RiskForBeech

Beech decline risk following the 2018 extreme drought event

Principle investigator: Catherine MASSONNET, UMR Silva

LabEx partners: Guangqi ZHANG (post-doc), Nathalie BREDA, Pierre-Antoine GAERTNER, Joseph LEVILLAIN, Julien RUELLE - UMR Silva

Collaborations: Tony LAROUSSE, Mathieu MIRABEL, Romaric PIERREL, François-Xavier SAINTONGE [Département de la Santé des Forêts (DSF)], Hubert SCHMUCK [ONF], Correspondants observateurs DSF du réseau Hêtre Grand-Est et Franche-Comté [ONF].

Thematic action concerned: WP2

Context **—**

Since 2019, beech forests in the North-East of France have been suffering from massive diebacks in the centre of the species' distribution area (Grand-Est (GE) and Bourgogne-Franche-Comté (BFC) regions). These diebacks cause a progressive degradation of the health of the crowns, sometimes leading to the death of adult trees. This crisis follows the exceptional drought of 2018 which was followed also by recurrent droughts in 2019 and 2020. This unprecedented major crisis in beech offers a unique opportunity to improve our understanding of the vulnerability of beech and the processes involved in both its dieback and resilience to improve our knowledge of the risks for the health and productivity of beech in Europe in response to future climate. The variation of anatomical characteristics of the xylem vessels are known to be associated with extreme soil water deficits. But whether these xylem anatomical parameters could be indicators of tree resistance, recovery or vulnerability remains to be demonstrated.

Objectives **—**

The main objective of the RiskForBeech project will be to have a better understanding of the physiological dysfunctions that cause a tipping point towards death or, conversely, favour the resilience of beech trees. Particularly, the project will analyse the hydraulic performance of trees estimated by retrospective measurements of xylem anatomy on wood cores during 3 periods: pre-drought (2015-2017), drought (2018-2020) and post-drought (2021-2022). Our hypothesis is that xylem anatomy before, during and after extreme climatic stresses would allow us to differentiate trees in the recovery/non-recovery phase of their water function.

Approaches —
In 2019, a network of 30 semi-permanent plots with15 trees per plot with contrasted crown condition was set up by the DSF to monitor the evolution of the health status of beech stands in the GE and BFC regions for 5 years. Since 2019, the DSF has noted the annual crown condition. From this network, a sub-sample of 4 plots has been selected with contrasting level and trends in leaf deficit evolution from 2019 to 2022 (worsening or stabilisation and with low or high leaf deficit level). In 2023, we will take cores at 1.3m from the 60 trees of these 4 plots. After cutting with a microtome, staining the tissues, the anatomical characteristics of the last 10 rings (2 rings before crisis, 3 rings during dry years and 2 rings after) will be observed under the microscope. Vessel size and density will be measured to calculate the specific hydraulic conductivity and potential hydraulic conductivity of the tree for each ring selected. These results will also be compared with growth data thanks to a dendrochronological study carried out in parallel on the same trees by a PhD student (Pierre-Antoine Gaertner) in partnership with the WSL (Switzerland). Soil descriptions of the plots will be carried out in order to parameterize the Biljou water balance model in order to retrospectively characterize the soil water deficits in the various plots.

Key results —
The project has just begun with the arrival of Guangqi Zhang, post-doctoral fellow in charge of the project, recruited from 1/12/2022. A Master 2 student, Nicolas Steil, will also participate to the project from 1/02/2023. The post-doctoral fellow's first task was to analyse the DSF leaf deficit data acquired over the period 2019-2022 on a sub-sample of 18 plots initially selected by Pierre-Antoine Gaertner (doctoral student studying carbohydrates reserves as part of the Labex Dephetre project). The 18 plots showed a gradient of changes in leaf deficits between 2019 and 2022 ranging from a strong deterioration (+33% average leaf deficit for the most deteriorating plot) to stabilisation or even slight improvement (-10% average leaf deficit for the most favourable plot). Four plots (60 trees) were selected within this gradient avoiding plots with too many dead trees during the period to have enough trees to core.

Main conclusions including key points of discussion —
At this stage of the project no conclusion.

Perspectives —
- After coring the selected trees for the study in February, the quantitative anatomical analysis will start within the SILVATECH platform.
- Quantification of water deficits on each plot by retrospective water balance modelling (Biljou©) after a description of the soil properties of each plot.
-Correlation of the anatomical parameters with the dendrochronological data.

Valorization —
Not yet.

Leveraging effect of the project —
- Co-funding from the region Grand-Est has been obtained for 6 months of Guangqi Zhang's post-doctorate.
- This project was initially planned with Swiss co-funding (SwissForestLab) but unfortunately it has not been accepted on the Swiss side. It has nevertheless allowed the development of a collaboration with a Swiss team from WSL (Georg Von Arx and Yann Vitasse) in the framework of the research project of the PhD student Pierre-Antoine Gaertner, whose work could also be used by Guangqi in the RiskForBeech project.