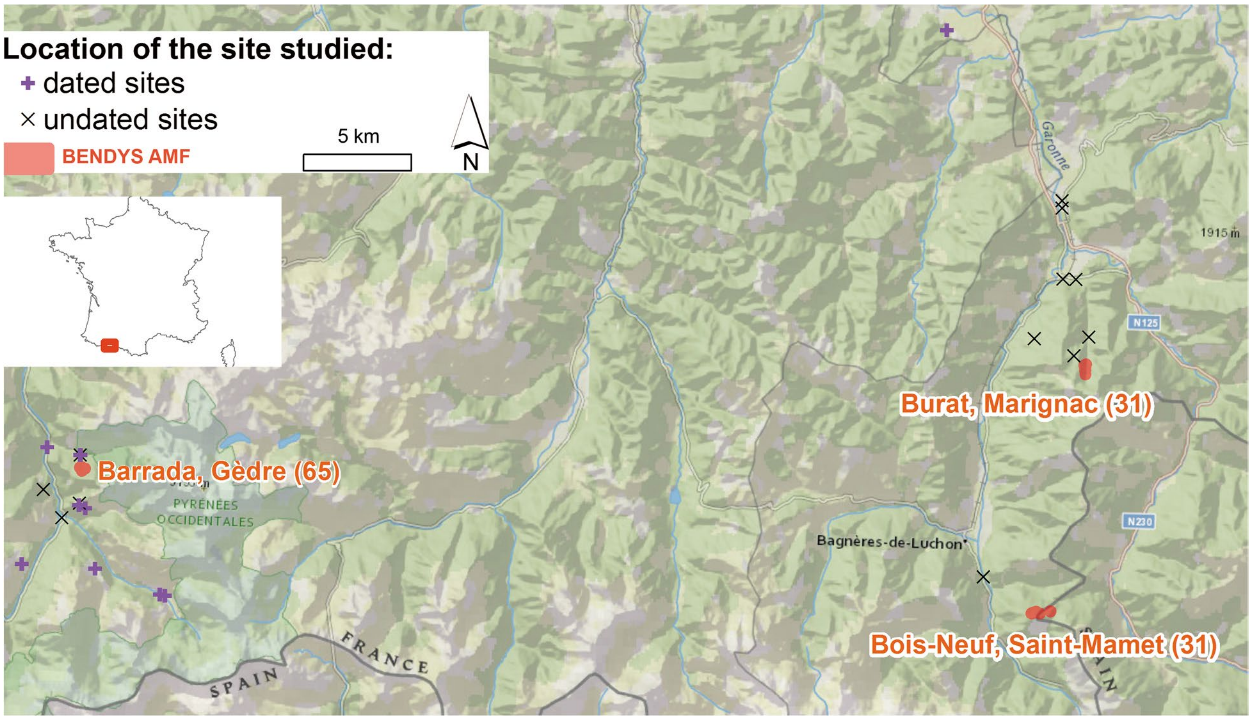

Fig. 1 Location map of the study areas. Informations are available in the dataset spreadsheet labeled "sites-informations" (Labbas et al 2023)

This dendroarchaeological research was also extended to the frameworks of high-profile buildings in which the number of timbers is important, such as certain religious buildings. Wherever possible, sites were selected within 1 km of the edge of the old forest. However, several buildings made with mountain timber located in close vicinity (up to 20 km) were also sampled. In total, we selected 24 buildings: 14 mountain barns, 6 churches, 2 mines, and 2 mills. Spatial coordinates are available in the "sites-informations" spreadsheet in the dataset. A stratigraphic reading was firstly carried out on each building (Harris 1989) in order to select the relevant pieces to be sampled. In most cases, we opted to significantly increase the number of samplings per structure to obtain more complete data on timber harvesting strategies. This process has the advantage of dating each stage of the construction sites and providing more analysis material for reconstructing past forest history.

2.2 Sampling, measurements, cross-dating

Investigated timbers have no carvings nor paintings, which means they can be invasively sampled. They were sampled by coring with a Rinntech borer (combined with a drill) and a manual increment borer when the building is preserved or extracting a wood section when it has collapsed. One to two radii were measured on each sampled timber. When two rays were measured, we averaged the two to establish an individual chronology. We sampled 480 timbers, of which 393 were measured to analyze the tree-ring series. The 87 unmeasured series consisted of samples that could not be read, or samples from ash (*Fraxinus excelsior* L.), cherry (*Prunus* sp.), and lime trees (*Tilia*). The samples were sanded (P120 to 600) to increase the visibility of tree rings and observed under a binocular. Wood taxa identification was based on wood anatomy atlas (Schweingruber 1988). The ring widths were measured using the incremental measuring table LINTAB-6 with 1/100 mm accuracy and TSAP-Win software (Rinn 2008). Individual chronologies were then indexed and cross-dated. The cross-dating accuracy was derived from the Student test (*t*) as defined by Baillie and Pilcher (1973) and calculated in Dendron IV software (developed with RunRev LiveCode, Edinburgh, Scotland, by G.-N. Lambert CNRS, University of Franche-Comté, Besançon, France and University of Liege, Belgium. Version: 20,150,221). Individual chronologies were then detrended using the Corridor method (Durost 2005; Lambert 2006, Lambert et al., 2010). Dating was performed using available master chronologies from southeastern France (Shindo et al. 2017). Among all measured samples, 124 individual fir series were successfully dated (Fig. 2) and 269 (fir, oak, beech, pine, and poplar) remained undated (Labbas et al 2023). Among the 124 individual dated series, 67 displayed less than

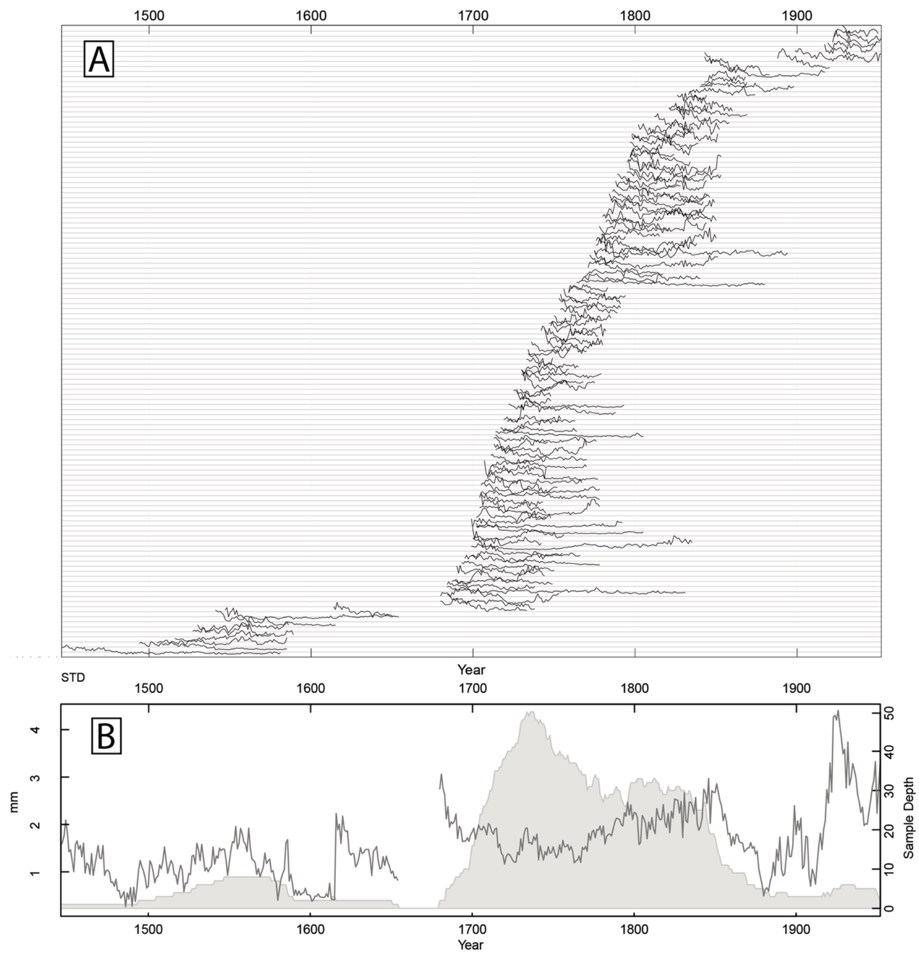

Fig. 2 **A** Diagram of the 57 dated fir tree-ring series available in the repository. **B** Two master chronologies: 1446–1655 AD and 1679–1952 AD. Master chronologies volume (sample depth) is represented in light gray

50 rings. To ensure robustness, the 57 series with more than 50 rings form the two average chronologies. The 67 short series are not included in the average chronologies. Nevertheless, they are part of the dataset. These data are indeed essential as they contribute to unravel trees harvesting strategies for timber supply (Billamboz 2008, Dominguez-Delmas 2020). Unfortunately, we failed to cross-date chronologies built with samples of beech, oak, poplar, or pine, using either regional or extra-regional reference chronologies. Undated and dated chronologies are provided and are also subject to change. The undated series are frequently re-analyzed to search for new dates and to increase the file of dated wood.

3 Access to the data and metadata description

3.1 Access to data and metadata

Dataset can be accessed at https://doi.org/10.48579/PRO/KH6HPC and reused, provided it is cited (Labbas et al. 2023) along with the license CC BY 4.0. Associated metadata is available at https://metadata-afs.nancy.inra.fr/geonetwork/srv/fre/catalog.search#/metadata/edba546e-3769-4f06-959b-f0d8db7fbcdb. The individual contact details of the four researchers are presented. If complementary data is necessary, the corresponding author should be contacted.

3.2 Dataset content, data and metadata description

There are six files in the dataset: a spreadsheet in tabulated format and two data files in Heidelberg format. The spreadsheet, labeled "site-informations," presents the following informations: site (site code), the type of site (barn, church, mill), the locality, the geographic coordinates (longitude and latitude in WGS 84), the altitude (above sea level), the distance to the nearest old growth forest, the number of samples for each species, the number of dates obtained (for fir trees only), and the dated range separated with a ";" when there is hiatus.

The five data files (three.fh format and two.csv) can be opened in most of all dendrochronology programs and can be used in R in the dplR package (Bunn 2008).

The format can also be modified with the TRiCYCLE software (Brewer et al. 2011). Here are presented dated data in three.fh files and two.tab files: Bendys-AA-PYR-DatedSeries.fh, Bendys-AA-PYR-DatedShortSeries.fh, Bendys-AA-PYR-Up50-tab.csv, and Bendys-AA-PYR-Under50-tab.csv for dated fir tree-ring series and Bendys_undated.fh for undated series. Undated tree-ring file contains fir, oak, pine, poplar, and beech tree-ring series from rural buildings from the Pyrenean northern slope. Dated and undated data consist in numerical and represent tree-ring widths measured at 1/100 mm. Data are provided in Heidelberg format (∗.fh) (Rinn, F., 2008 TSAP-Win software. Rinntech, Heidelberg) and *.fh files may also be open in notepad, in *.csv format. Each record consists of a header, containing informations on the individual chronology listed below, and the individual ring width chronology:

Header:

DateEnd = the date of the last dated ring in the series.
Length = the number of rings in the series.
Location = the place where the wood comes from.
Species = the species is indicated here by its scientific name such as *Abies alba* Mill. (Raab-Straube, 2014).
Pith = indicates presence (""OK"") or absence (""-"") of pith.
SapWoodRings = indicates the number of sapwood rings. Absence of sapwood is indicated by ""-"."
WaldKante = German term meaning ""wood edge"." This heading indicates the presence or absence of the last growth ring or cambium and therefore the accuracy of the tree felling date.
State = indicates the region of origin of the individual series.
PersId = indicates the name of the operator who made the measurement.
Latitude/Longitude = the geographical coordinates (Lt and Lg) are given in decimal degrees (WGS84 World Geodetic System, EPSG:4326).
Elev = the altitude (in meters) is given in relation to the global mean sea level.
KeyCode = indicates the name of the timber.
Country = indicates the country in which the site originates.
CreationDate = indicates the date the tree-ring series was imported into the Dendron IV software by the operator (date format YYYYMMDD).

Data: The data is provided here in ""Tree"" TSAP format (.fh) which corresponds to an individual.

The sequence of numbers following the header is the tree-ring series measured in 1/100 mm. A series is arranged in a row of 10 numbers. The first one, at the top left, is the oldest in the chronology, so the one closest to the pith. The most recent ring is therefore the last in the list. The sequence of "0" at the end of the list are not ring measurements but are incremented to form a final line of 10.

4 Technical validation

We used classical analysis methods in dendrochronology. The maximum number of timbers was sampled in each building after stratigraphic reading to contextualize the timbers. For each group of tree-ring series (buildings), cross-dating begins with the longest series (from 60 rings), from which shorter series are aggregated. We set t and r threshold values of 3.5 and 0.4 to build site chronologies. We then set minimum t and r values of 5 and 0.5 to cross-date site chronologies and create two mean silver fir chronologies. These two chronologies were cross-dated with master chronologies from Shindo et al. (2017) and unpublished chronologies from Massif Central and Rhône Valley provided by François Blondel (University of Geneva's Institute for Environmental Sciences). Cross-dating reveals several replications of the results with t values higher than 6 and r values higher than 0.5, validating the dates.

5 Reuse potential and limits

The data provide a valuable master chronology, useful to dendrochronologists and archaeologists for dating other tree-ring chronologies from living trees, timbers, buildings, or archaeological sites. Paleoenvironmentalists, dendrochronologists, and forest ecologists will be able to benefit from this data to reconstruct fir tree sensitivity to climate, and forest resilience and disturbances over the last 500 years. Rural building tree-ring series can be used to study wood uses and economy in the mountains in modern times (sixteenth–nineteenth century). Furthermore, the samples have the advantage of being preserved for verification measurements or other analyses. To ensure the robustness of the reference chronology, only series including more than 50 tree rings were used to build it.

However, the chronology has several limitations. The most robust period is between the eighteenth and mid-nineteenth century because of the presence of most tree rings during this period. Furthermore, the hiatus in the second half of the seventeenth century does not allow a continuous analysis over the whole period.

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Code availability
Not applicable.

Authors' contributions
Conceptualization: Vincent Labbas; methodology: Vincent Labbas; formal analysis and investigation: Vincent Labbas; writing—original draft preparation: Vincent Labbas; writing—review and editing: Mélanie Saulnier, Sylvain Burri, Laurent Larrieu, Vanessa Py-Saragaglia; funding acquisition: Vanessa Py-Saragaglia; supervision: Vanessa Py-Saragaglia. The authors read and approved the final manuscript.

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Availability of data and materials
The datasets generated during and/or analyzed during the current study are available in data.indores.fr/dataverse repository, https://doi.org/10.48579/PRO/KH6HPC.

Declarations

Ethics approval and consent to participate
The authors declare that the study did not involve human subjects, animal experiments nor data collected from social media platforms. Not applicable.

Consent for publication
All authors gave their informed consent to this publication and its content.

Competing interests
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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