Fire-related plant traits and ecosystem recovery

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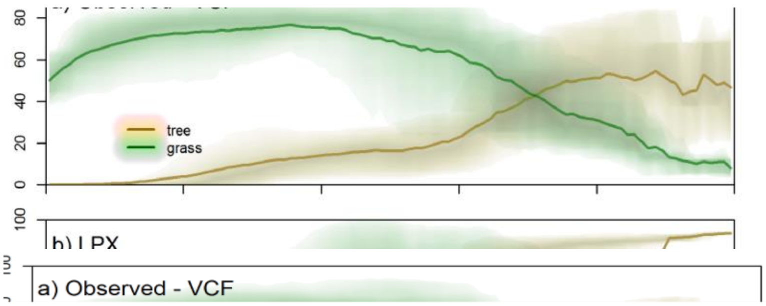
Wildfires are the major cause of disturbance in ecosystems, with both positive and negative impacts. Wildfire plays an important role in resetting succession and maintaining spatial heterogeneity and biodiversity. Wildfire is fundamental for the continued existence of some vegetation types, including savannas. At the same, wildfire is a destructive force, implicated in the loss of biodiversity in some ecosystems and as a driver of permanent shifts in vegetation type. Climate conditions promoting wildfire are predicted to increase over the 21st century. Understanding the impact of future changes in wildfire regimes on ecosystems is important not only in terms of biodiversity but also to be able to predict the consequences for the carbon and other biogeochemical cycles and hence fire feedbacks to climate. Coupled vegetation-fire models can be used to predict the trajectory of future fires. However, the vegetation component of these models was not designed to simulate fire-adapted vegetation.

Many woody species in fire prone regions exhibit traits that enable them either to resist or to survive wildfires. Traits such as thick bark allow trees to resist the damage; the ability to resprout after fire allows trees to recover quickly and again reduces population loss. Some plants have traits, such as seed dispersal only after fire or heat-stimulated germination, that capitalise on wildfire events to promote more successful competition with other plants. Some plants exhibit traits that are thought to promote fire, such as the production of volatile oils or branching structures that promote ladder fuel, again as a strategy to promote successful competition. There has been little systematic evaluation of the environmental controls that determine the geographic distribution of these traits, and so we have little understanding of how this might change in the future as extreme wildfire events become more common. Furthermore, there has been no investigation of how the deployment of these traits affects the speed of ecosystem recovery after fire events. Improvements in our ability to model the consequences of future fire regimes is crucially dependent on incorporating these two phenomena in vegetation-fire models.

The overarching goal of this project is to develop a theoretical model of plant behaviour in response to environmental gradients, including the incidence of fire, that can be used to predict the impact of fire on ecosystems. Large-scale data analysis and advanced statistical techniques will be used to relate the presence and relative importance of specific plants traits to environmental factors, fire frequency, and fire type, drawing on existing data resources such as the BROT and TRY databases. Eco-evolutionary optimality theory will be used as a basis for relating carbon investment costs to frequency of stresses related to fire disturbance in different ecosystems. Remotely sensed data will be used to reconstruct post-disturbance recovery rates in different ecosystems and as a function of the relative importance of different fire-related traits; this will likely involve combining multiple products (e.g. surface reflectance and albedo, Leaf Area index, vegetation optical depth, L-band radar) to map recovery of canopy cover and total biomass after known fire events. The new model will be exercised globally by coupling it to an existing model of primary production (the P model) embedded in a simple fire prediction scheme developed from the INFERNO model. This will provide the opportunity to examine the global consequences of changing fire regimes during the historic period and in response to future scenarios of climate change.



Observed abundances if resprouting (RS) and non-resprouting (NR) trees along an aridity gradient measured by the ratio of actual to potential evapotranspiration (ET) in Australia.

Training opportunities:

The. student will be embedded in the Leverhulme Centre for Wildfires, Environment and Society and have the opportunity of regular science meetings and training with the cohort of fire scientists working in the Centre. Since the project is partially funded from the Lemontree project, an international consortium working on new approaches to modelling the terrestrial biosphere, they will also attend monthly (virtual). science meetings of that project. They will be seconded to work at Assimila for a minimum of three months to gain experience in the processing and interpretation of remote-sensing products, both for use in their project and in a commercial context.

Student profile:

This project is suitable for students with a degree in physics, biology or environmental sciences. Good quantitative skills and programming experience in R or Python would be required. Experience with handling large data sets and advanced statistical techniques would be beneficial.

Funding particulars:

The project would be funded 50% from the Leverhulme Centre component of the Lemontree proposal.

https://research.reading.ac.uk/scenario/