ESAPP HIGHLIGHT 21

Carbon sequestration in Madagascar's forests

Global initiatives such as the United Nations' REDD+ programme hold great promise in harmonizing action towards sustainable forest management. But their success or failure in developing countries often hinges on local capacity and the availability of methods that may be adapted to local conditions. In Madagascar, ESAPP helped foster local expertise and develop transferrable methods for estimating carbon sequestration and forest cover change.

Main messages

- Sustainable forest management requires detailed, accurate, and up-to-date information on forest cover change, forest degradation, and forest carbon storage. This can only be achieved by developing or adapting methods that are adjusted to local contexts and forest types.
- Allometric equations adapted to the local context are essential for accurately estimating carbon stocks. Similarly important are methods of assessing forest cover, degradation, and deforestation using remotely sensed data.
- Young, local scientists in the global South should be supported to become experts in their fields. Local centres of research excellence, headed by home-grown talent and internationally renowned experts, are crucial to sustainable development.

Sustainable development challenge

The basic principles of sustainable development are universal, so it might seem natural to create globally applicable sustainability initiatives. However, each place has its own bio-geographical, economic, social, and political characteristics, making it difficult to apply sustainability initiatives the same way everywhere. The United Nations' Reducing Emissions from Deforestation and Forest Degradation (REDD+) programme is a good example. REDD+ was designed to attach a financial value to carbon stored in forests and enable compensation for forest preservation, thus incentivizing developing countries to reduce emissions from deforestation. Unfortunately, difficulties in adapting the mechanism to local realities often hamper its implementation.

Madagascar's forests are among the most biologically rich ecosystems in the world, but massive deforestation and degradation have eroded their species diversity. Recent national estimates suggested rates of annual forest loss of 0.83 per cent between 1990 and 2000, and 0.53 per cent between 2000 and 2005 (Rasolohery and Steininger 2008). However, observers say these figures overlook forest degradation caused by selective logging. To sustainably manage Madagascar's forests and properly implement REDD+, it is important to know the spatial distribution of non-degraded and degraded forests and their carbon stocks.

ESAPP's response

In an effort to generate context-specific knowledge, ESAPP collaborated on many local and subnational project sites throughout Eastern Africa. The resulting knowledge often made it possible to identify ways of adapting and implementing global sustainable development initiatives such as REDD+. Successful adaptation to local contexts depends on individual and institutional capacity at the local level, and on people's knowledge of global schemes and the nuances of their own setting. To build capacity and fill knowledge gaps, ESAPP frequently collaborated with local academic institutions.

At ESAPP project sites in north-eastern Madagascar, participants sought to quantify carbon sequestration in the tropical rainforest. Their scale-independent methodology was specifically designed to map different stages of forest degradation, quantify carbon stocks in relation to the degradation stage, and monitor the loss of biomass and carbon stocks over time. Based on their results, a regional baseline was developed and estimates of future (2020) forest cover were made according to different management scenarios. Training was provided to young scientists from the University of Antananarivo, enabling them to adopt and further develop the method.

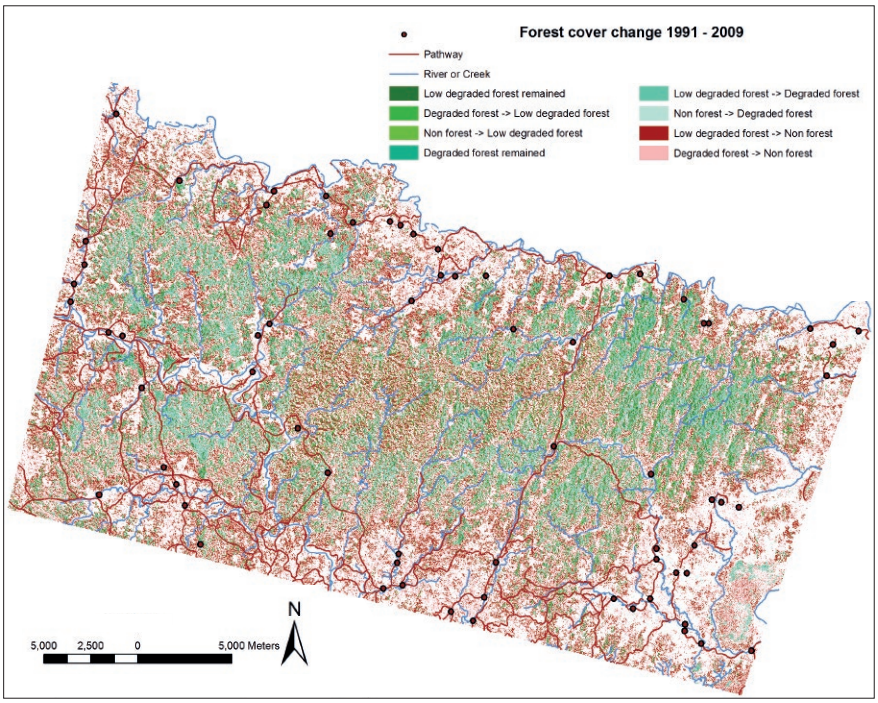
Non-degraded forest has a closed, dense canopy and a high level of plant diversity. It also has significantly higher carbon storage capacity than degraded forests. (Photo: Harifidy Rakoto Ratsimba)

The project story

The project began with a site-specific inventory of the tropical rainforest. Selective logging (mainly of precious woods) has degraded vast stretches of forest, creating gaps in the canopy. While these degraded forests still have a high diversity and quantity of plants, they are bound to store less carbon; the aim was to find out how much less. The inventory was done by local Master's students in forest engineering. They collected plant samples and analysed them in the laboratory at the Water and Forest Department of the School of Agronomy (ESSA Forêts) at the University of Antananarivo. By relating tree size and dry weight of their samples, they developed so-called allometric equations to estimate the biomass and carbon stocks of non-degraded and degraded forests. The calculations revealed that degraded forests store 32 per cent less carbon than non-degraded forests. This means that distinguishing between degraded and non-degraded forests is highly important: failing to account for degraded forests can lead to substantial overestimation of above-ground biomass and carbon stocks.

Subsequently, a PhD student at ESSA Forêts analysed forest change over time using satellite data for the years 1991, 2004, and 2009 (Rakoto Ratsimba 2011). His work was mainly funded by academic institutions in Belgium, Switzerland, and Germany; ESAPP made a small contribution to it. The student distinguished non-degraded and degraded forest classes, and mapped them for the three selected years. He then generated forest change and degradation maps. By combining the allometric equations with the map information, he was able to estimate forest carbon stocks and their change between 1991 and 2009. He used existing scientific methods, but adapted them to the Malagasy tropical rainforest to achieve accurate results. This was done in close collaboration with experts from the Centre for Development and Environment (CDE).

For the period from 1991 to 2009, the researchers estimated that 15,000 hectares of forest were lost. This corresponds to a decline of 34 and an annual deforestation rate of roughly 1 per cent – well above the original national estimates. Results also showed that the forest was heavily fragmented and that degraded forest areas increased from 39 to 64 per cent over the same 18-year period. These developments resulted in an estimated loss of 142,385 megatonnes of stored carbon (72 per cent). Based on their findings, researchers modelled baseline carbon stocks and generated change prediction maps for 2020 according to different management scenarios (Eckert et al. 2011; Eckert 2012).



Top: The modelling of carbon stocks was based on both remotely sensed information and field data. Allometric equations were used to estimate the above-ground and below-ground biomass of various forest types in randomly selected test plots. (Photo: Sandra Eckert)

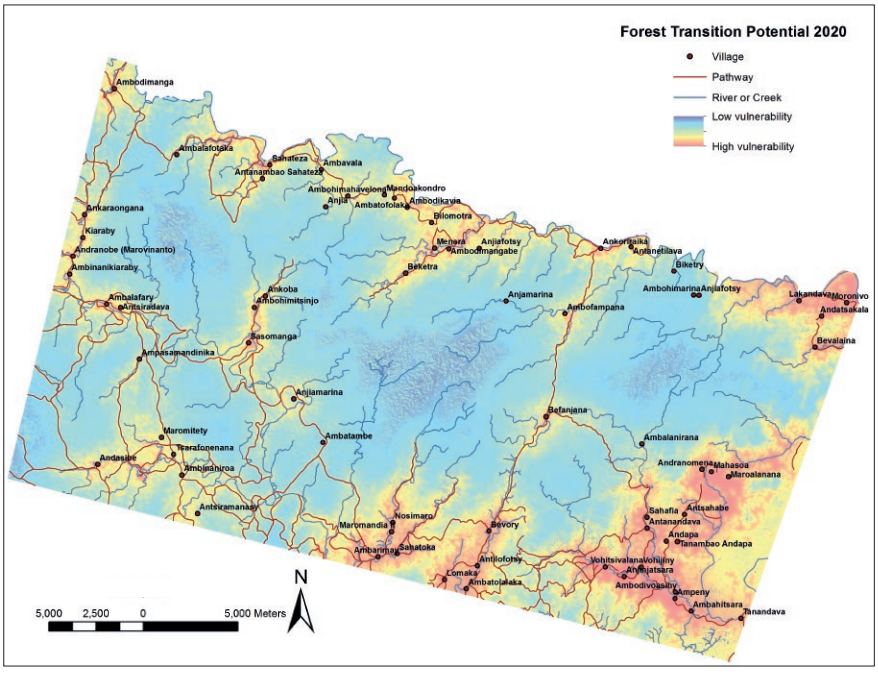
Bottom: Between 1991 and 2009, forest cover in the study area changed in different ways depending on its accessibility: forest areas close to settlements and pathways frequently experienced degradation or deforestation, while forest areas far away from settlements and pathways experienced little or no degradation.

Innovation and relevance

Most existing carbon assessment and monitoring methods were developed for temperate forests, whose vegetation cover is not nearly as dense as that of tropical rainforests. These methods fail to produce accurate results for tropical rainforests. The method developed in this project is innovative in several ways: (1) it works for non-degraded and degraded tropical rainforests; (2) it integrates different levels of forest degradation into the calculation of carbon stocks (overlooked by other methods); and (3) it can be transferred both to larger areas and to other regions with similar forest types. This makes it valuable for both the international research community and local stakeholders active in forest conservation and monitoring.

Because of its ability to predict possible carbon loss and the locations of future deforestation and forest degradation, the methodology developed is highly useful to REDD+ implementation. Importantly, the project confirmed that different forest classes contain different quantities of carbon. These differences had never been quantified before in Madagascar. They indicate that forest degradation, for example from selective logging, causes substantial carbon emissions, and confirm the importance of conservation, restoration, rehabilitation, and sustainable management of forests. These findings are not only of interest for research scientists but should motivate conservationists to continue their efforts. The project findings can also help policymakers improve the coherence of REDD+ activities, which are currently implemented at multiple levels and face risks of inconsistency.

The Malagasy junior scientists trained in the ESAPP project became national experts in their field. They have gone on to advise national and regional policymakers as well as to support the implementation of REDD+ projects in Madagascar. Their tasks at the national scale include setting national standards and registries, monitoring performance, generating data, and designing national programmes.



Top: Degraded forest is characterized by an open canopy cover, but still contains a high level of plant diversity and quantity. Distinguishing degraded forest as a separate category in forest models proved crucial, as it stores less carbon. Prior modelling attempts in the region ignored this, leading to significant overestimates of remaining carbon stocks. (Photo: Harifidy Rakoto Ratsimba)

Bottom: Based on analysis of prior forest cover change, researchers predicted where deforestation and forest degradation were likely to occur in the future. The resulting vulnerability map is a useful tool for sustainable forest management in the region.

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Highlight profile

This highlight is based on the achievements of 2 ESAPP priority action projects.

Implemented during:
2008–2014

Total funds contributed by ESAPP:
CHF 159,000

Implemented by:
Ecole Supérieure des Sciences Agronomiques (ESSA), University of Antananarivo, Madagascar

In collaboration with:
Savaivo, Antananarivo, Madagascar; Centre for Development and Environment (CDE), University of Bern, Switzerland

Main beneficiaries:
Academic staff of ESSA, relevant government offices in Madagascar, and international experts

References and further reading

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This highlight
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Savaivo

What is ESAPP?

The Eastern and Southern Africa Partnership Programme (ESAPP) is a research implementation programme funded by the Swiss Agency for Development and Cooperation (SDC), coordinated by the Centre for Development and Environment (CDE) of the University of Bern, Switzerland, and implemented jointly by CDE and a network of partner institutions in Eastern and Southern Africa. Launched in 1999 and completed in 2015, ESAPP implemented over 300 priority action projects in the programme region, which included Eritrea, Ethiopia, Kenya, Tanzania, Mozambique, and Madagascar.

What are ESAPP Highlights?

ESAPP Highlights are a series of 24 project descriptions providing insights into ESAPP's research and implementation partnerships. Each Highlight describes a succession of demand-driven priority action projects addressing local and regional sustainability issues. The 24 Highlights are collected in a publication that includes additional background information on ESAPP (see citation above). The individual Highlights and the entire publication are also available for download on CDE's website: www.cde.unibe.ch (keyword search: "ESAPP").

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