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Deliverable D2.2

Database of relevant leaf/wood economics and water relations traits for the GenRes collection.

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Workpackage leader: CREAF

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1 Summary

This deliverable D2.2 gathers the FORGENIUS WP2 phenotypic data related to leaf/wood economics and water relations traits collected in the field during the first two years of the project. The datasets provided as part of this deliverable have been summarised to make it easier to read and use as relevant datasets of phenotypic properties for the EUFGIS database.

This deliverable applies to four species: *Populus nigra* and *Pinus pinaster* (characterized in 2021) and *Fagus sylvatica* and *Pinus sylvestris* (characterized in 2022). The data for 2023 and 2024 (*Quercus robur, Picea abies, Abies alba, Malus sylvestris, Pinus halepensis* and *Pinus pinea*) are being analysed and will be provided once all analyses are completed.

More than 5,000 measurements have been collected by the WP2 field team for Deliverable D2.2 in the first two years of this project. In practice, we sampled branches from the canopy top of 10 trees for each GCU, with the number of GCUs varying between 12 and 15 per species. The samples were then measured in the laboratory.

The deliverable outputs are the datasets (§ 3.2) and the associated metadata (§ 3.1). All the data are already available in the official FORGENIUS Repository (Microsoft Teams).

2 Introduction

Following the Field and Laboratory Protocols submitted as part of Milestone MS3 (sheet 9, 10 and 11 of the Protocol in MS3), we determined phenotypic variability in traits belonging to the leaf economics spectrum, wood economics spectrum and variables affecting tree water relations.

The data presented here refers to the following GCU sampled during 2021 and 2022.

Date of collection	Species	Number of GCUs	Total number of sampled trees
2021			
Spring	*Populus nigra*	15	150
Autumn	*Pinus pinaster*	12	120
2022			
Spring	*Fagus sylvatica*	15	150
Autumn	*Pinus sylvestris*	14	140

We initially planned to sample 15 GCUs per species. The slight reductions in sampling intensity for two species is explained by the initial difficulties to maintain the sampling schedule during Year 1 because of tiredness in the field team (12 instead of 15 sampled GCUs in *Pinus pinaster*) and the loss of samples during shipment following sampling in the field (one GCU in *Pinus sylvestris*).

Following collections, all sampled were shipped to the laboratories for further analysis. In detail, the measurements carried out for this Deliverable 2.2 cover the following spectra of traits:

Trait spectrum	Symbol	Trait	Ecological significance
Leaf economics spectrum	SLA	Specific leaf area	SLA is the ratio of half of the total area of a fresh leaf to its dry mass for 10 individual adult dominant/co-dominant trees sampled either inside or in the vicinity of the circular plot. Specific leaf area is an estimate of the return of photosynthetic assimilates via leaf surface display per unit leaf biomass investment. Leaves with high SLA are said to be 'acquisitive' leaves. They are photosynthetically more productive per unit of mass invested and per unit of time, but generally have a shorter lifespan, which lowers their cumulative photosynthetic return in the long run.
	%C	Percentage of carbon in leaf tissue	%C is an index of the carbon invested per unit of leaf dry mass.
	%N	Percentage of nitrogen in leaf tissue	%N is an index of the nitrogen invested per unit of leaf dry mass, largely in proteins involved in photosynthesis.
Wood economics spectrum	WD	Branch wood specific gravity	WD is the ratio of dry mass to fresh volume of a branch wood sample across 10 individual adult dominant/co-dominant trees sampled either inside or in the vicinity of the circular plot. Wood density is a measure of mass invested per unit of volume. High density wood is generally correlated with long wood lifespan, high resistance to pathogen attacks and mechanical damage. It also relates inversely to volumetric growth, hence trees with high WD are said to be 'resource conservative'.
Leaf and branch water relations	P0	Osmotic potential at full turgor	P0 (negative number) is an index of the capacity for osmotic potential of leaves. It relates closely to TLP.
	TLP	turgor loss point	The water potential (negative number) at which leaves lose turgor for the apical branches of 10 individual adult dominant/co-dominant trees sampled either inside or in the vicinity of the circular plot. TLP is an index of drought tolerance, because plants with very negative TLP can maintain turgor even under water stressed conditions.
	C	branch capacitance	Water storage capacity is expressed as branch capacitance, which is the change

			in branch relative water content (i.e., water content relative to its maximum value at saturation) per unit change in water potential for 10 individual adult dominant/co-dominant trees sampled either inside or in the vicinity of the circular plot. During a severe drought, if capacitance is high, the tree can exploit its own water reserves to delay desiccation. Therefore, the water storage capacity of the wood is an index of drought avoidance. Here, values are normalised either per unit of total branch water content at saturation, leaf area or dry mass.
	d13C	Linked to leaf water use efficiency WUE	The ratio 13C/12C of the sample divided by the ratio of 13C/12C of the standard. It is linked to leaf photosynthetic rate per unit of stomatal conductance and to the ratio of inter-cellular to ambient CO2 concentration.
	HV	Huber value	The ratio of under-bark sapwood cross-sectional area to the leaf area distal to the cross-section in the apical branches for 10 individual adult dominant/co-dominant trees sampled either inside or in the vicinity of the circular plot. The HV is a measure of allocation of assimilates to build either leaf area for photosynthesis or sapwood to supply the leaves with water. A tree with high Huber values is efficient in providing support to the leaves but may not invest in high leaf areas.

In the initial proposal, we also proposed to collect replicated samples from both the top and the bottom positions within each tree crown to account for different radiation conditions. This element of the project plan was discarded during later planning, in favour of standardising all sample collections to the top of the canopy of the dominant trees for each stand. This choice was justified by the need to maintain sample collection within the limit of the processing capabilities of the laboratories involved, while maximising the number of trees that could be sampled. The choice is also justified by the presence of significant differences in the level of illumination at the bottom of the canopy at each GCU, which would have made it very difficult to standardise the sampling by light levels.

The dataset is complete for most of the variables reported above. Some datasets are still incomplete, specifically, %C, %N, d13C and d15N, for which laboratory analyses are still ongoing and the results are expected to be received during summer 2024. The delay is explained by our use of an allied laboratory in Italy, which provides the analyses at a much-reduced price but with some delay.

Further details on the detailed sampling schedule, names and codes of the sampled GCU for each species can be found in Deliverable D2.1. Data collection was coordinated by the two teams at CREAF-Barcelona and INRAe-Avignone, with the help of the local partners to confirm the choice of the relevant GCUs, obtain the relevant permissions and identify the most suitable sampling areas. Local partners provided an essential support to the WP2 field team. All laboratory work relied on the field team crew who shipped or carried all samples to CREAF, where these analyses were carried out.

3 Results

3.1 The data description file

The data description file reports the following information:

- The names of the people who conducted the measurements in the laboratory
- The times when the measurements were taken
- The country, species, GCU Code, Tree Code and tree id employed to identify individual samples.

The file contains also:

- The name of each of the measured traits, the units employed and a short description of the variable.

Names, units and variable descriptions are consistent with those given in the (conceptual) dictionary employed to define and explain the meaning of all the measured variables, i.e., they correspond to the EUFGIS dataset contained in the online table: *characterization-descriptors.xls* constructed by the WP5 team (Milko Škofič and Marjana Westergren, WP5 leader).

The content of the data description file is also reported here for completeness:

Data measured and recorded by Ana Hernandez and Joan Prunera-Olivé during 2021, 2022 and 2023
CURATED_DATA

Variable	Unit	Description	Notes
country	none	Country of origin of the GCU.	
species	none	Plant Species.	
GCUCode	none	EUFORGEN GCU Code.	
TreeCode	none	Tree number.	
id	none	Full tree code (GCUCode + TreeCode)	
HV	cm^2 cm^-2	Ratio between wood cross section area (without the bark) and one half of total surface area of leaves.	
SLA	cm² g-1	Specific leaf area, defined as one half of total surface area	
WD	g cm^-3	Calculated Density of the Wood ('Dry weight wood'/'Wood volume').	
Cap_RWC	%RWC MPa-1	Intensive capacitance (water loss per unit branch saturated water content and water potential difference)	
Cap_mass	g H2O g^-1 dry mass MPa-1	Intensive capacitance (water loss per unit branch dry mass and water potential difference)	
Cap_LA	g H2O cm^-2 MPa-1	Intensive capacitance (water loss per unit branch leaf area- defined as one half of total surface area- and unit water potential difference)	
P0	MPa	Leaf osmotic potential at saturation	
TLP	MPa	Leaf water potential at turgor loss point	
%N	%	nitrogen as percentage of leaf tissue dry mass	to be completed
%C	%	carbon as percentage of leaf tissue dry mass	to be completed
d 13C‰	per mil	carbon isotope discrimination (of 13C relative to 12C) relative to universal standard	to be completed
d 15N‰	per mil	nitrogen isotope discrimination (of 15N relative to 14N) relative to universal standard	to be completed

3.2 The dataset file

The dataset file consists of a number of columns, corresponding to the definitions given in the data description file, i.e., country, species, GCU Code, Tree Code, tree id, followed by the variable names.

The file ‘deliverable D2.2.xlsx’ containing the data description and the dataset is available in the official FORGENIUS Repository (Microsoft Teams). Data description and final dataset are given as separate sheets within the file.

4 Conclusions

The dataset provided here presents the first output related to the collection of phenotypic measurements carried out for four of the ten species that will make up the final complete dataset of traits related to leaf economics, wood economics and water relations traits.

5 Partners involved in the work

CREAF, INRAe Avignone. All partners involved in field sampling and collection.

6 Annexes

None.