Title:
PANTROPOCENE Earth System Simulations of Past Human-Forest-Climate Interactions in the Philippine Archipelago

Principle Investigator: Dr. habil. Patrick Roberts
Post-Doctoral Researcher: Dr. Sebastian Los

Tropical forests play critical roles in the operation of different parts of the Earth System as major components of the carbon cycle, as sources of water vapour, clouds, and precipitation, and modulators of aerosols and trace gases. These forests also host some of the most biodiverse ecosystems, support large and growing human populations, and provide sources of food, economic opportunity, and important products used globally. High rates of current forest loss and degradation therefore have serious and far-reaching implications for the climate, global biodiversity, food security, and geopolitics.

Despite previous notions of limited habitability for humans, it has become increasingly clear that tropical forests have been a key setting for hominin evolution and the development of human societies. In addition to simple land-clearing, growing evidence points to complex prehistoric and historic and human-forest interactions through various hunting, gathering, agroforestry, farming, and settlement practices. Recent studies have also called attention to the impacts on tropical forests of colonial arrival and expansion through the import of new flora and fauna, scaling up of extractive land-use practices, and severe impacts to native human populations. Earth system modelling work for tropical forest ecosystems has shown complex, scale-dependent feedbacks on precipitation, soil stability, and forest extent. The details of human influences on these feedbacks, particularly for past forest-human interactions, remain underexplored, but are important for discussions defining the Anthropocene and for informing current and future forest management practices related to biodiversity protection and carbon sequestration efforts.

PANTROPOCENE is an ERC-funded project studying the degree to which combined pre-colonial and colonial impacts on tropical forests across the bounds of the former Spanish Empire, initiated changes to climate, geomorphology, and the atmosphere. The modelling work described here is a component of PANTROPOCENE tasked with implementing archaeologically- and historically-derived maps of forest cover and land use within earth system models to study the environmental response of various human influences in tropical forests. We focus here on landscape maps of the Philippines recently compiled by the project. The archipelago, though less studied than other Spanish influenced areas in the Neotropics, presents a diverse evolution in human land-use from pre-colonial introduction of rice-cultivation and swine, to the impact of Spanish colonial culture and arrival of neotropical plant species, to the development of large-scale plantations and later industrial forestry practices during the later Spanish period into the American period.

For this modelling effort, our first phase is to begin with a series of WRF atmosphere-only simulations testing the response of the regional climate to various levels and patterns of deforestation through time from recently produced Philippine forest cover estimates. The next phase will be to run simulations for a sequence of land cover maps of the archipelago spanning four characteristic pre-colonial to late-Spanish periods. These land cover maps are based on maps of human land-use categories developed to model multiple collocated uses and impacts. Finally, we plan to conduct a series of simulations using these land cover maps for differing surface-atmosphere coupling configurations to investigate the sensitivity of the regional environment to these multifaceted human-forest relationships.