

Ecosystem services under uncertainty about future climate in Central African forests (ESAF)

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Biological and Environmental Sciences, University of Stirling

In partnership with Centre for Ecology and Hydrology

Supervisory Team

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Key Words

1. **Ecosystem services, climate change, structured decision making, African forests**

Overview

A funded PhD project is available in the Stirling Conservation Science group exploring uncertainty in the provision of services from forest ecosystems as a result of future climate change and its effects on biodiversity and human livelihoods. One of the main applied and interdisciplinary challenges for a sustainable future is uncertainty in environmental change leading to a range of undesirable outcomes such as species extinctions, increased poverty and reduced food security. This project will link large-scale climate predictions and land use change to regional and local decision-making scenarios to aid adaptation to a changing world. We will use the tropical forests in Gabon in Central sub-Saharan Africa as a case study, an area that is high in biodiversity but has been subject to large-scale exploitation of timber and non-timber forest products including bushmeat. Gabon is currently actively engaging with policy solutions to reconcile preservation of, and enhanced access to, sustainable ecosystem services, including carbon storage, with predicted long term growth in its currently natural-resource based economy. This studentship will help to develop a framework to make decisions under environmental uncertainty to improve livelihoods among the rural poor and to conserve biodiversity.

Methodology

Climate change and ecosystem services

There is currently great variation in predicted climate change among different global models and scenarios and as one downscales these predictions to regional climate models or finer, this variation is increased.

There is little explicit work on the mechanisms by which climate change may affect the provision of local or global ecosystem services, especially in the poorer parts of the world. In particular, there is a need to know how changes in climate will affect the supply of a range of ecosystem services, which are important to local human livelihoods.

Change to ecosystem service supply and demand will happen by climate altering: a) a variety of 'bottom up' biological processes at a range of scales; b) human land use patterns; and c) human needs for specific services as populations change and/or alternative services decline.

This project will use existing data from long-term socio-economic surveys in Gabon and parallel long-term data on local climate and forest dynamics, to understand the link between climate, provision and use of ecosystem services and human livelihoods. Dealing with uncertainty in climate change projections is key to useful analyses and models of ecosystem change. Ecosystem service models, such as ARIES <http://www.ariesonline.org/>, link abiotic and biotic variables to project the provisioning of ecosystem services in particular locations under alternative scenarios. Uncertainty in future climate models means that these outcomes are not alternatives but are rather within the range of possible outcomes and need to be modelled as such. The ARIES models beneficiaries of these services and has a Bayesian underpinning, which can be used to quantify uncertainty in projections. Decisions about responses at the level of individuals and institutions can therefore be informed by having a grasp of this uncertainty and a consideration of which decisions are best able to encompass the range of possible futures.

Individual decision-making

Climate change will lead to increased variation and uncertainty in natural resources and ecosystem services which drive change in local livelihoods, leading to yet further pressure on the natural environment and biodiversity. For example, natural resources (wildlife, agricultural production) can be impacted by stochastic variability of the ecosystem (e.g. weather, climate) and from unregulated use of natural resources. As a result, conflicts emerge between actions focused on maintaining and improving livelihoods and those focused on biodiversity conservation. Therefore, in theory as in reality, uncertainty from various sources can cause shifts in the benefits humans derive from natural resources, increase risks of loss of livelihoods and lead to increased poverty. Changes in supply of services then need to be related to changes in demand, as beneficiaries will have different needs under a changing climate and will employ different coping strategies. We will use the ecosystem services concept and structured decision-making methods to provide insights into how people respond to changes in climate and ecosystem services.

The key scientific advancement of this project will be to develop a framework that combines detailed understanding of the ecological dynamics of the system under climate change, the ecosystem services it provides and decision-making by stakeholders (local people, conservation organisations, managers, local and state authorities). The overall aim of the project will be to build resilience to climate and environmental change by empowering people with evidence based decisions making tools that can take a range of uncertainties into account.

Timeline

Months 1-6: Literature review of ecosystem services, climate change models, sustainable use, decision theory. Review of data available to parameterise the ARIES model, evaluate precision and accuracy, identify key gaps.

Months 6-12: Build a conceptual and mathematical model of ecosystem services under environmental and climate change using ARIES.

Months 12-18: Collate existing data on local people decision making in relation to ecosystem services under environmental and climate uncertainty and fill gaps with a local survey in Gabon.

Months 18-30: Enhance the ARIES model of ecosystem services and decision making, under uncertainty

Months 30-42: Communication of results to and discussions with stakeholders and writing up of thesis.

Training & Skills

The project will provide interdisciplinary training and skills on:

- Simulation modelling of ecosystem services and decision making;
- Developing, carrying out and analysing ecosystem services questionnaires;
- Approaches to quantify uncertainty and risks in climate change and conservation;
- Effective ways of tackling and minimising risk and communicating these strategies to decision-makers;
- Developing methods and approaches to identify objectives, indicators, monitoring approaches for conservation decision-making;
- Communication with stakeholders and policy makers.

References & Further Reading

Bunnefeld, N., Hoshino, E., Milner-Gulland, E.J. (2011) Management strategy evaluation: A powerful tool for conservation? *Trends in Ecology and Evolution* 26 (9): 441-447.

Bullock, J.M., et al. (2011) Restoration of ecosystem services and biodiversity: conflicts and opportunities. *Trends in Ecology and Evolution* 26: 541-549.

Huntingford et al (2013) Simulated resilience of tropical rainforests to CO₂-induced climate change. *Nature Geoscience* 6: 268-273.

Abernethy KA, Coad L, Taylor G, Lee ME, Maisels F. 2013. Extent and ecological consequences of hunting in Central African rainforests in the twenty-first century. *Phil Trans R Soc B* 368: 20120303.

Further Information

The supervisor team is highly interdisciplinary and is part of a strong network of academics, NGOs and governmental agencies.

Nils Bunnefeld (nils.bunnefeld@stir.ac.uk, www.sti-cs.org) combines ecology, social science and economics to develop approaches and models to achieve ecological as well as socio-economic sustainability in natural resource use systems

James Bullock carries out inter-disciplinary research into the links and conflicts between biodiversity conservation and management for ecosystem services in Europe and Africa using field studies and modelling

Chris Huntingford is a climate modeller and specialises in climate modelling, including translating projections to ecological impacts, both locally and their implications for the global carbon cycle.

Katharine Abernethy is an ecologist based in Gabon, carrying out research on ecosystem function to support innovative conservation policy integrating viable wildlife communities, ecosystem services and sustainable economies.