PHD POSITION OFFERED IN FOREST ECOLOGY

« Functional diversity of forest stands and resistance to droughts »

SUMMARY

Climate change is causing more frequent and intense droughts. Forest ecosystems are impacted by these recurrent droughts and are currently showing declining productivity and increasing mortality. Several factors are thought to modulate the negative effects of these disturbances and thus increase the resistance and resilience of forests, notably functional diversity — the variability of functional traits — and structural diversity — the degree of irregularity in the vertical structure of the stand. Revealing the potentially increased resilience of functionally and structurally diverse forests to drought would allow adapting management practices to climate change. The research conducted in this PhD will mainly draw on existing datasets (National Forest Inventory, TRY, etc.).

CONTEXT and OBJECTIVES

Climate change leads to an increase in the frequency and intensity of drought episodes (e.g., 2018–2019, 2022). These droughts have led to a decline in forest productivity and increased mortality in France and Europe (Ciais et al. 2005). Furthermore, the effects of these droughts are exacerbated by extreme temperatures (Van der Woude et al. 2023) as well as by pest outbreaks (Pirtskhalava-Karpova et al. 2024).

Several solutions for adapting forest ecosystems have been identified in order to mitigate their sensitivity to drought, including increasing stand complexity in terms of (i) species composition (multiple species exhibiting a range of functional diversity and coexisting in mixed stands), and (ii) vertical heterogeneity (irregularity in stand structure) (Pickering et al. 2025). However, several studies have shown that the effects of species diversification on the resistance of forest stands to drought are not universal and depend on numerous factors (e.g., Grossiord, 2019).

This PhD project aims to study the effect of the functional and structural diversity of forest stands on their resistance and resilience to drought across France, and particularly in the “Grand-Est” region, over the period 1980–2025, with data from the French National Forest Inventory (IFN). The detailed objectives of the proposed work aim to answer the following questions:

1. What is the functional diversity (e.g., Rao Index) of tree species in forest stands? While the botanical identification of tree species in the IFN plots is well established, no study currently exists to describe the level of functional diversity in these plots.

2. What is the level of complexity of forest stands in terms of structure (e.g., Gini Index)? Are there gradients of complexity associated with the different forest stands found in France? Does the type of forest management [public/private management, lack of management (e.g., Parks, Integral Reserves, etc.)] restrict or accentuate this complexity?

3. What is the impact of stand complexity (functional composition, stand structure) on the response of forests (in terms of growth and mortality) to the extreme droughts encountered over the last four decades? We will quantify potential synergies or, conversely, potential trade-offs.

This project will highlight the types of functional mixtures and stand structures that allow for greater resistance and resilience to drought. It will contribute to identify forest management practices best adapted to climate change for the forests in western Europe.

This project involves the use of concepts from functional ecology, community ecology (analysis of interactions between tree species), and forestry. It is therefore inherently interdisciplinary. This work will have direct applications for forest management practices.

METHODS

This PhD work will be primarily based on the analysis of existing data from the French National Forest Inventory (IFN) and from tree species functional trait databases. It will also involve delineating, both spatially and temporally, the extreme drought events observed in climate records and using the ©Biljou water balance model over the study period.

The PhD supervisors already have access to all the data on growth, mortality, number of species, etc., from the IFN. The PhD work will begin by compiling climate data and the functional characteristics of the species (e.g., TRY databases). It will then involve using statistical data analysis models to answer the research questions.

TEAM

The PhD project is jointly supervised by D. BONAL (Senior researcher INRAE, Silva research group in Champenoux, France) and L. HERTZOG (Junior researcher IGN, LIF research group in Nancy, France). This joint supervision allows for the combination of complementary expertise and research disciplines around a common research question. Partners from other French research labs (Montpellier, Grenoble) and the French National Forest Service will also bring their expertise to the project and participate in working meetings and the PhD monitoring committee (once a year).

PhD SUPERVISION

PhD Advisor: Damien BONAL, HDR, Senior Scientist in Functional Ecology, INRAE, UMR SILVA in Champenoux, France.

Co-PhD supervisor: Lionel HERTZOG, Junior scientist in Monitoring and Forest Ecology, IGN, USC LIF in Nancy, France.

CANDIDATE PROFILE

The candidate should hold a Master's degree (or equivalent) in ecology, forest, environmental sciences, or in a related field. The candidate should demonstrate strong quantitative and computational skills, with experience in handling large datasets and performing statistical analyses. A good level of English is expected while knowledge of French is not mandatory but a willingness to learn will be an asset

Salary and Conditions:

36-month contract with 2,200 € gross/month. All lab and travel expenses covered by funded projects. Further advantages linked to the position can be found at: https://guide-for-international-scientists.inrae.fr/working-at-inrae/10-reasons-to-join-inrae/healthly-working-conditions/

TO APPLY

Send your application to damien.bonal@inrae.fr and lionel.hertzog@ign.fr with email subject: "Application for PhD DIFOREST Project" and the following documents:

- (1) Motivation letter
- (2) Detailed CV with 1-2 reference contacts
- (3) Grades of Master or Engineer degree and copy of Diploma (when possible)

DEADLINE TO APPLY: 28th of June, 2026.

BEGINNING OF THE PhD CONTRACT: 1st October 2026.