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IMPACTS OF CLIMATE CHANGE ON RURAL LIVELIHOODS IN MADAGASCAR AND THE POTENTIAL FOR ADAPTATION



January 25, 2008

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QUARTERLY REPORT

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I. INTRODUCTION AND BACKGROUND

This report summarizes and analyzes the results of community level surveys and focus group discussions on the impact of climate change on local livelihoods that were carried out in several sites in Madagascar during October and November 2007. The information has been compiled by Chelsea Combest-Friedman of USAID/Madagascar, Bob Winterbottom and Firras Traish of International Resources Group (IRG), based on information and reports prepared by Wildlife Conservation Society, Ny Tanintsika, Centre ValBio and the World Wild Fund for Nature.

This report has been prepared with technical support mobilized under the Vulnerability and Adaptation to Climate Change Impacts Task of the TAS task order issued under the USAID-funded EPIQ II Indefinite Quantity Contract (contract no. EPP-1-00-03-00013-00). The objective of this activity is to build the core competencies required for a sustained USAID approach to address vulnerability and adaptation to climate change. Specific activities include: field testing a USAID draft methodology for assessing vulnerability to climate variability and change; accessing and disseminating climate information that can inform development planning; and assessing vulnerability in a key pilot area using and planning on-the-ground adaptation strategies in conjunction with ongoing USAID programs in water, agriculture, or natural resources management (NRM). As with other activities under the climate change program, this activity is designed to strengthen the capacity of USAID missions and their partners to build and improve climate change programs by integrating them into long-term mission strategies and country programs.

The impetus for the organization of the field work organized in Madagascar came from an initial meeting and discussions held in Washington, D.C. in August 2007 during the visit of Lisa Gaylord, team leader for USAID/Madagascar's Environment and Rural Development programs. These meetings provided an opportunity for Conservation International (CI), World Wildlife Fund (WWF), The Wildlife Conservation Society (WCS), and others involved in the planning and preparation of a workshop designed to assess the impacts of climate change on Madagascar's biodiversity to explore the opportunity to increase the level of analysis given to the impacts of climate change on local livelihoods, including the use of natural resources, agricultural production, and food security. John Furlow, of the USAID Climate Change team in the USAID/Washington Office of Economic Growth, Agriculture and Trade (EGAT), was able to share the results of recent work completed with the assistance of IRG to develop a manual for assessing vulnerability and adaptation to climate change and taking account of climate change in development planning. During the course of these initial discussions, it became apparent that there was a good opportunity to leverage and complement the research and analysis of climate change impacts being done by scientists, technical specialists and others working on issues related to biodiversity conservation, ecosystem services and modeling of rice production. The group felt that additional field work could be designed to add value to the ongoing workshop preparations by investigating, in more depth, community level perceptions of the impact of climate change on local livelihoods. Furthermore, the livelihoods work would contribute to understanding the interactions between climate, people, and natural resources. Climate change is not the only, or even the most significant threat to biodiversity in Madagascar; understanding the forces that push communities to turn to forests for survival will help address those pressures, helping to protect biodiversity.

It was envisioned that this work could help to engage the Government of Madagascar to a great extent in the climate change workshop and to contribute to a more balanced assessment of the impacts of climate change on biodiversity and people/livelihoods. The envisioned case study and field work would also provide an opportunity to reach out to additional stakeholders and project teams working on climate change and vulnerability and adaptation (V&A) of agrarian production systems and livelihoods. Finally, it was thought that the proposed field work could reinforce the assessment of climate change impacts on human communities (and rice production and food security) and help to provide a voice to local communities, to articulate their perceptions, and to present their qualitative assessment of the major risks, vulnerabilities and observed adaptations to climate change, with particular emphasis on the impacts of climate change on local livelihoods.

In the case of Madagascar, the following specific objectives were identified for this activity:

- i. Add value to the ongoing assessment of vulnerability of Madagascar's biodiversity to climate change in Madagascar through the application of the USAID/Global Climate Change (GCC) Team development planning case study methodology and assistance with the integration of V&A elements into proposed strategies and programs; broaden and deepen assessment of vulnerability and adaptation to highlight socioeconomic impacts
- ii. Consult with local community leaders, smallholders and key government stakeholders to identify and analyze local awareness of climate change, perceptions about vulnerability, observed adaptations and recommended interventions
- iii. Assess potential adaptations to climate change, particularly with respect to issues of enhanced food security, local livelihoods, and sustainable use of natural resources, in addition to conservation of biodiversity and protected area management
- iv. Contribute to the national climate change workshop planned in January 2008, and help to identify and prioritize pragmatic options for climate change adaptation at household, community, regional and national levels

In 2006, Conservation International and World Wildlife Fund-US mobilized funding from the MacArthur Foundation to investigate the impact of climate change on the conservation of biodiversity in Madagascar. CI received support to take the lead in investigating the impact of GCC on terrestrial ecosystems, and WWF-US on the impact of climate change on coastal and marine conservation. The goal of the project is to protect Madagascar's globally important biodiversity from the impacts of climate change by creating a management regime and network of protected areas that are resilient to climate change.

An initial planning activity for the Climate Change workshop was organized May 29-30, 2007 in Antananarivo, Madagascar, and agreement was reached on a tentative agenda for a major conference to be held January 28-31, 2008 in Madagascar. This conference would bring together some 200 national, regional, and international experts on climatology, oceanography, ecology, protected areas management, community-based conservation, and specialists working on adaptation to climate change to assess the vulnerability of biodiversity and recommend conservation strategies in the face of anticipated climate change. In recognition of the actual and potential impact of current and projected use of natural resources and rural landscapes on biodiversity conservation, outside of protected areas, a session of the conference was proposed to deal with the impact of climate change on rice production, fisheries, ecotourism, and local livelihoods.

In advance of the January 2008 workshop, a number of activities were organized to increase the level of attention given to an analysis of the impacts of climate change on local livelihoods:

- An initial country level field visit in late September/early October 2007 to gather information, consult with stakeholders, select survey sites, identify local survey teams, prepare survey questionnaire and contract for survey work to be carried out from mid-October to end-November. Interested stakeholders were briefed on October 12 about the proposed livelihood survey methodology, selected sites, and ongoing consultations with interested technical services, organizations, and projects.
- A follow-up visit in late November/early December to review, analyze, and present the preliminary survey results, and to consult further with key stakeholders about V&A issues and the organization of the livelihood session at the late January workshop on climate change and biodiversity conservation. The Ministry of Environment again convened interested stakeholders for a briefing and discussion of the preliminary results from the field surveys by WWF, Ny Tanintsika, Centre ValBio and WCS.
- Preparation of a summary report on the survey results, and participation in the late January 2008 workshop to present and discuss the survey findings with a larger group of stakeholders and decision makers.

2. PURPOSE

The following report provides an overview and analysis of the impact of climate change on local livelihoods in Madagascar with the intent to inform presentations in the January 2008 National Climate Change Conference. This report has been written based on the findings from the climate change surveys contracted and carried out throughout October and November 2007 in the regions of Itampolo (southwestern Madagascar), Fianarantsoa (central Madagascar), and Masoala/Makira (northeastern Madagascar).

These regions are recognized as distinct in terms of livelihood strategies and geographical landscape and were chosen as an attempt to provide a representative understanding of climate change impacts in Madagascar, within the constraints of time and available funds. However, climate change will no doubt impact livelihoods in every region of the country. It should therefore be emphasized that as this report is only referring to three of many vulnerable regions within Madagascar it should be seen not as a comprehensive assessment of climate change impacts, but rather a base for further discussion and research.

The specific aim of this report is to (1) categorically compile, review, and analyze data collected by partner organizations in order to comment on the observed climate trends, resulting impacts and vulnerability, current adaptations and barriers to adoption, anticipated risks/opportunities, and proposed strategies of intervention; and (2) use these results to identify major climate change related threats and opportunities for adaptation.

3. FIELD PARTNERS

ITAMPOLO, SOUTHWEST MADAGASCAR

World Wide Fund For Nature (WWF):

Established in 1961, WWF is present in more than 100 countries with the goal of creating a future in which humans live in harmony with nature. In Madagascar, WWF carries out projects in marine conservation, species conservation, freshwater conservation, forest conservation, and ecotourism.

WWF's current presence in the southwest of Madagascar centers on a marine natural resource management project between Anakao and Androka. The project's goal is to improve traditional fishing practices for the conservation and management of natural fish stocks and coastal ecosystems in this region. The key objectives include strengthening small-scale sustainable fisheries management systems, improving food security and livelihoods, and reviewing fishery agreements related to foreign vessels access compatible with sustainable exploitation of fisheries resources.

The region includes a forest with protected area status, "Ala Maiky," and a Land and Seascape conservation program aimed at setting up community protected areas in Ranobe and Onilahy areas. In addition, WWF is in the process of setting up a marine protected area along the barrier reef that runs parallel to much of the southeast coast of Tulear. Therefore, gaining an understanding of climate change impacts on fisheries in this region as well as priorities for building adaptation measures into their protected area plan is of importance for the organization. A comprehensive socio-economic survey was carried out by Felipe Trabanino of WWF in the commune of Itampolo in part to increase this understanding.

FIANARANTSOA, CENTRAL MADAGASCAR

Centre ValBio:

Located at the entrance of the Ranomafana National Park, Centre ValBio is an international research and training center for the study of biodiversity. Its mission of valorizing biodiversity is carried out through research, training and education activities.

Working in 22 villages along the eastern and western sides of the Ranomafana National Park, their conservation education program focuses on sensitization in three main areas: reforestation, biodiversity conservation, and improved well-being; as well as offering program support to local environmental education partners and field actors. They target children, adolescents, and adults as well as support several associations and groups.

Centre ValBio works closely with nine schools, and is expanding this in 2008 to six more. These schools integrate the government curriculum with Centre ValBio's environmental education, reforestation, and conservation programs. They are instructing in activities such as composting, building vegetable gardens, seed bank management, fruit tree diversification, artisan craft production, and health and hygiene education.

Centre ValBio was contracted to carry out the USAID/IRG climate change survey in 18 of their 22 intervention sites to better understand the existing community perceptions of the impact of climate change on livelihoods in this region. Centre ValBio has been measuring rainfall and temperature data for years but hopes to add more sophisticated climate measurement equipment in 2008 to better enable an understanding of climatic variability in this region. Centre ValBio is interested in including climate change adaptation planning into their conservation education program.

Ny Tanintsika:

Ny Tanintsika is a Malagasy association that was created in 2002 with support from the British NGO “Feedback Madagascar” (www.feedbackmadagascar.org). Ny Tanintsika works to alleviate poverty through an integrated approach that recognizes the inter-relationship between poverty, environmental degradation, and poor health; and emphasizes local capacity-building and the promotion of self-sufficiency. The team implements projects focused on improving primary health care, education, natural resource management, and income-generating activities.

Ny Tanintsika is currently active in four of Fianarantsoa's regions: Haute Matsiatra, Vatovavy Fitovinany, Amoron'i Mania, and Atsimo Atsinanana, with a focus on biodiversity hotspots where pressure on remaining forest is particularly evident. Ny Tanintsika is promoting the “Kaominina Mendrika” or “Champion Commune” approach in all of the communes targeted for this survey; an approach developed by the USAID-supported Ecoregional Alliance in Fianarantsoa. The approach assists communes and their development committees with development planning in order to achieve their objectives within a given period.

Ny Tanintsika was contracted to conduct the USAID/IRG climate change survey in five of the communes in which they currently carry out extension work. The survey data they collected represents communities in the southern portion of the Fianarantsoa corridor, helping to provide a better and more comprehensive understanding of the existing community attitudes and perceptions on the impact of climate change on livelihoods in Fianarantsoa.

Peace Corps:

The U.S. Peace Corps, founded in 1961 by U.S. President John F. Kennedy, aims to help provide basic needs to people in developing countries and promote cross-cultural exchange and friendship between Americans and people of other cultures. The Peace Corps program in Madagascar works in three sectors: Education, Environment, and Health. Projects are carried out by Peace Corps volunteers within these sectors and often in conjunction with local NGO's or other interested parties in Madagascar.

The Associate Peace Corps Director for Environment arranged for five volunteers working in the Fianarantsoa region to conduct the USAID/IRG climate change survey in their respective villages. The Peace Corps Environment Program is interested in hearing recommendations on climate change adaptation options in Madagascar for potential integration into existing and future volunteer-run projects.

MASOALA/MAKIRA, NORTHEAST MADAGASCAR

Wildlife Conservation Society

The Wildlife Conservation Society saves wildlife and wild lands through careful science, international conservation, education, and the management of the world's largest system of urban wildlife parks. These activities change attitudes toward nature and help people imagine wildlife and humans living in sustainable interaction on both a local and a global scale.

Active in Madagascar since 1991, WCS is committed to ensuring the conservation of Madagascar's biodiversity through sound management practices that are based on solid research. To this end, WCS works on a variety of conservation and sustainable management issues throughout Madagascar. In the Antongil Bay landscape, northeastern Madagascar, which includes Masoala National Park, Makira Forest Protected Area Project, and the Antongil Bay Marine Program, WCS is working in collaboration with numerous partner organizations to better understand the biology and human ecology of this critically important landscape in order to ensure its lasting protection.

WCS has been working in the region since 1991 and helped establish the Masoala National Park in 1997; the largest National Park in Madagascar (230,000 hectares) and the first national park with associated Marine Reserves (three reserves totaling an area of 10,000 hectares). Since 2000, WCS has been managing Masoala Park in collaboration with the Malagasy Parks Service, ANGAP. Contiguous with Masoala, the forests of the Makira Plateau had always been identified as important biodiversity area but were relatively unexplored. In 2003, WCS started a project aimed at understanding the biodiversity of the forests and designing a protected area in collaboration with local people. Now known as Makira Protected Area, it is a model project in the Government of Madagascar's commitment of tripling the protected area network of Madagascar.

Given its long-standing relationship with the communities surrounding the Makira Protected Area and Masoala National Park, WCS was contracted to carry out the climate change survey in three zones (10 villages) of this northeastern region. A region significant in climatic differences from the southwest and central regions of Madagascar, these surveys help form a comparative analysis of the overall impacts of climate change on livelihoods within the country.

4. SURVEY SITES

4.1. CRITERIA FOR SELECTION OF SURVEY SITES

The regional survey sites were chosen based on their potential to contribute to a better understanding of the impact of climate change on various livelihoods in Madagascar and the availability of logistical support, time, and funding. In light of these needs and restrictions, three regional sites were chosen: Itampolo in Southwestern Madagascar, Fianarantsoa in Central Madagascar, and Masoala/Makira in Northeastern Madagascar. Within these regional sites, individual commune and village level sites were chosen by the partner organizations carrying out the surveys. In general, site selection followed the guidelines of ensuring a diversified collection of sites that was representative of the region in terms of livelihoods, ethnicities, climate, and geographical landscape, accessibility to markets, and proximity to national parks. The following describes more specifically the site selection process for each of the three target regions.

Itampolo:

Four villages (Besasavy-Sud, Befolotse, Itampolo, and Malangariake) within the commune of Itampolo were chosen for a WWF survey on sustainable fisheries in the southwest region of Madagascar. This specific commune was chosen because it was recognized for having high rates of lobster production. As an in-depth survey requiring three days per village, the opportunity was used to collect additional information on community perceptions and adaptations to climate change. The commune was comprised of villages with a mix of coastal *Vezo* people and *Tanalana* farmers, including the *Temitongoa* and *Milabebi* clans.

Fianarantsoa:

Sites were chosen on the eastern and western sides of the Fianarantsoa forest corridor to represent the different ethnicities as well as climatic and landscape variability between the two sides. In addition, sites were chosen to represent proximity or distance from national roads or railroads, which make communities more accessible to commerce, education, and communication. Although all sites were relatively proximate to the boundary of the Fianarantsoa forest corridor, sites were also chosen based on proximity and distance to the National Parks within the corridor, Ranomafana National Park, and Andrigitra National Park.

Masoala/Makira:

This region is the most diverse in terms of geographic and livelihood variability. Divided into three main zones by landscape and livelihood variability, nine sites were chosen in total, three from each of these designated zones. The principal geographic factors considered in the selection of zones include altitude, water resources, ocean proximity, wind, and natural resource types. The main livelihoods considered in the selection of zones include agriculture and fishing.

4.2. DESCRIPTION OF SURVEY SITES

Itampolo (see Annex 1)

Located in the dry, desert landscape of southwest Madagascar, the commune of Itampolo is predominantly dependent on fish, both as an income and food source. However, three kinds of livelihoods are observed in the region—herders, fisherman, and agriculturalists. With its arid climate, loose sand, and low levels of rainfall, the area has limited agricultural ability. Those crop varieties that are grown include manioc, corn, sorghum, and cactus. Droughts and famine occur cyclically in

the region. Access and communication are limited as no paved roads exist. The commune is predominantly made up of *Vezo* fishermen; however there are also some farmers from various clans of the *Tanalana* ethnic group (*Temitongoa, Milabehi*).

Fianarantsoa (see Annexes 2 and 3)

Although livelihoods are almost exclusively agriculture-based, the region of Fianarantsoa is diverse both physically and culturally, consisting of five different administrative regions, various ethnicities, and two distinct climates. The forest corridor that runs through the region, made up of two national parks, Ranomafana and Andringitra, is the dividing line between climate and ethnicity. The eastern side is characterized by high levels of rain, particularly at higher altitudes. The area of the eastern side included in the survey is inhabited by the *Tanalana* ethnic group. Predominantly hunter-gatherers before the creation of the national parks, the *Tanalana* traditionally rely more heavily on forest products than extensive agriculture, leading to their use of slash-and-burn crop production and rain-fed rice fields versus irrigation-based agriculture.

On the western side, the existence of less rainfall creates a less forested landscape with much of the land surface area used for irrigated rice fields. The *Betsileo* ethnic group, which inhabits the portion of the western region that was surveyed, has a reputation for being the most hard-working and agricultural-based of Madagascar's eighteen ethnic groups. In surveyed communities around Ranomafana, villagers on the western side of the corridor are viewed as being more open to forest conservation efforts, seeing them as being positive. Communities on the eastern side are seen to be less open to forest conservation efforts, possibly because there is still a significant area of forest left and a preference to be free of government control. However, this trend was not observed in communities around Andringitra. Roads are significantly better on the western side, allowing the *Betsileo* more access to communication, schools, and transportation of marketable produce than the *Tanalana*.

Masoala/Makira (see Annex 4)

The principle ethnic group within each of the three zones chosen for survey is the *Betsimisaraka*, with Merina, Betsileo, and Tsihimety comprising smaller percentages of the population. Zone I, bordering onto the Makira Forest, is characterized by dense, tropical, low and mid-altitude eastern humid forest. The villages surveyed in this zone are situated along the Antanambalana River, the principle waterway that bisects the Makira forests from northwest to southeast, and serves as one of the principle river drainages into the Antongil Bay. Livelihood practices in this zone include the production of vanilla, cloves, irrigated rice agriculture, hillside slash and burn agriculture, and artisan crafts. Zone II represents the coastal zone bordering the Bay of Antongil, while Zone III covers the exposed eastern coast of the Masoala peninsula. Both zones are characterized by intermixed coastal forest, mangrove, and *penja* marshes, with the villages of Zone II being in much closer proximity to existing low altitude eastern humid forest. Livelihood practices in both zones are mixed and include the production of vanilla, cloves, and irrigated rice agriculture, as well as artisanal fishing. As a result of these livelihood practices much of the historically existing coastal forest and *penja* marshland has given way to irrigated rice. Villages surveyed in Zone II are characterized as having a mixed household economy based on agriculture and fishing. Villages surveyed in Zone III are characterized as having a more homogenous household economy centered on fishing complemented by production of vanilla, cloves, and subsistence agriculture.

5. SURVEY METHODS

As indicated in the introductory sections of this report, before the field surveys were organized, an effort was made to consult with projects and institutions working on issues related to the impact of climate change on local livelihoods and to take stock of information already gathered. While a number of reports and studies have been done, it was not possible to obtain much recent, site-specific information about the impact of climate change on local livelihoods. Furthermore, it was observed that information about ongoing and proposed Climate Change and Vulnerability & Assessment activities was not widely shared among different stakeholders.

The overall approach and methodology for the livelihood survey work and related activities to be carried out in Madagascar are based on the Guidance Manual for Development Planning for climate change Vulnerability and Adaptation assessments (see August, 2007 report by USAID). In particular, the field level stakeholder meetings, consultations, and focus group discussions with local communities were designed to gather information about the vulnerability of local livelihoods and rural production systems to (i) increased climate variability and climate change (step 1), (ii) to identify adaptation options (step 2), and (iii) to conduct some initial analysis (step 3) to summarize and report on community-level perceptions, concerns, and recommended interventions.

Given the limited time frame between the initial phase of information gathering, consultations with stakeholders, and survey planning started in early October, and the planned national workshop in January 2008, it was necessary to organize and carry out the focus group discussions over a period of 4 to 6 weeks, beginning in mid to late October 2007. With limited financial resources, it was also decided to focus on two main areas: the rice-growing area of the central plateau in the areas between Fianarantsoa and the Ranomafana National Park (focusing on local communities close to the national park and farther south, and along both the eastern and western sides of the natural forest corridor), and in the relatively more humid northeast region of the Masoala peninsula and the districts of Maroantsetra and Antalaha. In order to broaden the geographic scope of the sites surveyed through community level consultations, WWF also agreed to carry out surveys in the south western coastal areas with a much drier climate (see Annex 1).

The specific communities for the focus group discussions were identified by the local organizations recruited to carry out the livelihood surveys. The focus group discussions were organized to consult with younger and older members of local communities, and with men and women. A questionnaire was developed to provide guidelines and suggested discussion topics to focus group facilitators (see Annex 5). The suggested topics covered several subsets of questions and issues in the following areas:

- Local awareness and perception of climate variability and trends related to climate change and associated impacts on natural resources
 - Changes in rainfall seasonality, abundance
 - Observed changes and trends in temperature
 - Cyclones – frequency and severity
 - Floods – frequency and severity
 - Droughts – frequency and severity

- Water resources – changes in quality, quantity
- Forest Cover – changes in extent, wood supply
- Soil fertility, extent of erosion, runoff
- Wildlife/Fisheries/Other natural products
- Consequences and impacts of climate related changes and trends, with particular attention to livelihoods and socio-economic impacts
 - Impacts on human health
 - Changes in food security
 - Changes in principal sources of income, livelihoods
 - Changes in crop yields, productivity of rural production systems
 - Changes in land use mix changes in labor/time devoted to secure water supply
 - Changes in availability of fodder, fuel-wood, non-timber forest product (NTFPs)
 - Changes in incidence of bush fires or other consequences
- Expectations of future changes and perceptions of vulnerability
 - Expectations for rainfall
 - Anticipated patterns for cyclones, floods, drought
 - Anticipated changes in land use
 - Anticipated situation regarding food security
 - Observations on major drivers of observed changes in rainfall, temperature, food production
 - Other sources of major impacts on local livelihoods and the conservation of biodiversity
- Observations on responses and adaptation
 - Local initiatives and adaptations adopted in terms of mix of crops planted
 - Adoption of soil/water conservation practices
 - Other measures taken to intensify or diversify agricultural production
 - Other major changes in use of natural resources or shifts in relative importance of local livelihoods
- Observations about barriers or principal constraints to adaptation to climate change and implementation of interventions to reduce vulnerability
 - Principal interventions that could be implemented to reduce risks and negative impacts associated with climate change
 - Major constraints or barriers to implementing recommended interventions
 - Potential actions that could facilitate and support local level adaptations to climate change

In addition to the use of this proposed questionnaire and guide for focus group discussions, one of the organizations collaborating in this effort to gather additional information about community level perspectives on the impact of climate change on local livelihoods, WWF, opted to use the *Climate Witness Community Toolkit* as a methodology to gather and analyze information. The WWF South Pacific Climate Change team developed this toolkit to assist in documenting the local impacts of climate change and to devise appropriate adaptation measures that local communities can implement themselves. A number of the proposed survey techniques are derived from participatory techniques used to facilitate the design and implementation of community conservation and development projects. They involve:

- participatory mapping
- construction of seasonal calendars
- community time lines
- plant and animal inventories
- analysis of the linkages between local level changes and climate change
- identification of concerns and opportunities
- review of community values and root causes
- brainstorming and visioning exercises
- assessment of adaptation options
- elaboration of community action plans

WWF/Madagascar devoted several days in each of the selected villages along the coast of southwestern Madagascar to apply these tools and to gather information from local communities, which is being incorporated into the overall findings of this survey.

6. SURVEY RESULTS AND FINDINGS

6.1. CLIMATE-RELATED VARIABILITY, TRENDS, CHANGES

This section will evaluate changes in temperature, rainfall, cyclones, drought, and flooding along a geographic transect from South to North Madagascar, where South is represented by data from Itampolo, Central is represented by data from Fianarantsoa, and North is represented by data from the areas surrounding Masoala National Park and Makira Protected Area. The survey asked participants to discuss observed changes in the major climatic factors relevant to their landscape and livelihoods, as well as any overall changes to climatic trends over a period of twenty years.

Table 1. Climate Changes and Associated Community Perceptions

Climatic Factors	South		Central		North	
	Changes	Community Perceptions	Changes	Community Perceptions	Changes	Community Perceptions
Rain	Decreased over the past 20 yrs (from scientific data)	The agriculture and fishing calendars have shifted and rainy seasons are no longer predictable	Decreased overall (note that it was abundant in the eastern villages by Ranomafana)	Gradual decrease in rainfall noted in all but eastern Ranomafana villages; all noted that rain patterns have changed (become more unpredictable): later arrival, shorter time period, and fewer but more severe rain bouts	Increased	Forest zones observed the least change in rainfall; almost no dry season exists and it is hard to tell the summer and winter rainy seasons apart; shorter but more frequent/violent rainfall; shift in rainy season months but a prolonged rainy season

	South		Central		North	
Temperature	Increased over the past 20 yrs (from scientific data)	The agriculture and fishing calendars have shifted and seasons are no longer predictable	Increased	Progressive increase over the past 20 years; noted drying up of water sources except for villages close to the forest; in eastern Andringitra villages, a hot period in the past was recalled (5-10 yrs ago)	Decreased	Change in rainfall and temp are linked, longer winter rains mean lower temperatures overall; more pronounced annual fluctuations in temperature (increase in 2003, decrease in 2004) as well as seasonal fluctuations (colder winters, hotter summers)
Cyclone	No major change in frequency	Particularly the fisherman noted that winds have become more violent over the past 20 yrs	No change	Inland protection, not a coastal zone	More frequent and intense	Cyclones had been considered a legend amongst people from the NE zone, they were never observed by children during the 90s; however now cyclones are frequent and intense
Flooding	No major change	No change noted; there are no cyclones and floods follow the natural cycle	Less frequent in Andringitra area; No change in Ranomafana area	Flooding occurs after cyclones pass, some noted a decrease in flooding but a higher intensity	More frequent and intense	Least impact in Zone III on the Masoala coast, more critical impact in Antongil Bay and Makira
Drought	More severe over the past 5 yrs	No change noted; there have always been periods of drought	Inconclusive (particular emphasis on 2005-2006 drought)	The eastern villages by Ranomafana where rain is abundant viewed drought as rare	N/A	N/A

The overall community perception in the South was that there has been no change in climate or climatic trends except that the agriculture and fishing calendars have shifted and seasons are no longer predictable (this is mainly a factor of rainfall unpredictability). Most believe that climate is a product of a five-year cycle with the following continuous pattern: cyclone – crickets – rain – drought – cyclone. It is likely that because inhabitants of this area are already used to extreme climatic changes including years of no rain, severe cyclones, or severe drought, they have a harder

time noting gradual increases or decreases in particular climate factors. In both the Central and Northern regions of the country villagers were more pessimistic, describing more severe climatic changes and discussing the anthropogenic causes of these changes at both a local and global level. In all three regions, but particularly in the central and northern regions where agriculture is more widespread, unpredictability of rainfall was the most consequential change, both in terms of time (arriving early or late) and quantity (when present either insufficient or too abundant). Changes in temperature and therefore seasons also had a detrimental effect as rainfall and temperatures no longer coincided for appropriate planting conditions. Many villagers mentioned that they could no longer use the cultural calendar of seasons they were accustomed to.

Table 2. Changes in Rainfall

Region	Change	Comment
South	Decreased	This is based on scientific data for rainfall in the region, most villagers did not note a change in quantity of rainfall
Central	Decreased	Andrigitra: Gradual decrease over the past 20 years. The rainy season arrives later; reduction in quantity of rainfall. Ranomafana: Overall decrease in rainfall however many of the eastern villages saw an increase in rainfall; the instability of the rainfall is more detrimental than the increase/decrease as villagers can no longer expect when it will fall and what quantity will fall
North	Increased	Winter rainy season has been elongated from June to October, compared to the previous July to September season

Table 3. Changes in Temperature

Region	Change	Comment
South	Increased	This is based on scientific data for temperature in the region; most villagers did not note a change in temperature
Central	Increased	Andrigitra: Gradual increase over the past 20 yrs Ranomafana: Extreme highs and lows, but an overall longer hot period – this year (2007) the cold period was actually longer
North	Decreased	Winter season is elongated, decreasing the overall temperature; major changes observed within the last 5 yrs

Table 4. Changes in Cyclone Activity

Region	Change	Comment
South	More Violent Winds	Winds have become more violent over the past 20 yrs
Central	No Change	Andrigitra: Cyclones occur every year, their damage is expected; the eastern villages noted a decrease in cyclone frequency and intensity Ranomafana: Cyclones are very prevalent on the west side but due to mountain protection are rare on the East
North	More Frequent and Intense	There have been 6 in the last 7 years, with 3 occurring between December 2006 and April 2007

Table 5. Changes in Flooding

FLOODING		
South	No Change	No change noted in cyclone frequency
Central	No Change	Andrigitra: Western villages noted that flooding did not occur very often but always followed cyclones; eastern villages noted a decrease in frequency but an increase in destructiveness Ranomafana: Between January and March (the cyclone season) there is always flooding in the lowland areas
North	More Frequent and Intense	A result of increased rainfall and cyclones

Table 6. Changes in Drought

Region	Change	Comment
South	More Severe	This is based on scientific data for temperature and rainfall in the region, most villagers did not note a change in frequency or length of drought
Central	Inconclusive	Andrigitra: Western villages noted the drought in 2005/2006; eastern villages said drought was becoming increasingly frequent, long and severe Ranomafana: Overall severe drought is rare even when there are months with no rain, however there was a severe drought in 2005-2006 – however the western villages note that drought occurs frequently
North	N/A	N/A

6.2. CLIMATE CHANGE-RELATED IMPACTS AND VULNERABILITIES

The Southern and Central regions were most impacted by climatic changes in rainfall and temperature, while the Northern region was significantly impacted by cyclones along with increased rainfall and flooding. Sedimentation is reducing fish stocks and potable water supplies are declining in the South; agricultural yields and water resources are decreasing in the Central region; and an overall decline in both fish stocks, mainly from cyclone activity, and agricultural production, from crop destruction, reduction in cultivable land, and soil degradation, is being observed in the North. Despite the differences in climate-induced impacts within each region, the overarching vulnerabilities observed are food and water insecurity. The livelihood that appears to be at most risk is subsistence agriculture. Across the board it was cited that the unpredictability of seasons, or agricultural calendars, has been one of the main reasons for the decline in agricultural production. Cardiovascular disease is being observed more frequently, as well as many heat and water-related illnesses. Due to interventions, health care and hygiene have improved slightly in the Central region; however food and water-related illnesses remain common and detrimental to the working population in all regions.

6.2.1. RAINFALL

Change in rainfall has had an impact on water sources and availability, as well as agricultural production. This has led overall to increased vulnerability in food and water security, with direct impacts to health (mainly nutrition and water-borne illness) and poverty. In the South, where communities have always been vulnerable to water scarcity, decreased rainfall has created a dire

situation for access to water and production of rain-fed crops (particularly manioc). In the Central region, the unpredictability of rainfall has made agricultural production, the main source of income, difficult and undependable. In the North, where water is more abundant, the change in rainfall has been problematic for agricultural production due to increased erosion and silting rather than water availability.

Table 7. Impact and Vulnerability Caused by Changes in Rainfall

Region	Change	Impact	Vulnerability
South	Decreased	Water sources are deeper and riverbeds are drying; decrease in food stock (agriculture reliant on rain-fed crops)	Less water availability for humans and livestock; decreased food security; decreased nutrition
Central	Decreased/very unpredictable	Decrease in agricultural productivity and harvest of crops from lack of water; destruction of crops; perturbation of the agricultural calendar; decreased water quality	Decreased food security; increased water-related illness; decreased nutrition
North	Increased	Erosion (coastal, riverbeds, mountainsides); Silting (coastal and lowlands); disappearance of forest species; reduction in cultivable land (particularly marshland); reduced soil quality; decrease in plants for local crafts	Decreased food security from decreased food stock; destruction of crops; decreased nutrition

6.2.2. TEMPERATURE

Although temperatures have increased in the Southern and Central regions and decreased in the Northern region, the result in terms of vulnerability is the same – increased food insecurity. In the South and North, where fish comprise a significant portion of the food stock, either an increase or a decrease in temperature have equally detrimental direct and indirect effects to fish stocks. In all regions where agricultural production is present, harvests have diminished; in some cases because of water shortages induced by higher temperatures, in others because of disturbed crop cycles. In addition to increased food insecurity, in the Central region there was evidence of growing heat-related illnesses, including an increase in mosquitoes.

Table 8. Impact and Vulnerability Caused by Changes in Temperature

Region	Change	Impact	Vulnerability
South	Increased	Increased coral mortality; increased drought	Reduced fish stock; reduced agricultural stock
Central	Increased	Drying of water sources in villages far from the natural forest; decrease in agricultural productivity; increased mosquitoes	Increase in food insecurity; heat-related health conditions/illnesses
North	Decreased	Disturbance to vegetation cycles; reduced agricultural harvest; fish mortality; reduction of pasture land; increased animal sickness; decrease in plants for local crafts	Increase in food insecurity; decreased husbandry (to the point of abandonment by some); income insecurity

6.2.3. CYCLONES

Cyclones are mainly an issue for the Southern and Northern regions, since the part of the Central region surveyed is inland and fairly protected from the full impact of cyclones. In these two regions coastal erosion and sedimentation were the most crucial impacts observed from an intensification of cyclone activity. Ocean sedimentation has become an increasingly severe issue for fisherman, forcing them further out into the ocean to fish, and aggravating a cycle of increased fishing pressure and a decreased resource base. Cyclones cause destruction of crops and houses, lead to increased livestock mortality, and increase the destruction of marine habitat; therefore the intensification of these tropical storms has and will continue to augment these impacts.

Table 9. Impact and Vulnerability Caused by Changes in Cyclone Activity

Region	Change	Impact	Vulnerability
South	More Violent Winds	Coastal erosion; creation of sand dunes (coupled with deforestation); encroachment of sand into crop fields and wells; ocean sedimentation Note: Cyclones always cause destruction of crops and lead to zebu mortality; crop yields increase the following year	Reduced cultivable land, increased food insecurity from reduced crop yield and reduced fish stock, reduced water supply; endangered fish species (around 4)
Central	No Change	Beneficial for the community who wait for the water before starting to farm (particularly communities living far from the forest); destruction of crops & houses	Increased water-borne diseases; increased food insecurity if crop yields are destroyed

North	More frequent and intense	Erosion; silting; uprooting of trees; species loss; destruction of crops (particularly in plantations); marine habitat destruction (cyclone caused erosion and flooding); decreased livestock; decreased materials for local crafts; destruction of houses	Increased food insecurity; increased income insecurity (particularly from vanilla/clove crop loss); decreased fish stock; increased isolation (i.e. roads/communication)
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6.2.4. FLOODING

Given that flooding in these regions is generally a product of cyclones, the largest impacts were seen in the North, where both an intensification of cyclones and rainfall has been observed. While cyclones have been problematic in the South, the perception continues to stand that cyclones, floods, and droughts are all part of a natural cycle; therefore floods are viewed as having detrimental effects to food stocks in cyclone years and beneficial effects to agricultural production in the years following cyclones. However, sedimentation (increased by a number of factors, flooding being one) has been seen to have a significant negative impact on the marine environment and therefore fish populations. In the Central region, flooding follows the normal pattern of occurring in association with cyclones, therefore no major changes were noted in frequency or intensity of floods; however in years where other climate factors have led to increased vulnerability, a loss of crops from flooding would augment overall vulnerability. Increased food insecurity is the most notable vulnerability for communities in all three regions.

Table 10. Impact and Vulnerability Caused by Changes in Flooding

Region	Change	Impact	Vulnerability
South	No Change	Damage to crops in cyclone years, but in the following year increased soil moisture increases agricultural production; increased sedimentation	Decrease in food stock, particularly from decreased fish stock caused by sedimentation; endangered fish species (around 4)
Central	No Change	Silting/sanding-up of lowland rice fields; beneficial for certain regions in the west; soil erosion; deterioration of hydro-agricultural infrastructure; destruction of crops	Decrease in food stock
North	More Frequent and Intense	Erosion, silting, inability to cultivate flat lowland areas, cattle mortality	Decrease in food stock; increased income insecurity from decrease in livestock; increased isolation

6.2.5. DROUGHT

The South has by far been most affected by increased drought due to its pre-existing hot/dry climate. The mortality rates for people, livestock, fish, and crops have increased. Infant mortality was so high

during the 2005 drought that a gap in the child population can be observed that corresponds with children born in 2005. The Central region has been more impacted by drought in some areas than in others; communities on the western side of the Forest Corridor that have a drier climate have been more impacted, whereas eastern communities have in some instances seen an increase in rainfall. There was also a difference between communities that were closer to Ranomafana, and those further out. Those further out reported a higher impact from drought, while those closer to forest and water resources reported drought to be rare. Food and water insecurity are the major vulnerabilities experienced by communities facing increased drought.

Table 10. Impact and Vulnerability Caused by Changes in Drought

Region	Change	Impact	Vulnerability
South	More severe	Increased coral, livestock, crop mortality; increased infant mortality	Increased food and water insecurity; population gaps from infant mortality; increased income insecurity (especially from loss of livestock)
Central	Inconclusive	Southern corridor: A large surface area of rice fields are not planted; low agricultural yields (rice, cassava); decrease in water sources Northern corridor: with the exception of 2005 severe drought is rare, although there are months with no rain; increased infestation of rats associated with drought (2005/2006)	Increased food insecurity; new heat-related health conditions; water insecurity
North	N/A	N/A	N/A

6.3. CURRENT ADAPTATIONS AND BARRIERS / CONSTRAINTS

While the impacts mentioned above paint a fairly negative outlook for communities, current and projected impacts of climate change are, and can continue to be, lessened through the adoption of adaptation strategies and risk management measures, which increase community resilience. "Adaptations," while perhaps not named so before, have a long historical presence in the daily life of villagers. It is natural that villagers will develop coping strategies to ensure the best possible standard of living. This section will therefore explore the current adaptations being observed in the surveyed communities in response to climate change impacts. While it is complicated to pinpoint a precise association between adaptation and climatic change, as a variety of driving forces (both climatic and anthropogenic) are generally involved, the link between the two will be made as best as possible. The main adaptations currently being adopted include diversification (both within and between livelihoods), improved technology, migration, supplementary livelihoods, and reforestation:

Diversification: In both the Southern and Northern regions there is conversion from agriculture to fishing and from fishing to agriculture. The main causes behind this conversion include a decrease in

both the food and fish stocks, which are aggravated by climatic changes in rain and temperature and increased cyclone activity. The result is an increasingly difficult application of appropriate technology since those that convert generally come from a history of culturally learned practice in the livelihood that they are converting from, with little experience in the livelihood they are converting to. In the Central region one of the most common adaptations is a diversification of crops. There are not only an increasing number of villagers planting crops that traditionally were not present in their agricultural planting cycles, but there is also an increase in counter-season cropping. It is common to see counter-season crops planted in rice paddies, which many villagers mentioned also improves the soil quality for future rice production due to the fertilizer applied to these crops. The main cause of diversification in the Central region is lower crop yields, particularly rice. In fact in some *Tanalala* communities beans are being produced strictly to be sold for rice (they are not eaten), even if it is economically disadvantageous for the communities to do so. However, the poor quality of soils and seeds coupled with increasing population pressure has proven to be a significant barrier to the large-scale success of crop diversification.

Technology: In the South, due to the water shortage from decreased rainfall, the water levels of wells have reached extremely low levels. To adapt to this change, there are efforts to build pumps for wells. However, pumps are costly and cannot be purchased or installed by the communities alone. In the Central and Northern regions, due to the disruption of the agricultural calendar, there has been an increased use of more resistant and productive seeds and a shift in agricultural practices. Adopted practices in the Central region include increased watering of rice seedlings, replanting seeds, increased use of natural fertilizer from composting, and the use of a plough instead of fire to prepare crop fields. Adopted practices in the North include improved rice techniques (choosing different rice varieties and planting in November to avoid flooding), an early cultivation period and the construction of small dams for better water management and control.

Migration: This adaptation was most noted in the Southern and Central regions. In the South, migration to new fishing grounds is an old practice among the semi-nomadic *Vezo*. However, with increased sedimentation, this practice is on the rise, causing an increase in population pressure on an already limited supply of resources and, in many cases, conflict among migrating and settled groups. In the Central region, migration generally occurs during the non-harvest season when villagers look for additional work elsewhere. As food stocks continue to diminish, preventing storage of excess food from the harvest season, migration continues to rise. In addition, there has been an increased trade of rum (east to west) as well as tobacco and salt (west to east) across the forest corridor.

Supplementary Livelihoods: The reduction in the viability of the principal livelihoods in these three regions, namely fishing and agricultural production, have led individuals to adapt by taking on supplementary livelihoods. This was principally observed in the Central and Northern regions where agriculture and husbandry are more widespread. In the Central region, the main supplementary forms of income generation observed were handicraft production, charcoal production, aquaculture, husbandry, and apiculture. One man interviewed claimed to have around 100 self-constructed beehives. Honey production from apiculture is also significantly on the rise in the North. Handicraft production, tourism, the production of traditional medicine, and increased subsistence agriculture in the coastal zones are additional income generation strategies that more rural communities in the North are turning to as alternatives or supplements to principal livelihoods.

Reforestation: This is an adaptation that was mentioned as occurring in all three regions, however does not yet appear to have significant success in any of them. In the South, reforestation is purely a coping strategy to address the decrease in fodder for cattle due to the increased temperature and decreased rainfall in this region. In the Central region, reforestation is mainly an adaptation to address the decreased firewood and construction wood supply. In the North, reforestation is used to counteract erosion from cyclones and floods in coastal areas, while inland reforestation efforts

address deforestation for agricultural purposes. The main barriers reported for the adoption of reforestation activities are sensitization and technical capacity-building.

In addition to these four main categories, there have also been policy adaptations within fishing communities in the South and North. Given the declining fish stock in the South, there is now a greater importance placed on the creation of fishermen’s associations or cooperatives as a method to give fishermen more control over the price of fish, and therefore revenue. In the North, a community management system for marine resources, GELOSE, was instituted in 2001 within villages around Antongil Bay. While the system still requires significant support from organizations such as WCS and CARE who have long-standing relationships with communities in the region, it does provide the first step in ensuring that management of marine resources is controlled by community associations.

There are various barriers to the adoption of these adaptations including sedimentation for fishermen, soil infertility for farmers, and investment/marketing for supplemental livelihoods. However, the main overarching barrier is an increased need for education and sensitization to address the lack of technical knowledge and capacity-building needed to adapt to many of the climatic changes that villagers are witnessing.

Table 11. Current Adaptation Measures and Barriers to Widespread Adoption

Region	Impact/Change	Adaptation	Barriers
SOUTH	Forest loss/deforestation – aggravated by increased drought and high winds	Reforestation for cattle foraging	1. Isolation 2. Illiteracy 3. Population Pressure
	Sedimentation (caused by cyclones) Note: Communities are semi-nomadic so migration is not a new change; it is aggravated by climate induced sedimentation	Migration	4. Price of fish fixed by intermediaries so revenue cannot be adjusted by fisherman according to available fish stock
	Increased drought, temperature; decreased rainfall	Diversification: shift from agriculture to fishing within a village	
	Decreased food stock both in crops and fish	Stocking dried manioc (this is an old practice but is increasing)	
	Decreased Rainfall	Wells with pumps	
	Decreased fish stock	Creation of fishermen’s associations/cooperatives	
	Overall decrease in standard of living	Repeated sacrifices to the sacred tree, Hazomanga	
	Lower crop (mainly rice) yields due to increased temperature and decreased rainfall;	Crop Diversification (cassava, sugarcane, banana, taro, sweet potato, beans, peanuts, vanilla)	1. Low soil fertility 2. Poor seeds 3. Population Pressure 4. Theft

Region	Impact/Change	Adaptation	Barriers
CENTRAL	Lower crop (mainly rice) yields and less income overall	Trading between neighboring communes	5. Land Tenure 6. Recent extreme poverty (former security of coffee production)
	Disruption of agricultural calendar and lower rice productivity from decreased rainfall and drought	Switching to more resistant and productive seeds	7. Lack of access to communication 8. Insufficient cultivable land
	Less water availability and lower agricultural productivity, particularly from unpredictable rain/temp	Changing agricultural practices: watering rice seedlings; re-planting when first seeds do not germinate; increasing compost use; use of plough	9. Lack of knowledge 10. Poor success rate for reforestation: insufficient saplings; lack of protection from cattle grazing; fires; lack of proper technique and follow-up/monitoring
	Lower rice yields	Increase in counter-season crop production	
	Reduction in viability of agricultural livelihood	Supplemental income from increased handicraft production; charcoal production; animal husbandry (aquaculture, poultry rearing)	
	Insufficient water to enable improved rice-farming techniques (i.e. SRI)	Building of traditional dams	
	Food shortage from crop failure or lower harvests	Increased temporary migration (mainly during non-harvest season)	
	Increased drought; decreased rainfall	Fire control mechanisms	
NORTH	Less firewood and construction wood	Reforestation	
	Less cultivable land; soil erosion in highlands	Settlement of lowlands	1. Level of instruction/technical know-how
	Water management and control for farming	Improved agricultural infrastructure including construction of dams	2. Health: malnutrition 3. Population Pressure
	Disruption of agricultural calendar and lower rice productivity from changes in rainfall and temperature	Improved rice techniques: selection of alternative seeds, planting in November to avoid flooding, diversification of crops, alternate cropping cycles	4. Access to communication 5. Investment/access to capital
	Changes in rainfall and temperature	Advancement of the cultivation period	

Region	Impact/Change	Adaptation	Barriers
	Lower fishing and agricultural yields	Livelihood conversion: agriculture to fishing; fishing to agriculture	
	Erosion from cyclones and floods	Reforestation and restoration efforts	
	Lower fishing yields; fish further out in ocean; tenure	Implementation of GELOSE (community management system)	
	Reduction in viability of fishing and agriculture livelihoods	Supplementary income: honey production; local crafts; tourism; traditional medicine; further developing market access	

6.4. ANTICIPATED CLIMATE CHANGE RELATED THREATS, ISSUES AND OPPORTUNITIES

Overall, communities report a pessimistic outlook for the future unless very urgent action is taken. In the Central and Northern regions most community members make the link between the rapidly changing climate and human activities. There exists the understanding that deforestation, burning, and fueled machinery provoke climate change; in fact in some communities the extent of awareness of the causes of climate change go so far as to include the actions of industrialized countries. In addition, there was some consciousness as to the role of air pollution in the destruction of the ozone layer, and consequently changes in the climate; as well as the capability of trees to store carbon. In the South, it was generally felt that life is difficult and will continue to become more difficult in the future, but not necessarily because of changes in the climate.

What is becoming quite clear in all regions is that climate change will exacerbate existing rural development challenges including income generation, food and water security, and health. Without the resources available to fall back on, rural populations are extremely vulnerable to small upsets in their livelihood production, making climatic unpredictability extremely dangerous for their continued subsistence. In addition, the increase in natural disasters and their effects (mainly cyclones and flooding) will require more emphasis to be placed on disaster management measures as well as disaster warning systems.

However, in the Central and North regions, it was noted that things could improve if the proper support and attention were given to creating solutions. In the Central region, community members showed a willingness and recognition of the need to adapt. Without provision of support to the extent necessary, though, they acknowledged that they would be forced to migrate in search of new work. This would greatly increase pressure on urban environments as most migration flows to urban centers. In the North there is already a large amount of conversion occurring between fishermen and agriculturalists demonstrating the present difficulty to maintain traditional livelihoods. In the Central region, proposed solutions focused on capacity-building within local communities as well as the construction of dams to improve water management for rice fields. Communities' current coping strategy of increased sugarcane cultivation for rum production could be channeled into other potentially more profitable industries if there were investment in the area. Likewise, current efforts to cultivate and sell tobacco could be improved if fair trade measures were promoted; with the added benefit of decreasing illegal sales.

In the Northern region, proposed solutions were centered on improving subsistence agriculture, including agricultural techniques, improved agricultural infrastructure including dam construction,

and crop diversification. Local fishermen are most in need of improved fishing techniques including more effective equipment.

The table below shows a more comprehensive list of solutions proposed by community members, which, given sufficient outside investment and support, could help address the major threats from climate change being faced by communities. These solutions are categorized by region and by applicable livelihood areas of intervention.

Table 12. Proposed Solutions to Adapt to Climate Change and Threats Addressed

Region	Areas of Intervention	Proposed Solutions	Threats Addressed
SOUTH	AGRICULTURE	Increased technical capacity-building (especially for those converting to agriculture) More resistant seeds	Food security; drought; soil fertility
	HUSBANDRY	Increased access to veterinarians	Income generation; food security
	FISHING	Cold room for storing marine produce	Food security; income generation
	HUMAN DEVELOPMENT	Improved hygiene and sanitation Improved storm warning system	Health; food security Food security; income generation; cyclones; health
CENTRAL	ENVIRONMENT/ NATURAL RESOURCES	Further support to capacity-building in reforestation/tree-planting, especially species that increase soil fertility like <i>Bonara</i> , flowering plants, and fruit trees	Water supply, fuel supply, soil fertility, lack of technical ability in tree-planting; lack of pollen for bees; food security/income generation (fruit trees)
		Further support to curbing “tavy” or slash-and-burn agriculture particularly along waterways and mountain-tops	Inland flood protection, water supply, soil fertility, low yields, biodiversity loss, health
		Find alternative sources of fuel	Insufficient firewood
		Growing grass for erosion prevention (i.e. vertiver)	Soil fertility
	AGRICULTURE	Further construction of dams (need technical assistance and funding) Improved supply of seeds: provision of improved seeds adapted to climatic changes	Food security
		Adoption of fallow periods and crop rotation	Soil fertility

Region	Areas of Intervention	Proposed Solutions	Threats Addressed
		Assistance for improved agricultural techniques: composting (production for natural fertilizer), watering, counter-season crops in rice paddies, plough vs. burning land, regeneration of sugarcane lots	Food Security; income generation; soil fertility
		Improved agricultural equipment	Food security - low crop yields
		Further crop diversification (increase number of cash crops to replace coffee; vegetable gardening; cultivation of yams – for increased nutritional value)	Income generation (past over-reliance on coffee has increased poverty with the drop in coffee prices) ; food security; health
		Plant cassava earlier so that it is available in the ‘non-harvest’ season	Food security (responds to the prolonged “non-harvest” season)
		Closer monitoring, support and control of agriculture projects	Food security (improved agricultural practices from increased external intervention)
		Increase irrigation channels and banks around rice fields	Food security; flood protection
		Increased channels at the top of and around “tavy” fields	Soil fertility
	HUSBANDRY	Improved animal health (i.e. vaccinations)	Income generation; food security
		Further develop apiculture, aquaculture, and poultry-farming	
		Develop pig farming	
	HUMAN DEVELOPMENT	Infrastructure for clean water provision	Health; agriculture
		Sensitization on family planning practices	Health; food security; biodiversity loss
		Build new schools to promote access to education in rainy season	Flooding; food security; poverty

Region	Areas of Intervention	Proposed Solutions	Threats Addressed
		Improved natural resource management and governance: stricter controls on hunting/collecting species; respect harvesting times of fish; stop practice of fish poisoning	Biodiversity loss
		Make houses more solid and increase warning of storms for advance preparation	Flooding
		Improved hygiene and sanitation	Health; low yields
		Development of new industries around sugarcane production (ethanol) – need investment	Income generation
		Improve capacity-building to adopt new income-generating activities or improve existing ones	Income generation; low yields; biodiversity loss
		Improve marketing and open new markets for produce (improve roads)	Income generation
		Increase creation of community rice/grain stores	Food security
		Increased creation of village associations and communal action	Food security; income generation
NORTH	ENVIRONMENT/ NATURAL RESOURCES	Reinforcement of COBA activities	Biodiversity loss, water supply, fuel supply, unsustainable resource management
		Increased Reforestation and restoration efforts	Water supply, fuel supply, soil fertility, lack of technical ability in tree-planting; lack of pollen for bees; food security/income generation (fruit trees)
	AGRICULTURE	Research into short-cycle seeds	Food security
		Construction of dams and tributary canals that better control water flow into ag fields	Flood protection
		Increased technical assistance to improve cultivation techniques	Food Security; income generation; soil fertility

Region	Areas of Intervention	Proposed Solutions	Threats Addressed
		Improved agricultural infrastructure	Food security; flood protection; increased rainfall management
		Improvement of plantation cultivation (intensified rice and cash crop agriculture)	Food security; income generation
	HUSBANDRY	Better management of pasture land (Makira zone)	Income generation; food security
		Increase access to veterinarians	
	FISHING	Technical, material and financial aid	Income generation; food security; cyclones
		Promotion of small fishers (mainly through fishermen's associations with gov. control)	Income generation; food security
		Improved line fishing (put in place a fishermen's association for line fishing)	
	HUMAN DEVELOPMENT	Improved education and literacy among rural population	Income generation; food security; health
		Improved access to health care – construction of a health center in each Fokotany was proposed	Health; food security

6.5. PROPOSED IMPLEMENTATION STRATEGIES

Based on the proposed solutions put forth by communities, a preliminary list of proposed strategies of implementation (or priority action areas) was compiled. Since many of the constraints to the adoption of coping mechanisms revolve around levels of technical capacity, knowledge, and support, many of the proposed interventions center on providing more technical assistance. Support for organizational development, improved agricultural techniques, and marketing are particularly important. In the Central region, improved governance, rural security, provision of seeds and saplings for tree-planting and local capacity-building were identified as key conditions necessary for the adoption of specific adaptations. In the North, there was emphasis placed on the need for community-led adaptation strategies, particularly the creation of local-level associations that would be able to work with technicians, search for financing and ultimately implement projects.

Although the regions have somewhat distinct climate change impacts and vulnerabilities, those elements that were identified as being key for adapting to these vulnerabilities were across-the-board quite similar. Overall, an increase in education (especially literacy), technical capacity-building (particularly for agriculture), reforestation, animal health, family planning, development of fisheries associations, and diversification of income-generating activities was called for.

These are not new approaches, emphasizing once again that climate change will exacerbate already acknowledged challenges in rural development and environmental conservation and create a serious threat to poverty alleviation efforts. What is clear is that the implementation of adaptation measures will be consequential for curbing the impacts of climate change on the rural population in Madagascar.

Table 13. Proposed Implementation Strategies to Facilitate Adaptation to Climate Change

Areas of Intervention	Strategies
ENVIRONMENT/ NATURAL RESOURCES	<ol style="list-style-type: none"> 1. Reforestation; each household should plant trees including trees for construction purposes and trees that promote soil fertility 2. Increase protected areas (each household should have its own protected area and management plan) 3. Reinforce COBA activities
AGRICULTURE	<ol style="list-style-type: none"> 1. Capacity building on improved agricultural techniques, including promoting ploughing rather than burning (spades rather than sickle), compost-making and the use of fallow periods and crop rotation 2. Improved fire-management, including stopping deforestation/”tavy” around spring sources and hilltops and using fireguards 3. Support to forest management committees and fire committees (capacity building, monitoring) 4. Increased research into adaptive/resilient seed varieties 5. Increased investment and capacity-building for water management systems (ie. dam and drainage canal construction)
HUSBANDRY	<ol style="list-style-type: none"> 1. Programs to promote livestock health, particularly of cattle 2. Improve management of pasture land 3. Diversification of animal farming, i.e. increase pig farming 4. Increase capacity-building for bee and fish farming
FISHING	<ol style="list-style-type: none"> 1. Creation of associations/cooperatives for line fishermen 2. Increased support for small fishermen’s associations/cooperatives 3. Increase technical capacity-building and investment in equipment
HUMAN DEVELOPMENT	<ol style="list-style-type: none"> 1. The promotion of family planning 2. Environmental education particularly in schools 3. Diversifying income-generation activities 4. Finding new markets for local products 5. Improve education, particularly literacy 6. Increase communication access, particularly for disaster warning

7. DISCUSSION

7.1. IMPACTS AND ADAPTATIONS FOR AGRICULTURE:

Climatic changes will reduce soil fertility, particularly in highland areas where increased rainfall is decreasing soil cover through erosion. In the Central region, sensitization on composting has already begun in many communities; however, the amounts of natural fertilizer being produced through compost are still not fulfilling the agricultural need. In most cases, a mixture of natural fertilizer and chemical fertilizers is being used. However, in some cases where farmers are unable to afford the chemical fertilizers, the only input to agricultural fields is biodegradable waste, thrown on before being properly composted. This mainly occurs in *Tanalana* communities in the Central region. Scaling up natural fertilizer production in these areas would be very useful to cope with soil degradation, particularly compost centers that collect compost waste and produce enough to sell back to surrounding farmers at a low cost. Reforestation activities have also been started in many communities, but need to be scaled up for real impact.

Climate changes are increasing crop failure due to unpredictable rainfall, droughts, and cyclones. Communities on the whole are currently adapting by diversifying the varieties of crops planted and planting more than one crop at the same time. An increase in counter-season cropping and vegetable gardening is already observed, but should be scaled up. Vegetable gardening could be productive if efficient market linkages were made.

Cropping seasons are no longer routine due to erratic rainfall and changes in temperature. Farmers must now decide when to plant crops and which varieties to use. Increased research into adaptive seed varieties and consequent access to these varieties is necessary.

Water supply for agriculture on the whole is expected to decrease, with increasing concerns for the level of water management/control necessary to intensify agricultural production. The construction of small dams will be particularly important for coping with water control. Overall increased infrastructure and capacity-building for use and maintenance of water management systems will be required. Other water-harvesting techniques may alleviate stress in the near term.

7.2. IMPACTS AND ADAPTATIONS FOR FISHING:

The increase in cyclones appears to have the largest effect on fishing by worsening sedimentation. As a result of this there has been increased migration to new fishing grounds, increased supplementary livelihoods, and, in worst case scenarios, conversion from the livelihood altogether. This latter adaptation is especially dangerous because conversion from fishing is mainly towards agriculture, a livelihood that is even more vulnerable to climate changes and may not be able to provide a viable or sustainable alternative.

Fishermen are on the whole required to travel longer distances out to sea to fish, creating an increased reliance on material and financial aid to obtain the necessary equipment (i.e. motors) to do so. In order to best obtain material, financial, and technical aid, as well as increase the rights of small-scale and line fishermen, more attention should be given to the creation and improvement of fishermen's associations/cooperatives. Further energy should also be put into the development and improvement of community management systems for marine resources.

7.3. IMPACTS AND ADAPTATIONS FOR SUPPLEMENTARY LIVELIHOODS:

An increase in livelihoods (stand-alone or supplemental) has been observed as agriculture and fishing are becoming less able to sustain human needs. These generally include husbandry, apiculture, aquaculture, charcoal production, tourism, and handicrafts. Most of these options require strong market linkages, micro-financing and technical capacity-building in order to be viable. Improved and expanded husbandry will require increased access to veterinarians.

An increase in apiculture (bee-keeping) for honey production has been observed in the North and Central regions. The advantage of bee-keeping is that beehives can be constructed very quickly by local community members and bees take very little effort to maintain. However, in some cases, bee-keeping was reported to be unsuccessful because of a lack of flowering plants and bee colony disturbance/migration due to a change in seasons. Aquaculture or fish-farming is another option that has been observably increased within communities in the North and Central regions. Commonly used fish species used include royal carp (only in the Central region) and tilapia.

While erratic weather patterns have had some reported effects on grasses used for handicrafts, overall it seems that this livelihood is not very climate-sensitive, providing a good option for supplementary income. Rum (from sugar cane) and tobacco production have also increased as a diversification/supplemental income measure, and could continue to be viable in the future with increased infrastructure and market development.

7.4. IMPACTS AND ADAPTATIONS FOR HUMAN DEVELOPMENT:

Water supply and/or quality are expected to decrease. In the Northern region, where water is more abundant, water quality and sanitation are increasingly problematic. In the South and Central regions, where water is on the whole less abundant, water supply is the more urgent issue. Nevertheless, there appeared to have been an increase in water-borne illness across the board, both for humans and livestock.

An increase in flooding has restricted access to schools. Increased infrastructure will be needed to cope with this problem, either by constructing more accessible schools or by improving flood protection to enable road access to those in existence.

Decreased food stock, both from climate changes affecting agriculture and fishing, as well as decreased income generation, is one of the major current challenges for communities and is expected to worsen in the future. Increased malnutrition and related illnesses (i.e. faintness/headaches) are already being observed and have detrimental effects on worker productivity.

Cyclones, flooding, and droughts destroy crops, reduce fish stocks, decrease plants used for handicraft production, ravage plantations, and increase livestock and human mortality. In order to prepare and take necessary precautions for these events, better access to communication is necessary to enable disaster warning systems to function.

Population pressure aggravates many of the impacts of climate change, increasing the difficulty for adaptation. Many of the communities mentioned an awareness of this issue and an interest in increasing family planning measures.

8. CONCLUSIONS AND RECOMMENDATIONS

The impacts of climate change will increase the challenge of ongoing poverty alleviation efforts in Madagascar. It will hit hardest those whose livelihoods are more intimately tied to local resource bases and therefore more climate-sensitive. Survey findings point to high vulnerability within agriculture-based livelihood systems and fishing-based livelihood systems. This demonstrates the immediate need for an acknowledgement and improved understanding of vulnerabilities so that appropriate adaptation measures can be implemented swiftly. In addition, within these subsistence systems, those groups already marginalized will be at a higher risk; special attention should be given to reducing vulnerability amongst women, young children, elderly, and the ill/disabled. In Itampolo, for example, infant mortality was so high during the 2005 drought that a gap can now be observed in the child population that corresponds with children born in 2005.

The specific impacts of climate change on rural populations around Madagascar are many; however it appears that the ultimate result will be a reduction in food security, water quality and supply, and income. Livelihood options are becoming scarcer or more difficult, leading to conversion or migration. Population pressure is cited continuously as an external driving force that compounds the impacts of climate change.

Table 14. Climate Change Impacts and the Development Commitments of the Madagascar Action Plan (MAP)

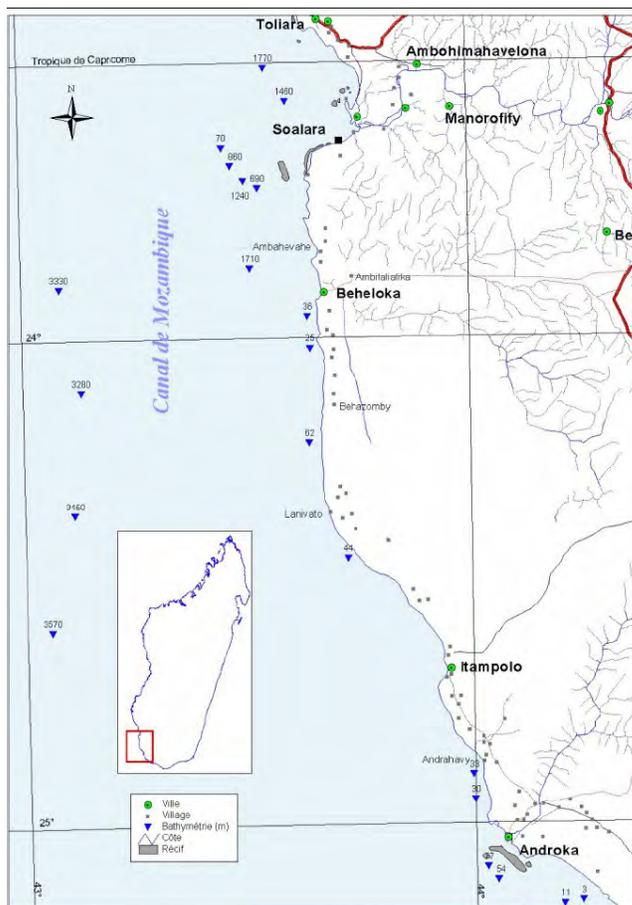
MAP Commitments	Potential Climate Change Impacts on Commitments
<i>Responsible Governance</i>	<ol style="list-style-type: none"> 1. Increased security threat (increased theft mainly of cattle) 2. Increased need for good governance and management of protected areas and marine systems 3. Need for increased provision of health clinics and schools
<i>Connected Infrastructure</i>	<ol style="list-style-type: none"> 1. Destruction of infrastructure from increased cyclones and flooding 2. Decreased access to potable water 3. Increased threat to sanitation and hygiene 4. Increased need for disaster warning system
<i>Educational Transformation</i>	<ol style="list-style-type: none"> 1. More children will have to forego school to help earn an income or with increasing chores (ie longer distances to fetch firewood) 2. Malnourishment and increased illness will reduce attendance and/or impair learning potential 3. Flooding and storms reduce access to schools for many children
<i>Rural Development and a Green Revolution</i>	<ol style="list-style-type: none"> 1. Damage to homes, water supply, health, and food stocks, undermining the ability to earn a living 2. Exacerbate conflict over natural resource use, possibly causing migration 3. Insufficient water or control of water for agricultural intensification 4. Increased erosion causing soil infertility

MAP Commitments	Potential Climate Change Impacts on Commitments
<i>Health, Family Planning and the Fight Against HIV/AIDS</i>	<ol style="list-style-type: none"> 1. Increased water-borne illness (i.e. cholera and dysentery) and increase in malaria 2. Increase in heat-related illness (i.e faintness or headaches) reducing worker productivity 3. Increased malnutrition from reduced water quality, supply, and food stock
<i>High Growth Economy</i>	<ol style="list-style-type: none"> 1. Potential increase in tourism and handicraft-based livelihoods 2. Reduction in agricultural productivity, including cash crops for export (.e. vanilla, cloves) 3. Increased unskilled labor force searching for jobs
<i>Cherish the Environment</i>	<ol style="list-style-type: none"> 1. Increasing soil degradation 2. Reduction of forest cover and increased biodiversity loss 3. Decrease in water supply and quality
<i>National Solidarity</i>	<ol style="list-style-type: none"> 1. Devaluation of ancestral wisdom, particularly in agricultural practices 2. Potential increase in solidarity from shared challenges caused by climate change amongst rural population; however, an increased poverty gap could cause animosity between urban/rural or less vulnerable/more vulnerable groups

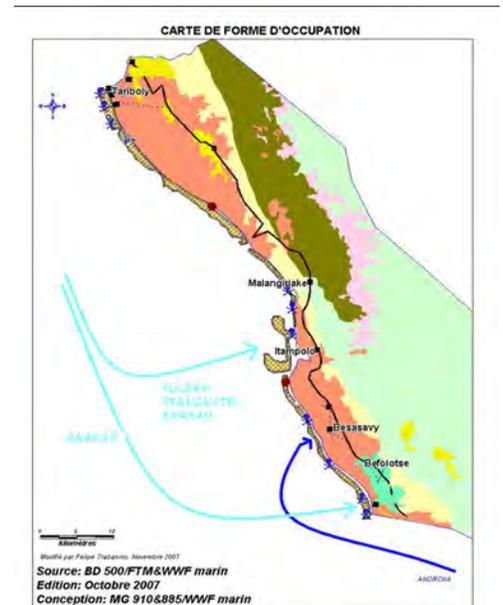
The findings from the local-level surveys conducted demonstrate that rural populations in Madagascar are already experiencing climate change. Therefore it is imperative that support for adaptation is provided immediately and that efforts to develop a strong cross-cutting national adaptation strategy are prioritized. Sectors that address water, food security, health, and disaster management must be involved and have a coordinated action plan. Many of the solutions proposed by communities to adapt to climate change are existing intervention activities; therefore, in some cases, building up project support for adaptation may simply be a matter of scaling up or reprioritizing certain activities.

Finally, impacts of climate change on cultural knowledge are creating both a threat and an opportunity. Rice farmers and other agriculturalists, for example, can no longer rely on the wisdom of their ancestors (cultural calendars) since the structure of seasons has been devalued by climatic changes. While this threatens cultural identity, it also may help convince rural populations of the need for adaptation, thereby increasing openness to new agricultural techniques.

ANNEX I. MAP OF TULEAR SUD REGION (SOUTH REGION) AND COMMUNE OF ITAMPOLO



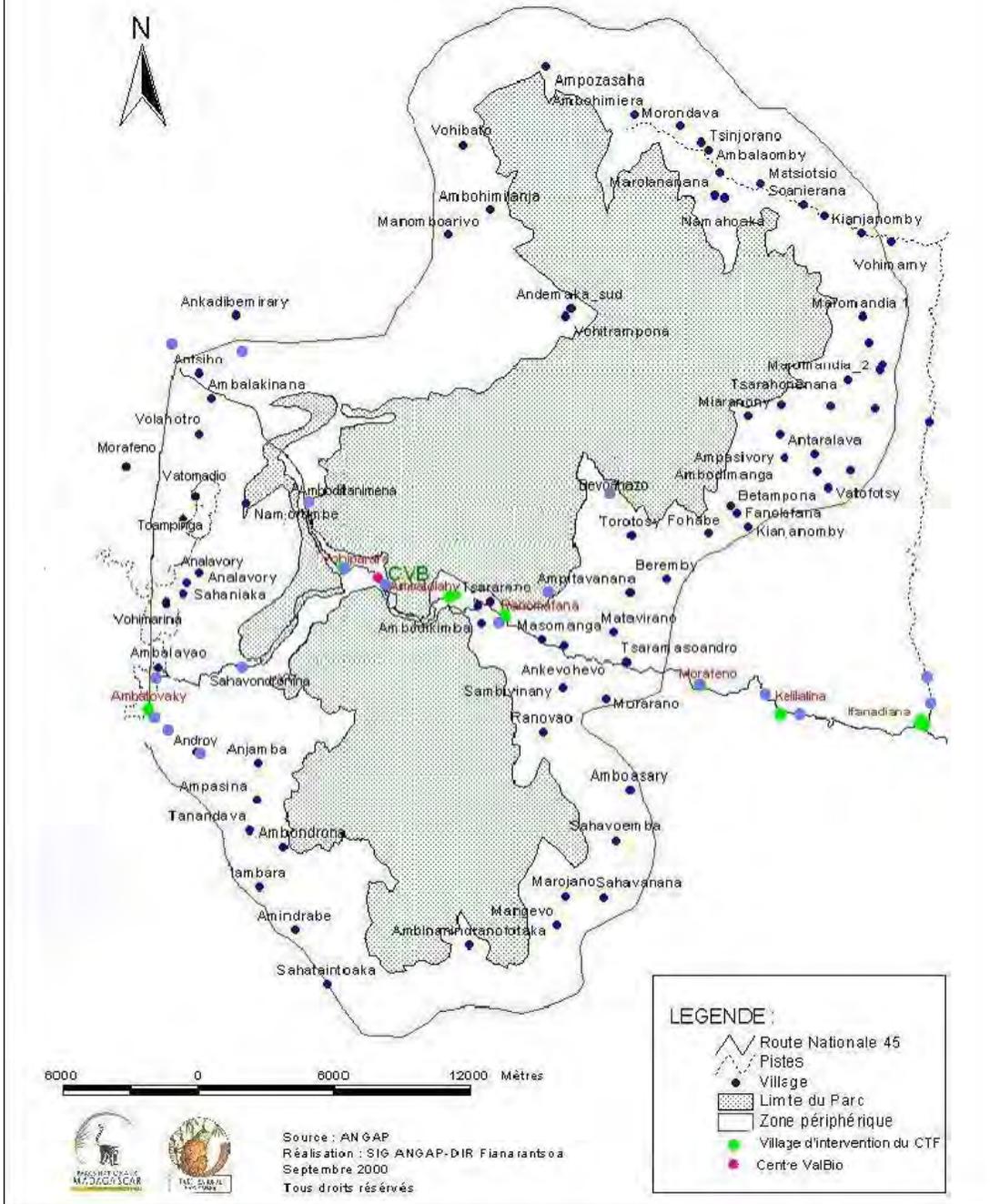
Source: WWF



Source: WWF

ANNEX 2. MAP OF CENTRE VALBIO SURVEYED SITES (LIGHT BLUE) AROUND THE RANOMAFANA NATIONAL PARK (CENTRAL REGION)

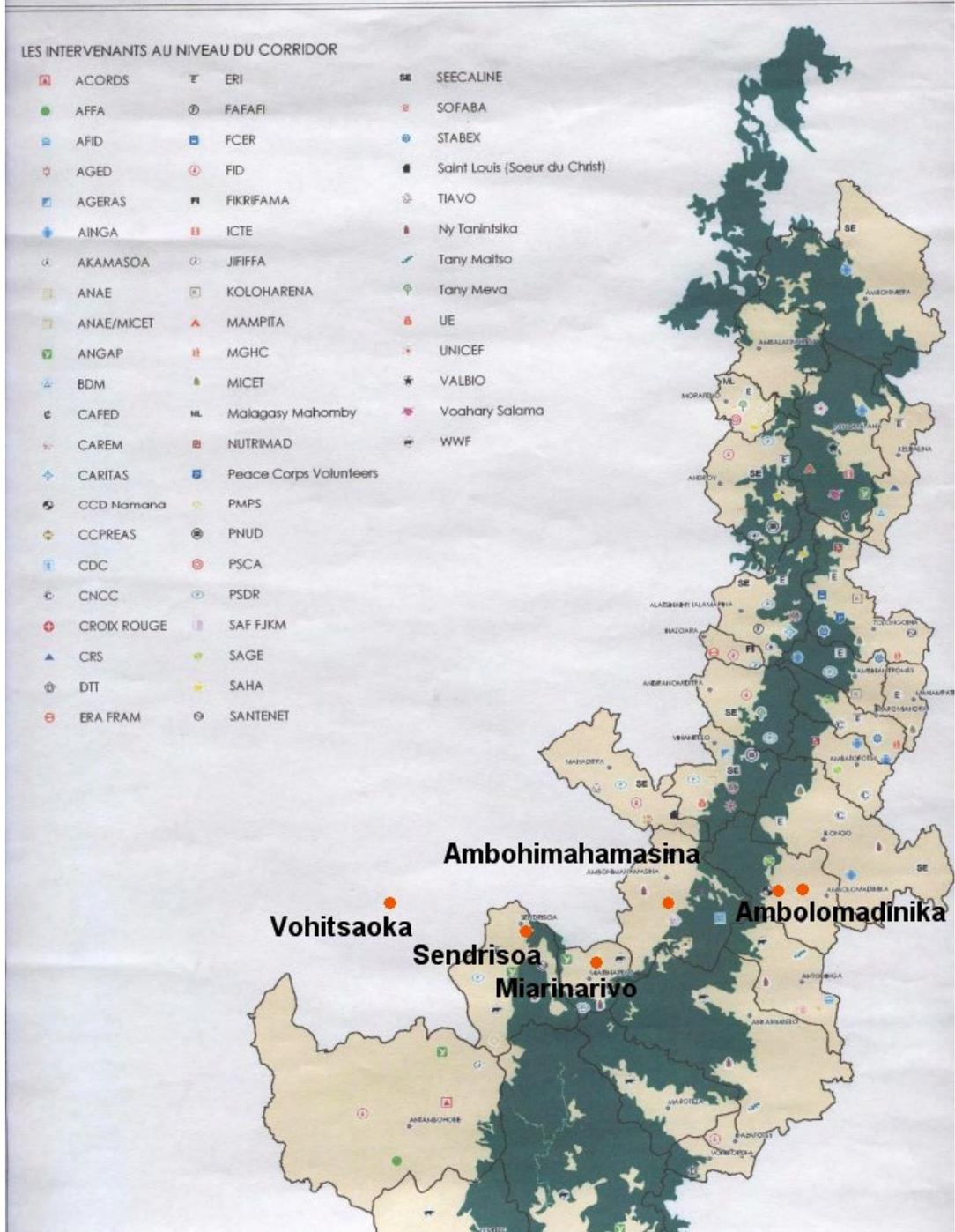
Localisation des interventions du programme CTF dans la zone périphérique du Parc National Ranomafana



Source: Centre ValBio

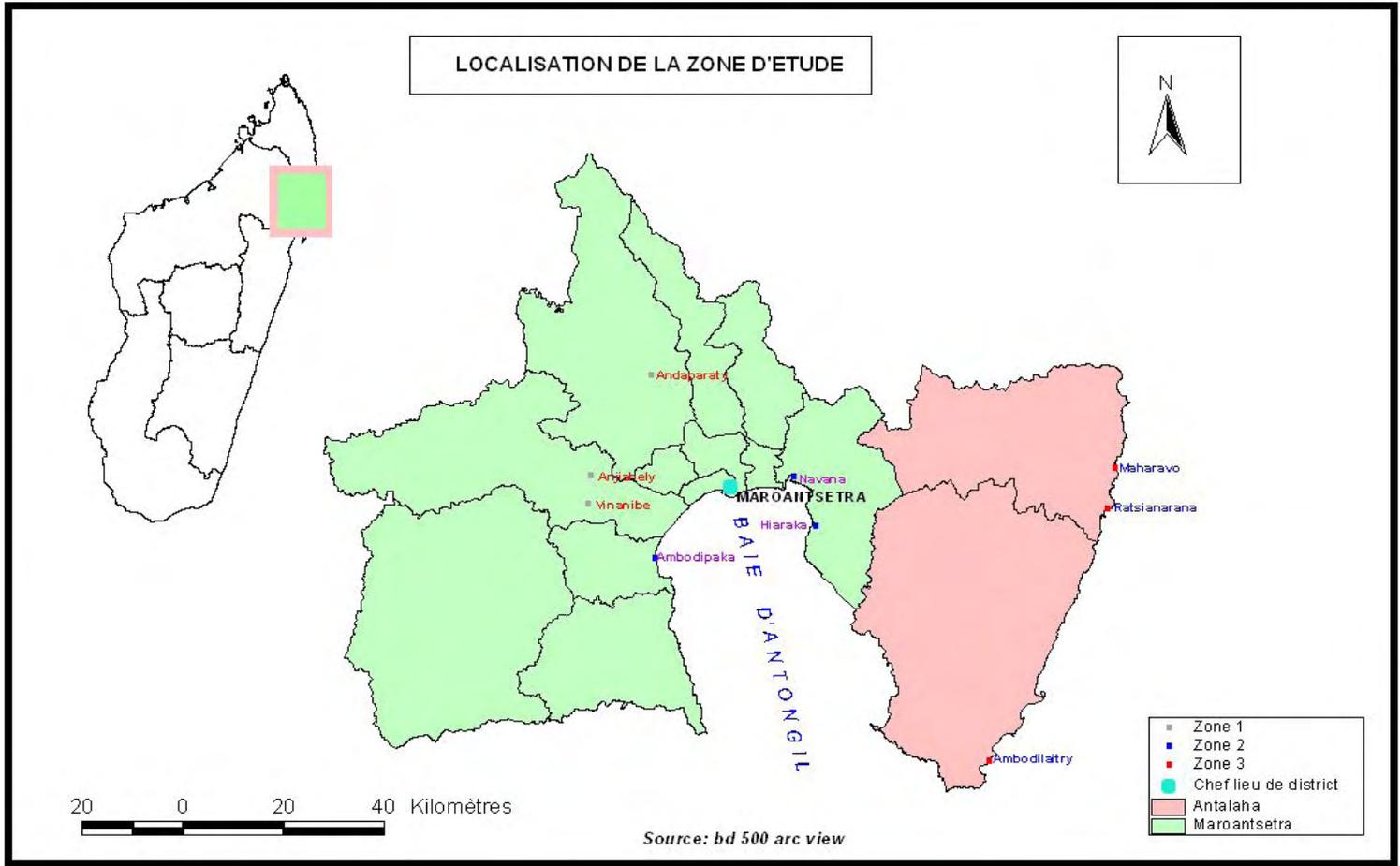
ANNEX 3. MAP OF NY TANINTSIKA SURVEY SITES NEAR ANDRIGITRA NATIONAL PARK (CENTRAL REGION)

LA REPARTITION DES INTERVENANTS DANS LE CORRIDOR RANOMAFANA - ANDRINGIT



Source: Ny Tanintsika

ANNEX 4. MAP OF WCS SURVEY SITES AROUND MASOALA AND MAKIRA PROTECTED AREAS (NORTH REGION)



Source: Wildlife Conservation Society

**ANNEX 5.
QUESTIONNAIRE USED
FOR CLIMATE CHANGE
SURVEYS CONTRACTED
BY USAID/IRG IN
CENTRAL AND NORTH
REGIONS**

FOCUS GROUP

A. Identification and Characterization of Stakeholder Group

Interview animator :

Address :

Date

Hour

Area

Region

District

Commune

Fokontany

Quarter

Denomination or category of the interviewed group

Fokonolona

COBA

Other association

Age intervals		
Sex	M	F
Number of participants		

Population's income-generating activities (list by order of importance) :

Cultivation	
Farming	
Fishing	
Other (to specify)	

The supporting associations operating in the area:

Associations / NGOs	Domains of intervention	Forms of cooperation

B. Local Awareness and Perception of climate variability and trends related to climate change
(over the past 10-20 years)

B-1- Rainfall:

Important

Unchanged

Little

(in historical matrix)

Rainfall	Last year	5 years ago	10 years ago	15 years ago	20 years ago	Observations
Quantity						
Period						
Duration						

Impacts of the situation on the population's overall existence, the way they lived it, and suggestions for addressing the problems.

B-2- Temperature

Hot

Constant

Cold

(in historical matrix)

Season :	Last year	5 years ago	10 years ago	15 years ago	20 years ago	Observations
hot						
cold						

Particular observation (Impacts of the situation on the population's overall existence, the way they lived it and suggestions for addressing the problems)

B-3- Cyclone

Frequent

Rare

Violent

Normal

Particular observation (Impacts of the situation on the population's overall existence, the way they lived it and suggestions for addressing the problems)

B-4- Flood

Frequent

Rare

Important

Constant

Little

Particular observation (Impacts of the situation on the population's overall existence, the way they lived it and suggestions for addressing the problems)

B-5- Drought

Frequent

Rare

Severe

Constant

Particular observation (Impacts of the situation on the population's overall existence, the way they lived it and suggestions for addressing the problems)

B-6- Water sources

Numerous

Constant

Fewer

Good

Bad

Water source	At the present	5 years ago	10 years ago	15 years ago	20 years ago	Observations
Number						
Abundance						
Quality of the water						

Particular observation (Impacts of the situation on the population's overall existence, the way they lived it and suggestions for addressing the problems)

Changes in terms of time spent for fetching water for the household needs:

B-7- Surface of the forest core

Diminishing

Expanding

Unchanged

(List the tree species often used)

Usage of timber	At the present	5 years ago	10 years ago	15 years ago	20 years ago	Observations
Cooking timber						
Building timber						

Particular observation (Impacts of the situation on the population's overall existence, the way they lived it and suggestions for addressing the problems)

Changes in terms of time spent fetching cooking timber:

Changes in terms of varieties of the other forest products (ex: rainfall, humus,)

B-8- Agricultural land

Diminishing	<input type="checkbox"/>
Sterile	<input type="checkbox"/>
Unchanged	<input type="checkbox"/>

List changes observed concerning the different existing kinds of soil:

Soil	Ricefield	Land	Cultivation of ...	Cultivation of	Cultivation of...	Observation (changes occurring compared to the previous situation)
Surface						
Fertility						
Characteristics (ex: crumbling/showing red soil...)						

In which area is the soil degradation obvious? Why?

Particular observation (Impacts of the situation on the population's overall existence, the way they lived it and suggestions for addressing the problems)

Changes observed concerning the quantity of pasture:

B-9- Living creatures

➤ **Tree species**

How does the quantity of tree species vary (per species)?
What are the extinct and disappearing tree species? Why?

➤ **Forest or land fauna species**

How does the number of fauna species vary (per each species)?
What are the extinct and disappearing land fauna species? Why?

➤ **Aquatic fauna species (sea, water)**

How does the number of aquatic fauna species vary (per each species)?
What are the extinct and disappearing aquatic fauna species? Why?

Particular observation (Impacts of the situation on the population's overall existence, the way they lived it and suggestions for addressing the problems)

C. Consequences and impacts of climate related changes and trends – with particular attention to livelihoods and socio-economic impacts

C-1- What are the different impacts of the climate related changes and trends on the people's health?

	Sicknesses	Frequencies
1		
2		
3		
4		

(1): high, low, constant

Particular observation (Impacts of the situation on the population's overall existence, the way they lived it and suggestions for addressing the problems)

C-2- Changes in terms of food stock and the summer period (hard season)

Food stock

	Observations (reasons)
Diminishing	
unchanged	
Increasing	

Summer period (Hard season)

	Observations (reasons)
Extended	
unchanged	
longer	

Particular observation (Impacts of the situation on the population's overall existence, the way they lived it and suggestions for addressing the problems)

C-3- Changes occurring in terms of economy, income-generating activities:

➤ **Cultivation**

Income-generating activities	At the present	5 years ago	10 years ago	15 years ago	20 years ago	Observations
Income-generating activities and crops quantities....						
Varieties....						

(matrix showing population rate practising different IGAs).

Impacts on cultivation land

Types of cultivation land	Land surfaces and types (1)				Observation
	At the present	5 years ago	10 years ago	15 years ago	
Ricefield					
.....					
.....					
.....					
.....					
.....					

Particular observation (Impacts of the situation on the population's overall existence, the way they lived it and suggestions for addressing the problems)

.....

.....

.....

.....

.....

C-4- Fire

Specify the burnt land surface:

Types of fire	At the present	5 years ago	10 years ago	15 years ago	20 years ago	Observation (period during which fires are frequent, the agents...)
Charcoal fire						
Park fire						
Agricultural fire						

Intended fire						
----------------------	--	--	--	--	--	--

Particular observation (Impacts of the situation on the population's overall existence, the way they lived it and suggestions for addressing the problems)

C-5- Other impacts worth to specify particularly

D. Expectations of environmental and socio-economic changes in the future and perceptions of vulnerability based on local observations and assessment of current trends

D-1- In your opinion, how would be the rainfall and the temperature in the future?

D-2- In your opinion, how would cyclone, flood and drought occur in the future?

D-3-According to the present context, how would be the use of land and natural resources in the future?

D-4- How do you perceive your livelihoods in the future with these climate changes (Food sufficiency, health, income, standard of living...)

D-5- Which of these climate changes may entail important problems in daily life? Why?

D-6-According to you, what may be the origins of such climate changes?

D-7- Apart from climate changes, what may be the other reasons which can negatively influence the earning of living, nutrition, standard of living and health?

D-8-What are the consequences of the climate changes on the sustainable use of natural resources and environment protection?

D-9- Apart from climate changes, what may be the other reasons which can negatively influence the sustainable use of natural resources and environment protection? (forest core, park, water, aquatic resources, and living creatures)

E. Observations on Responses and Adaptation

E-1-What did the farmers do to cope with climate changes?

What are the farmers' other means for multiplying crops (export/consumption products)

Barrage	<input type="text"/>
Fertilizers	<input type="text"/>
Technologies	<input type="text"/>
Other	<input type="text"/>

Methods used for preventing soil erosion (DRS)?

Methods used for managing and using water in a sustainable way?

Methods used for protecting forest core?

Other methods used for managing and using natural resources?

Other means used for increasing family income?

E-2- What were the strategies used for multiplying farming products?

E-3- Setting up of a management plan relating to the fishing sector and fishing period?

Request for cooperation with projects?

F. Observation about barriers or principal constraints to adaptation to climate change and implementation of interventions to reduce vulnerability / facilitate adaptation

F-1-What are the basic strategies for reducing the drawbacks of climate changes?

F-2-What may be the constraints to the implementation of these strategies?

F-3-What other possible solutions or suggestions do you propose for enabling the basic population to cope with climate changes?

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