Improving access to FORest GENetic resources Information and services for end-Users

Deliverable D1.6

Predicting GenRes Forest state

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1 Summary

Two complementary, process-based models were used to predict species-specific indicators of vulnerability to climate change across the entire GenRes collection. The carbon metabolism centered model (Castanea) and the Plant hydraulic model (SurEau), that were previously evaluated across multiple sites (D1.5), were applied to each GCU. The models were forced using (1) climatic data from ERA5Land (0.1°spatial resolution) from 1980 to 2024, (2) species specific parameters previously collected and 3) remotely sensed LAI data.

2 Introduction

Predicting the state of GenRes, in terms of risk related to climate change, can be achieved through vegetation models. A wide panel of models is available. In the FORGENIUS project we chose to focus on two complementary process-based models (PBM), in terms of their plant physiological representation. One model is based on water flow within the plant and is designed to predict the consequences of extreme drought stress of trees (SurEau). A second model is based on plant carbon metabolism (Castanea) and is dedicated to predicting phenological mismatch (e.g. late frost) and long term effect of cumulative stress (carbon starvation). These two models were parameterized and evaluated across multiple sites and species across Europe in previous studies (see deliverables D1.3, D1.4, D1.5). In this deliverable we used these two models to produce a set of five indices representing the GENRES state in terms of risk related to climate changes (Table 1). The two models were initialized using the traits data collected in D1.3, and using the soil data from (Tóth et al. 2017), as well as the climatic data from the ERA5LAND Reanalysis provided by Copernicus. The two models were applied to all GCU with the dominant species targeted in WP2 (see Figure 1).

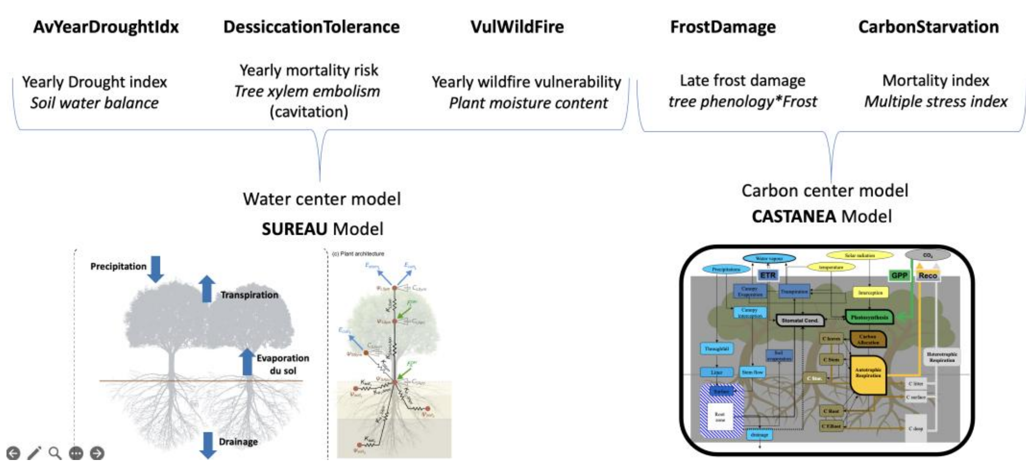

Figure 1: Models used to compute various indicators of GCU state in terms of risk.

Table 1 : Definitions and units of the five indices representing the GENRES state in terms of risk related to climate changes

ID	Identifiers	Indicator name	Short description	Measurement unit	Valid data range
chr_FrostDamage	FD	Risk of frost damage	The simulated fraction of leaf buds killed by one or more frost events during the year		0-1
chr_DessiccationTolerance	PLC	Risk of desiccation during drought	Simulated loss of hydraulic conductance	% loss of hydraulic conductance	0-100
chr_CarbonStarvation	CS	Long term mortality risk	The simulated annual risk of mortality due to different stress (including carbon starvation late frost and drought stress)computed with the Castanea model		0.0 - 1.0
chr_VulWildFire	VulWildFire	Vulnerability to wild fire	The simulated GCU's canopy fuel moisture content which is a key driver of fire ignition and spread if there is an ignition source	g_H2O/g_DryMass	0-300
chr_AvYearDroughtIdx	AvYearDrou ghtIdx	Average yearly drought index	The average of the number of days of the year with the soil relative water content below the threshold of 0.4.		0-365

3 Results

The five indicators were produced for each GCU. An illustration of the five indicators for two different GCU is provided in Figure 2. The indicators for the first four species studied in WP2 were uploaded to the EUFGIS platform. The indicators for the remaining six species are being computed and will be uploaded to the EUFGIS platform by December.

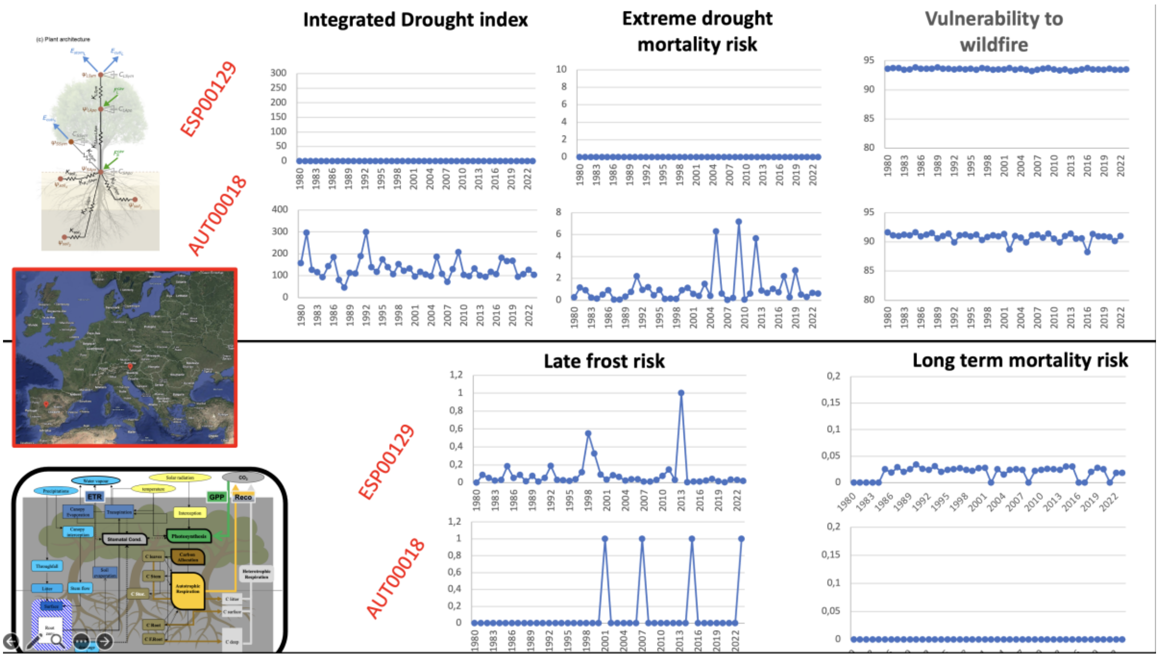

Figure 2 : Illustration of the dynamic of the five indicators for two example GCU (ESP00129 and AUT00018) produced using the two models. The definitions of the indicators are provided in Table 1.

4 Conclusions

The temporal dynamics of the modelled indicators showed consistent patterns. The coarse resolution of the climate data (0.1°) and the poor quality of the global soil database can explain the relatively low correlation obtained when the index were compared with field observations of the tree ring width time series (as illustrated in D1.5). These limitations can be overcome in future using the algorithms developed in the project (D1.4, D1.5) which are under publication (Druel et al. 2025; Druel et al. in prep).

5 Partners involved in the work

INRAE, CREAF, JRC, GIS

6 Annexes

References:

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- Tóth, B., Weynants, M., Pásztor, L., Hengl, T. (2017). 3D soil hydraulic database of Europe at 250 m resolution. *Hydrological Processes*, *31*(14), 2662–2666. https://doi.org/10.1002/hyp.11203.