

## People, forest use and biodiversity on islands

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Small island states comprise some of the world's poorest countries and are often home to extraordinary levels of endemic biodiversity at substantial risk of extinction. The underlying causes of both are somewhat interconnected, including limited access to natural resources and isolation, from markets, wealth, sources of genetic variation. In such circumstances, environmental and societal changes may be especially problematic if native forest and biodiversity are to be retained. Islands have been used as model systems in ecological and biodiversity conservation theory and practice. Nevertheless, island flora and fauna are also exceptionally vulnerable to extinction, with almost 90% of all recorded extinctions of birds having occurred on islands. Habitat loss, overexploitation and introduced species are among the reasons most frequently cited for such declines. Habitat loss can be especially critical on islands, where the total amount of available habitat is constrained by geography.

The studentship will focus on the feedbacks and trade-offs across environmental and societal factors and how they interact to both shape, and be shaped by, the unique geography and biodiversity of small islands. In particular, the studentship will take an interdisciplinary approach to understand how the links between forests, biodiversity and society vary in time and space, assessing the role of people with varying dependencies on forest resources (e.g. rural dwellers vs urban residents) and taking into account forest traits such as structure, function and biodiversity.

While each island state is unique, the studentship will be based in the island nation of São Tomé and Príncipe, identifying patterns that might be relevant globally. São Tomé and Príncipe is the second smallest country in Africa, and is classified as a 'Least Developed Country', lying 142<sup>nd</sup> on the United Nation's Human Development Index. Almost 90% of the country is forested, with over a quarter of this is native (Jones et al. 1991). The importance of its biodiversity in the global context has long been recognised, mostly due to the high number of endemics (Buchanan et al. 2011; Collar and Stuart 1988; Le Saout et al. 2013). Some 29 birds, 19 butterflies (Mendes and Sousa 2012), 49 snails (Gascoigne 1994) and 107 flowering plant species (Figueiredo et al. 2011) are found nowhere else. The levels of endemism are exceptionally high, both in the proportion of the total number of species and considering the area of the islands – outstripping “poster-child” biodiverse island systems such as Mauritius, and the Galapagos Islands. Despite this, we still know little about the populations, distribution and ecology of the endemic species (but see (Dallimer et al. 2009; de Lima et al. 2013), or forest structure and function. Fortunately, large areas of the islands retain native and old-growth forest cover, and protected areas are legally in place since 2006. However, demand for agricultural land is increasing, as is that for timber and non-timber forest products. Much of

this is spurred by a rapid increase in the human population, which stands at about 200,000 and is predicted to grow rapidly at a rate of 3.6% per annum in the coming decades.



Figure 1. The forested mountainous interior of São Tomé island.

The forests of São Tomé and Príncipe (Figure 1) have been, and still are, shaped by human influence, such as the extraction of timber and non-timber forest products and the impacts of introduced species. Changing societal needs, including rapid population growth, expansion of agriculture and agro-forestry, requirements for protein and demands for timber are radically altering the forests across the islands, which will affect forest structure and diversity, but also forest functions and the ecosystem services that they can provide. Untangling the complex relationships between forests, environmental change and societal dependence on forests is thus a key challenge.

Depending on interests, the studentship could consider any or all of the following topics:

- (i) Forest resilience to societal pressures
  - Historical temporal elements: In contrast to many tropical regions, São Tomé and Príncipe has an exceptional historical record of land-use changes, since it was discovered by the Portuguese in the late 15th century. This studentship could make use of this record, alongside archival material and remote sensed imagery to identify patterns of forest loss and gain, risks of future forest loss and the resilience or vulnerability of particular forest types and biodiversity to environmental and societal stressors (e.g. (Willcock et al. 2016).
  - Seasonal temporal elements: Present-day forest resource use is strongly seasonal, with timber extraction taking place mostly in the dry season while snail harvesting occurs mostly during the rains. Using a range of remote sensed imagery, field gathered forest structure, function and biodiversity metrics (e.g. species richness, functional diversity,

abundance of endemic species), historical archive material, semi-structured interviews and household questionnaires, the studentship will examine the feedbacks and interactions between seasonally varying forest traits, ecosystem service provision and human activities.

(ii) Quantifying the use of, preferences for and values associated with forests across a land use and urbanisation gradient

The studentship could quantify and identify relationships between: (1) the use of, and demand for, timber and non-timber forest products across a gradient of urbanisation (e.g. (Ahrends et al. 2010); (2) the prevalence of urban, peri-urban and rural agriculture, and (3) appropriate monetary and/or non-monetary values and preferences that the population of São Tomé and Príncipe may have for endemic and non-endemic biodiversity, habitats and landscapes (e.g., (Dallimer et al. 2012; Dallimer et al. 2014a; Dallimer et al. 2014b). By stratifying sampling spatially across biophysical land-uses, as well as socio-demographic groups, the studentship will quantify spatial variation in usage of, and values for, biodiversity and forest structure/function and thus be able to relate these to temporal patterns identified under (i).

(iii) Scenarios and global implications

Understanding the past and present can be pre-requisites for projecting into the future, and if São Tomé and Príncipe's unique biodiversity and forest ecosystems are to be conserved, an awareness of likely future scenarios for the island will be essential. The studentship could use a variety of approaches to forecast likely scenarios for São Tomé and Príncipe, drawing on (i) and (ii) as well as linking to Small Island States and forest conservation globally, examining questions such as:

- What lessons can be learnt from environmental and societal change trajectories in other Small Island States? Using a range of remote sensed imagery, secondary data and the available literature, the student could examine common patterns of land use change, societal development and forest/biodiversity loss across a suite of Small Island States.
- Under locally stakeholder-developed scenarios of development, how might land use, forest cover and the status of endemic biodiversity alter in the coming decades? How might policy and practice across multiple sectors act as barriers or enablers to forest and biodiversity conservation?
- How might island systems be used as models for understanding processes that operate in forests globally?

## **Data**

Some biodiversity datasets, along with historical material on land use and agricultural production exist for São Tomé and Príncipe within GIS, but the student will have the opportunity to extend these, for instance by building on the existing high quality avian datasets with additional taxonomic groups, or focussing on native and introduced tree species. Similarly, the addition of more recent remote sensed data on forest type, structure and change will be a valuable extension to the current knowledge base.

## **Fieldwork**

If desired, the studentship will have substantial opportunities for fieldwork, funded through the NERC DTP research allowance. During their time in the field, the student would be working closely with Dr Lima and his team, as well as experienced and knowledgeable local forest and biodiversity experts from ECOFAC and Associação Monte Pico. A good knowledge of Portuguese will be essential. If required, the student would be able to spend time in Lisbon to improve their language skills prior to any fieldwork.

## Research groups

The student will have the opportunity to discuss their work within the Environment and Development Research Group in the School of Earth and Environment, as well as with the Ecology and Global Change research cluster in the School of Geography. This represents an exceptional opportunity to gain expertise and training from across multiple disciplines.

## References

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