

**Name of project:** Climate Adaptation for Biodiversity, Ecosystem Services and Livelihoods in Rural Madagascar

**Overall objectives:** Assist Madagascar to improve its understanding and assessment of the impacts of climate change, including climate variation and extremes; local and regional vulnerability; and available climate adaptation solutions and help make informed decisions on practical adaptation actions and measures.

**NWP work areas to which the pledge is relevant:** Methods and tools; data and observations; climate modeling, scenarios and downscaling; climate risks and extreme events; socio-economic information; adaptation planning and practices; research; and economic diversification

**Project purpose:** Roughly 15% of Madagascar is covered with natural forest and deforestation due to resource extraction and unsustainable farming practices removes 50,000 hectares of forests every year. The loss and degradation of forests as well as coastal and marine ecosystems jeopardize the availability of ecosystem services such as water and food provision, flood regulation and erosion control. The adverse impacts of climate change will further diminish the capacity of these services to sustain local communities, creating the impetus for immediate and significant climate adaptation actions. The project had two goals:

- A. **Terrestrial:** to develop recommendations, based on a series of feasibility studies, for an action plan to maintain and restore forest cover and connectivity in priority areas, and to reduce pressure on natural forests.
- B. **Marine:** to build key knowledge about coral systems in Madagascar, and develop effective approaches for improving the resilience of these systems.

This project operated in accordance with ecosystem-based approaches to adaptation (EbA) acknowledges the invaluable ecosystem services upon which local communities depend, and the role these services play in reducing their vulnerability to climate change and climate variability.

### **Preliminary Activities**

- **Vulnerability Assessment and Adaptation Planning**

In 2007, a vulnerability assessment (VA) and preliminary adaptation planning process were initiated by Conservation International (CI) and the World Wildlife Fund.

### **Results**

The vulnerability assessment provided:

1. Projections of future climate and oceanographic scenarios for Madagascar (up to 2080), which predicted warming across the island and regional changes to rainfall regimes (wetter in the northwest and drier in the southeast);

2. An understanding of the impacts of climate change on the distribution of terrestrial and marine species, their population sizes and habitat shifts on the island; and

3. Development of recommendations to increase adaptive capacity of communities and terrestrial and marine species to climate change; to support ecosystem management in protected areas (PA) for sustaining livelihoods.

- **Technical Workshop and Community Consultations**

The vulnerability assessment culminated in a technical workshop attended by a wide array of stakeholders such as local community members, policymakers, researchers, and scientists. The participants of the workshop discussed the results of the VA and provided important technical and policy recommendations.

Community consultations in three different bioclimatic zones of Madagascar provided critical information regarding the vulnerability of specific local livelihoods and rural production systems. [A report summarizing community concerns and recommendations is available via USAID's International Resources Group information portal. [http://pdf.usaid.gov/pdf\\_docs/PNADP632.pdf](http://pdf.usaid.gov/pdf_docs/PNADP632.pdf)]

## **Terrestrial Activities**

- **Surveying and Testing Methods for Natural Forest Regeneration**

CI organized a survey to understand and document the experiences of forest restoration projects in three forest types in Madagascar: southern spiny forest, western dry forest, and rainforest. Data from seventeen forest restoration projects was used to document the range of restoration techniques used, the effectiveness of each, and the costs involved. Methods for forest restoration were also tested in a demonstration project at Andasibe, eastern Madagascar.

### **Results**

1. To provide guidance to future restoration projects, the results of the survey of seventeen projects work were presented at a workshop and published as a document entitled "*Restauration forestière à Madagascar: Capitalisation des expériences en vue de l'élaboration d'un plan d'action de restauration*".

2. Lessons learned from the Andasibe restoration project focused on the importance of proper planning, providing avenues for effective participation by local communities, and the importance of controlling alien, invasive species. These lessons can guide and inform future forest restoration plans.

- **Riverine Corridors: feasibility study to assess the current conditions of riverine forests in Madagascar and their potential to act as migratory pathways for species under climate change**

Based on analysis of Landsat images captured in 2005, CI identified existing riverine forests. From this forest cover data, forests within different distances from major rivers were mapped. Statistics for each scenario to measure fragmentation and connectivity of the existing forests were developed. A score that serves as a useful proxy for determining the ease with which forest-dependent animals and plants might be able to move through a riverine corridor landscape in response to climate change pressures was developed from the statistical analysis.

Our work here is especially important since the relationship between forest ecosystems and the forest-dependent species influences adaptive capacity to climate change. The adaptive capacity of species to climate impacts depends heavily on their ability to migrate within forest corridors and between forest fragments, while at the same time these species play an important role in maintaining healthy ecosystems. For example, in Madagascar, thousands of plant species depend on lemurs for dispersal, which in turn depend upon fruit as a major food source. Climate impacts that disrupt fruiting cycles will adversely affect lemur populations, which in turn will reduce fruit dispersal. Therefore, if lemurs are unable to migrate in order to find fruit because of increased forest fragmentation, their limited mobility will negatively impact both their own survival and fruit seed dispersal. This dynamic can also impact human livelihoods, especially those dependent on harvesting of wild and agricultural crops. Furthermore, as rainfall regimes becomes less predictable due to climate change, subsistence farmers dependent on rain-fed crops, which account for 70% of the Malagasy population, will have to rely more heavily on wild forest food, including fruit. As discussed above, forest fragmentation hinders sustained ecosystem service output, and reduces local communities' capacity to adapt to climate impacts.

## **Results**

**1.** Measuring the fragmentation/connectivity of these forests allowed us to create a map highlighting riverine forests and forest fragments warranting high priority in restoration and protection efforts. We identified the Mangoky River as a priority site for a more detailed study, since it has the highest remaining riverine habitat connectivity in the western region of the country.

**2.** We developed a modeling approach to estimate the paths that species would take through the Mangoky-Ihotry landscape and used this to identify the sites where restoration activities to increase habitat connectivity would be most cost-effective. We then developed a detailed restoration plan for a priority site on the Mangoky River.

- **Sustainable Livelihoods Activities Testing**

Unsustainable farming practices such as slash and burn agriculture (locally known as '*tavy*') is identified as the primary driver of forest loss in Madagascar. *Tavy* therefore reduces the ability of natural ecosystems to provide services useful for climate adaptation but also the people practicing such techniques are usually highly vulnerable to climate change effects. Identifying and expanding the use of alternatives to *tavy* that reduce agricultural risks for their practitioners is therefore essential for a large part of Madagascar's rural population.

CI surveyed different approaches used by projects in Madagascar to provide sustainable alternatives to *tavy*. We then analyzed the factors related to the project's ability to provide livelihood options to farmers and techniques to reduce pressure on forests. The study covered a wide range of activities that had been tried, including agricultural activities, improved food storage, small-scale animal-rearing activities, alternative wood sources and improved wood-burning stoves, ecotourism, and a variety of other small-scale revenue generating activities. Many projects combine several of these approaches together. In addition, these approaches also include income diversification options such as beekeeping, cultivation of fruit trees as well as improving market access for farmers in remote regions.

## Results

1. Permanent vegetation cover technique allows for continuous crop production without burning the land, while also improving soil quality. This is a very promising approach, but it is still only practiced on a small scale and requires more promotion to be widely adopted. In addition, the Intensive Rice System technique (SRI) has also been successful at improving irrigated rice yields. SRI is a viable alternative to *tavy* that should be more widely promoted.

2. Alternatives to rice as a staple crop have also been identified. These include crops such as manioc and yams. These can substantially reduce food shortages in areas where rice is a seasonal crop. There is a good potential for bringing the native Malagasy yam species into cultivation. The common challenge for all these approaches is to achieve wider adoption, but they are feasible on the scales at which most forest restoration programs operate.

3. Financing is a key constraint to farmers' accessibility to techniques allowing for agricultural diversification. Micro-finance is usually not available to the poor farmers due to their remote locations and high interest rates. Although village savings groups are probably more effective in these areas, they are still relatively new in Madagascar. It is necessary to address the lack of financing with regards to market access to make viable alternatives to *tavy* more widely adopted.

4. A detailed report on the results of this study on sustainable livelihood activities and a practical Malagasy language guide for project developers has been published and distributed within Madagascar.

- **Human Adaptation and Secondary Impacts: Analyses of Crop Vulnerability (rice, cassava, vanilla and cloves)**

Even with moderate temperature increases of 1-2 degrees Celsius, Malagasy farmers are already experiencing changing seasonal patterns, including a shortening and intensification of the rainy season and a longer and hotter dry season. How climate change affects the production of staple agricultural crops and how people respond to these shifts in productivity will greatly affect communities' resilience to climate change and their ability to ensure future food security.

We conducted a preliminary analysis of potential crop vulnerability to climate change by modeling the changes in spatial suitability for different crop types. Our main objectives were to map current distribution of different crops in Madagascar, model future suitability for these crops and produce a comparative analysis between current distribution and future suitability. We focused on a fine scale to estimate climate change impacts on suitability of subsistence and cash crops in Madagascar.

## Result

We identified the need for continued research on crop vulnerability and concluded that the impact of future climate change on crop production in Madagascar may be restricted to specific zones and crop types. For example, Northwest Madagascar seems to be particularly at risk for changes in suitability for maize production. However, crop suitability does not correlate with yield and this should be one of the main areas for

future research. Improving crop productivity in the face of climate change can strengthen local communities' adaptive capacity through enhanced food security.

### **Marine Activities**

- **Rapid Rural Assessment Program: Northeastern coast of Madagascar**

In an effort to assess new biodiversity hotspots and climate resilient areas, CI conducted a marine Rapid Assessment Program (RAP) in the northeastern coast of Madagascar in April 2010. We surveyed 130 km of coastline from the Bay of Ambodivahibe to Vohemar. The coral reefs and seagrass in the region were generally healthy, with coral cover averaging 50% in suitable locations.

Although generally in good health, the surveyed habitats are not pristine. The algae, echinoderm, and fish species present were indicative of human impacts and disturbed conditions likely due to urban pollution and subsequent high dissolved nutrient levels. The absence of sea cucumbers and large fish was also indicative of high levels of exploitation by local villages and by migrant fishers.

Coral bleaching was widespread, but at low overall rates (5% of colonies affected), with almost zero mortality observed. This was comparable to most parts of the Western Indian Ocean and less than the worst-affected sites nearby in the Comoros (Mayotte), so there is high likelihood that bleaching protection is active in the region.

#### **Results**

1. Based on our observations, we put forward several policy and technical recommendations to guide follow-up work in this region.
  
2. The evidence of overfishing reaffirms the need for successful alternative livelihood projects.

### **Indicators of Success**

- Area of land reforested
- Improvement in health of ecosystems and their related services
- Number of local farmers assigned land rights and area of land for which these rights correspond
- Proportion of reduction in the use of traditional *tavy* agriculture
- Profitability of diversified income options