Constraining the carbon balance of tropical forest landscapes

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Intact tropical forests play a key role in determining the rate of climate change, as they can act as either a significant sink, or potentially source, of carbon. Data from long-term forest inventory plots indicate that over recent decades, these ecosystems have acted as a carbon sink [1-3], but this has been greatly reduced during drought events [4].

In Amazonia, a key issue is how to extrapolate the estimates of the carbon balance of forest plots to estimate the carbon balance of tropical forest landscapes. In particular, approaches are required that simultaneously integrate spatial variation in sink strength and disturbance and recovery processes. The development of these methods is important to encourage uptake of the finding of a carbon sink within intact forests within a national and international policy context. The aim of this PhD is therefore to link analysis of ecological and remote sensing data to improve estimation of the carbon balance of intact tropical forest landscapes, and insert the methods and results within national reporting of carbon emissions in tropical forest countries.

Depending on the interests of the candidate, the project could involve:

- New ecological analysis of spatial and temporal trends in the carbon balance of Amazonian forest plots, as a basis for improved extrapolation of its strength. For example, analyses could explore how forest carbon balance varies regionally and with variation in forest structure, soils and climate [5], in relation to indexes of fragmentation such as the distance to the nearest forest edge [6], or in relation to known sites of historical human occupation [7]
- Novel evaluation of existing and emerging remote sensing products that aim to measure the carbon balance of intact forests [8, 9], including consideration of appropriate statistical methods to cross scale-gaps between remotely sensed and plot datasets
- Integrating plot and remote sensing datasets to develop new products to estimate landscape-level carbon balance that extrapolate sink strength spatially and incorporate the contribution of disturbances [10], degradation and the dynamics of secondary forest regrowth [11]

A key impulse behind this project is to improve national-level accounting of carbon in tropical forests. This aspect of the project would be focussed on existing strong collaborations with government organisations in Peru, including the Peruvian Protected Areas Authority (SERNANP) and the Ministry of the Environment (MINAM). We estimate that intact Peruvian forests act as a substantial carbon sink

(0.88 Mg C ha^{-1} a^{-1} (1990-2017; [12]), which is equivalent to 16.4 million tonnes of carbon in the protected areas of the region – twice the annual national emissions of fossil fuel in Peru in 2005 [13]. Currently, this flux is not included in national communications to the UNFCCC by Peru; in fact, intact forests are explicitly considered to be carbon neutral (p. 74 in [13]). Developing and integrating methods and results to achieve this step is envisaged as a key impact of this project, and would set an important international precedent amongst tropical forest nations, and provide comparable or exceed levels of reporting to the UNFCCC by the UK and USA [14, 15].

The supervisory team leads successful projects and collaborations to support this new research project, including the RAINFOR network, the ForestPlots.net initiative to collate forest dynamics data from across the tropics and the analysis of remote sensing products to assess the carbon balance of Amazonia. The team also has close existing links to Peruvian institutions as a result of an on-going initiative to monitor the health of forest in protected areas, funded by the Gordon and Betty Moore Foundation. You will have the opportunity to interact extensively with collaborators and stakeholders across Amazonia, during the project.

Is this landscape a source or sink of carbon?

Fit to NERC Science

The project closely fits within the Terrestrial and Freshwater environments research area of NERC under the Ecosystem-scale processes and land use research subject.

Potential for high impact outcomes

This project addresses a key question concerning the science of global environmental change, and the team has a strong record of high-impact publications including on carbon storage and sequestration. This project responds to the challenge to use high quality science to achieve substantial policy impact; such opportunities for impact are highly valued component of researchers' portfolio of activities.

Training

The student will work closely with the supervisory team at University of Leeds. Training at Leeds will include analysis of remote sensing images using Google Earth Engine, the management and analysis of ecological datasets, and field observational techniques, as well as guidance in developing equitable professional relationships with collaborators. The candidate would also have opportunities to join on-going fieldwork expeditions to re-measure existing forest plots in Amazonia, as well as designing their own fieldwork to validate remote sensing data, as appropriate. The Ecology and Global Change group in the School of Geography at Leeds, where the student will be based, is a dynamic world-leading group focusses on tropical ecology, biogeochemical cycling and global change.

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