Holistic modelling of ecosystem services provided by forest landscapes under multiple perturbations

Duration: 24 months, ideally from 1 March 2024 – 28 February 2026

City: Montpellier, France

Institute and lab: INRAE (National Research Institute for Agriculture, Food and Environment (INRAE) - UMR AMAP (botAnique et bioinforMatique de l'Architecture des Plantes)

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Salary: c.a. 2200€/month (net)

Project: Horizon Europe eco2adapt - Grant ID: 101059498
(https://cordis.europa.eu/project/id/101059498; https://eco2adapt.custom.hub.inrae.fr/)

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Potential collaborators: other members of the eco2adapt project

Desired candidate profile

- Holding a PhD with a strong background in ecological modelling, programming and/or data analytical skills
- Clear communication in English in both spoken and written forms
- Good interpersonal skills needed for teamwork
- Knowing social approaches, including interviews and surveys will be a bonus, but not essential
- Speaking French or Chinese will be a bonus, but not essential

Project description:

Forest landscapes are generally complex socio-ecological systems, with spatially heterogeneous land covers and multifaceted interactions involving biological, economic and socio-cultural processes. Forest landscapes support large populations and provide a large bundle of ecosystem services. In the era of global changes, with intensifying perturbations (e.g., droughts, fires) and associated cascading effects (e.g., insect epidemics following drought stress), it becomes critical to understand the resilience of forest landscapes and to predict the fate of multiple ecosystem services as a function of contrasted management scenarios.

Facing such a challenge, modelling is widely considered to be an effective way of addressing questions related to multiple ecosystem services and their dynamics. A commonly used modelling approach is to couple several quantitative models, each of which allowing one or more services to be assessed independently. However, one of the main drawbacks of this approach is that it may not adequately take into account the potentially close interdependencies between these services. Recently, network-based models have become increasingly popular and are seen as a promising alternative for dealing with multiple ecosystem services. The latter approach represents a complex landscape into a simplified network, in which the associations between ecosystem services can be grasped more holistically.

This postdoctoral project aims to **explore the potential of an existing network-based model, namely DORIAN, in the case of multiple ecosystem services** (Mao et al. 2021). DORIAN is a discrete-event model that computes the dynamics of any socio-ecological system in the form of an ecosystem (interaction) network composed of two elements: (i) discrete objects ('nodes'), which correspond to concrete (e.g., a forest, a village, etc.) or abstract (e.g., a season) components of a system, and (ii) discrete rules ('edges'), which mimic biophysical and/or socio-ecological processes (Gaucherel et al. 2019). Each node has a binary and qualitative state: 'On' or 'Off'. The appearance or disappearance of some nodes, or the appearance or non-occurrence of some edges, can lead to the appearance, maintenance or disappearance of one or more ecosystem services along to the computed system trajectory. This ecosystem network is defined using a formalism derived from theoretical computer science (i.e., Petri nets and some logics).

In the framework of the eco2adapt project, the model will be tested in two Living Labs (LLs):

(i)   the Bordeaux pine plantation in France (in collaboration with Dr. Hervé Jactel's group) and/or
(ii)   the Mulan forest in China (in collaboration with Prof. Shuirong Wu's group).

Each of the two Living Labs hosts a forest-based socio-ecological system that provides multiple ecosystem services and is exposed to one or more perturbations linked to global changes. In each LL, **social studies including interviews and surveys** will be conducted to fully understand the context of the forest-based socio-ecological system and to identify possible management scenarios. Then, a holistic modelling will then be carried out for the targeted system to test the impact of the multi-risks and management scenarios on the future of the whole system and its associated ecosystem services. Via the modelling work, the postdoc is expected to (i) **standardize the use of discrete modelling in the case of ecosystem services**, and (ii) **produce a set of computed dynamics for the studied forested landscapes**.

References

Gaucherel, C., Pommereau, F. (2019). Using discrete systems to exhaustively characterize the dynamics of an integrated ecosystem. *Methods in Ecology and Evolution*, *10*(9), 1615-1627.

Mao, Z., Centanni, J., Pommereau, F., Stokes, A., Gaucherel, C. (2021). Maintaining biodiversity promotes the multifunctionality of social-ecological systems: holistic modelling of a mountain system. *Ecosystem Services*, *47*, 101220.