

Climate Change Adaptation Series: Document 4

VILLAGE VULNERABILITY ASSESSMENT AND CLIMATE CHANGE ADAPTATION PLANNING (V&A): MLINGOTINI VILLAGE, BAGAMOYO DISTRICT, TANZANIA



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1. Coastal and Marine Ecosystems in a Changing Climate: the Case of Tanzania.
2. Workshop Proceedings: Tanzania Coastal Climate Change National Adaptation Planning Workshop
3. Village Vulnerability Assessments and Climate Change Adaptation Planning (V & A): Kitonga, Bagamoyo District
4. Village Vulnerability Assessments and Climate Change Adaptation Planning (V & A): Mlingotini, Bagamoyo District
5. Rapid Assessment of Shoreline Characteristics and Dynamics of the Lazy Lagoon at Mlingotini Village, Bagamoyo
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7. Livelihoods, Climate and Non-Climate Threats and Adaptation: Bagamoyo District Coastal Villages
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10. Village Vulnerability Assessments and Climate Change Adaptation Planning (V & A): Mwembeni, Pangani District
11. Village Vulnerability Assessments and Climate Change Adaptation Planning (V & A): Sange, Pangani District

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1. INTRODUCTION

There is now wide agreement by most scientists and climate change professionals that climate change and increased climate variability are already occurring and having serious consequences for many African countries, including Tanzania. The predictions from the experts on climate change are that the problems caused by climate changes will increase and make management of coastal ecosystems and improvements to community resilience even more difficult. The following threats are predicted to cause major problems for coastal resources and the well-being, safety, and food security of coastal communities:

1. More unpredictable precipitation (seasonality and intensity)
2. Increases in strong storms
3. Sea level rise
4. Increased sea surface and ambient air temperatures
5. Increased ocean acidification

These climate and chemical threats and the problems they create are on top of and in addition to existing local stresses. In most of coastal Tanzania, these include deforestation, over fishing, deterioration in water supply and quality, and development pressures.

Beginning in 2010, the Pwani Project initiated an effort to help local leaders and government to assess climate change impacts and find ways to adapt to current and future climate change impacts in a strategic way using their own resources and knowledge. This is part of a larger coastal management effort in a partnership with the government of Tanzania and the United States Agency for International Development (USAID). This Project has a geographic focus on the island of Unguja in Zanzibar and the ecologically important northern coast of mainland Tanzania – Bagamoyo and Pangani Districts. The overall goal is to help sustain the flow of environmental goods and services; revise the trend of environmental destruction of critical coastal habitats; and improve the wellbeing of coastal residents in the Bagamoyo-Pangani and Menai Bay Seascapes.

The initial work on climate change targeted two coastal, rural villages in Bagamoyo District – Mlingotini and Kitonga. Historic Mlingotini village is located directly on the Indian Ocean, sheltered by the nearly pristine Mlingotini Bay (also sometimes referred to as “Lazy Lagoon”). Livelihoods are predominantly resource based: traditional fishing, seaweed farming, small scale agriculture and more recently the beginnings of small-scale ecotourism. In this rural village people are close to the sea, the rise and ebb of the tide, and the seasonality of rain and prevailing winds. They are aware of climate change and climate variability and how it effects their lives.

The Pwani Project, in partnership with District government staff and CEEST, a local NGO, began a process of meeting with and working with village leadership in the two locations to conduct village-level climate change vulnerability assessments and adaptation planning (V&A). In each village, a 12 person Climate Change Committee, with an equal number of men and women was formed. This report documents the methods used and results of the V&A.

Specific objectives of village-level V&A include the following:

- Develop awareness and understanding of climate change impacts, vulnerability and adaptation options
- Find local champions for climate change adaptation actions
- Demonstrate low cost, low technology methods for vulnerability assessment and adaptation planning
- Share experience and best practices across villages and with District government

The overall goal is to maintain healthy coastal ecosystems and reduce the harmful effects of climate change impacts on coastal communities. The intention of the Pwani project is to transfer and build on the lessons learned from this experience in V&A to other coastal villages in the Pwani Project area



Figure 1 Steps in the climate vulnerability assessment process. Source: USAID, 2009



Figure 2 Mlingotini, along the shore of Mbegani Bay

2. METHODOLOGY

Vulnerability is defined as the degree to which a human or natural system is susceptible to, or unable to cope with, adverse effects of climate change. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Following the guidance of the USAID report “Adapting to Coastal Climate Change: A Guidebook for Development Planners” (available at <http://www.crc.uri.edu/download/CoastalAdaptationGuide.pdf>), this V&A exercise sought to understand the **potential impact** of climate change and climate variability and develop an initial list of response options (planned adaptation measures). **Planned adaptation** is a process of deliberate decision making to take societal actions to reduce harm or exploit beneficial opportunities in response to actual or expected climatic changes or their impacts.

Potential impact is a function of both climate and non-climate stresses and vulnerability factors. Vulnerability factors are the types and amount of assets at risk (**exposure**), the degree to which those assets and people are impacted (**sensitivity**), and the ability to cope with actual or expected changes (**adaptive capacity**).

Mlingotini was selected because of its vulnerability to climate change threats and locally expressed interest in assessing climate change and finding ways to limit harmful impacts. Mlingotini village is located directly on the shoreline of the Indian Ocean and is dependent on and influenced by the sea. Mlingotini is a very old village in Bagamoyo history and it has 9 sub-villages (these are Mji Mpya, Kwafaki, Kijiweni, Kiamboni, Kwadosi, Bondeni, Kibuyuni, Bisibisi and Mbuyuni). Mlingotini and its sub-villages are relatively small in population size, in the order of 2,000 residents.

Qualitative focus group meetings were used to gather information from villagers on vulnerability and adaptation options in August 2010. The focus group for was comprised of 12 individuals, and having an equal number of men and women. Focus group members were comprised of village leaders from the Village Council and other positions of leadership.



Figure 3. Focus Group discussions at Mlingotini Village



Figure 4. Gender Balance at PRA Focus Group Discussion in Progress at Mlingotini Village.

When meeting the group, the objectives of the meeting and the meaning of climate change were explained. In Swahili, climate change can be translated as 'tabia nchi' = climate, and badiliko = change'. Most of the participants were already aware of climate change and how menacing it can be.

During the discussion, a flip-chart was used to record information. This was done by one researcher and another acted as a facilitator of the session. The facilitator moderated the group process and also:

- Acted as a catalyst between the individuals of the group
- Integrated dominant and quiet people and made sure that all group members were able to express their opinions
- Made sure that the group kept to the topic while being flexible in handling additional important information
- Repeated in his own words what people said to confirm that there was a good understanding
- Supported the note-taker in gathering all relevant information

Participatory rapid appraisal tools were applied with the village focus groups. The tools that were used included the following:

1. **Seasonal calendar.** A seasonal calendar is a participatory tool to explore seasonal changes (e.g. rainfall patterns, food availability, income, gender-specific workload, diseases, and expenditure) that affect vulnerability.
2. **Community time line.** The purpose of the time line is to help the community better understand what historic natural and human events have influenced the lives of the communities. It facilitates discussion and examination of past trends and problems. It is useful in adaptation planning to think back on these past events and experiences and look at how they influence present attitudes and community responses. The events which are recorded on the time line may include movements of people, introduction of new technology, natural disasters, and development decisions. In developing a time line community members record back as many generations as they can.
3. **Community animal and plant inventory.** The purpose is to collect information on local biodiversity. Communities often build an intimate knowledge of the plants and animals which share their land. The inventory provides for a quick method of obtaining what plant and animal types are known to be within a community's boundary.
4. **Review of results** and linking results from different tools to climate change. The purpose is to identify climate change impacts with respect to the seasonal calendar, community time line and inventory of plants and animals. This can include changes in seasonality, changes in the intensity and frequency of storms and precipitation, and changes in abundance of plants and animals and their cause.
5. **Identification of concerns and opportunities.** The purpose is to help the focus group to identify and prioritize specific community concerns and to look for possible ways to solve or address them.
6. **Identification of community values.** The purpose is to encourage discussion about what community members feel are important objects, assets or cultural values and what they wish to maintain into the future.

7. **Priority community values.** The purpose is to assist the focus group to determine which objects, assets or cultural values are of greatest importance to the group as a whole.
8. **Root cause analysis.** The purpose is to determine whether climate change is a contributing factor to identified community concerns. Root Cause Analysis is a useful tool that enables the focus group to identify the many parts of a problem, the dominant causes and the most effective areas for action.
9. **Two way vision.** The purpose is to determine how communities perceive climate change will impact their lives and how they would like their future to be like instead.
10. **Assessment of adaptation options.** The purpose is to identify a range of actions that could be undertaken to address issues relating to impacts of climate change or integrity enhancement objective (for example, maintain a certain reef area in good condition, or protect a certain forest area) while also meeting community development objectives. Systematically, the focus group assesses the appropriateness and prioritizes each of these possible actions for each climate change issue or objective.
11. **Community action plan.** With agreed to priority adaptation actions, the focus group defines WHO will be responsible for it, WHAT resources will be needed and by WHEN it will hopefully be completed.

3. CLIMATE CHANGE PROJECTIONS AND TRENDS

Large scale climate change models and projections, such as those of the Intergovernmental Panel on Climate Change (IPCC), as well as on-line regional mapping tools and downscaling models provide a starting point to understand large-scale climate change projections but lack the resolution and specificity needed to assess climate change at the scale of individual villages, or even Bagamoyo District.

The overall projection for Tanzania is that sea level will rise, surface water temperature and ambient air temperature will rise, the sea will become more acidic from carbon sequestered in the sea which then forms carbonic acid, and areas with bimodal rainfall patterns (as in Mlingotini) will experience increased rainfall. These are the trends suggested by existing models and research.

More intense rainfall over the rainy season can cause flooding and loss of crops. Higher sea temperature can result in coral bleaching and mortality, increase incidence of disease in marine organisms, and alter the seasonality of biological events and abundance and distribution of fish.

From this starting point, the village level V&A sought to overlay local knowledge on climate trends that are beginning to show themselves in the village and to plan accordingly. For example, local knowledge can help answer the basic question: “Has the frequency, magnitude, or timing of precipitation, flooding, or drought events changed in the last several decades?” By integrating best available scientific knowledge with local knowledge, communities and government can take responsible action even in situations where there is imperfect climate change information.

4. LOCAL KNOWLEDGE ON CLIMATE CHANGE TRENDS AND IMPACTS

The use of the Participatory Rapid Appraisal tools with the focus group in the village resulted in information on seasonal changes, historical trends, and changes in plant and animal biodiversity that could be partly caused by global climate change and climate variability. Mlingotini has been subject to a long history of environmental degradation and non-climate stressors making it difficult to associate many of the environmental and resource trends with global climate change.

The primary impacts of concern, which the groups believed are tied to anthropogenic causes of global climate change, are floods, drought, and sea level rise. The latter causing shoreline erosion, inundation, and salt water intrusion in fresh water aquifers. A full description of climate trends that were revealed in the village is available in a report prepared by the Centre for Energy, Environment, Science and Technology (CEEST) by Meena and Lugenja, 2011.

Mlingotini village is located in Zinga division in Bagamoyo district. It is about 15 km away from the Dar es Salaam – Bagamoyo road with a total of 2,164 people and 150 fishers. It is among the oldest villages in the district where Bagamoyo town started. It is next to Mbegani Fisheries institute.

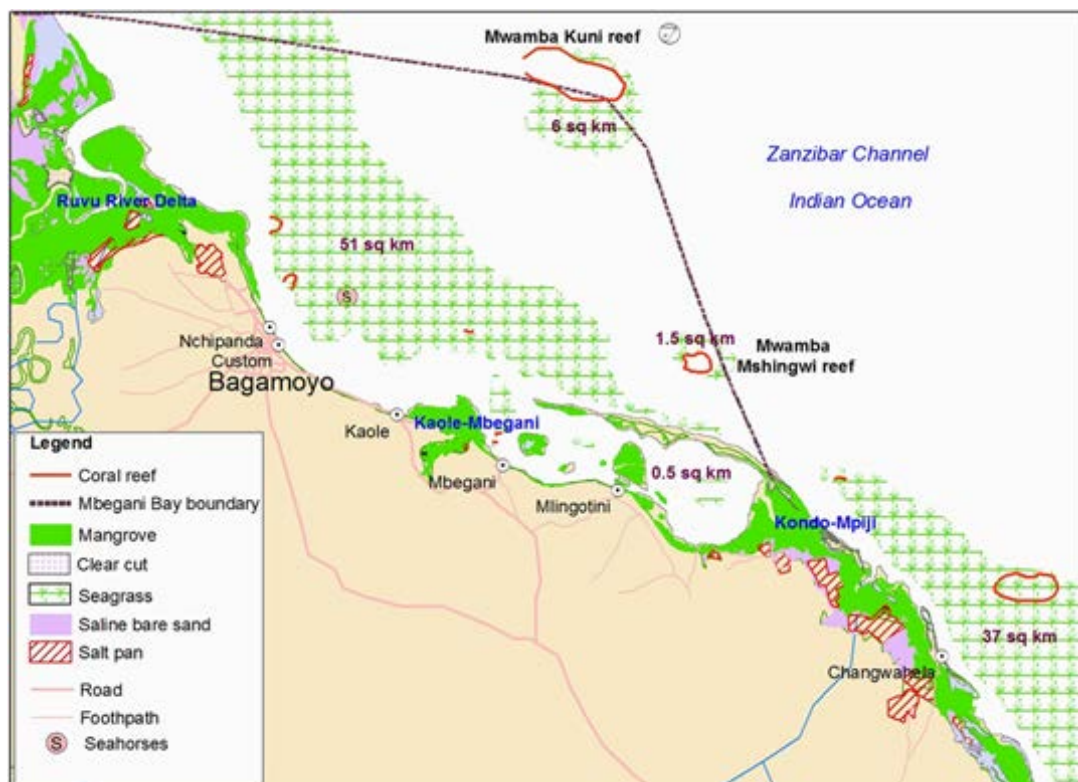


Figure 5 Map showing Mlingotini and habitat and land cover in Mbegani Bay and surrounding ecosystem

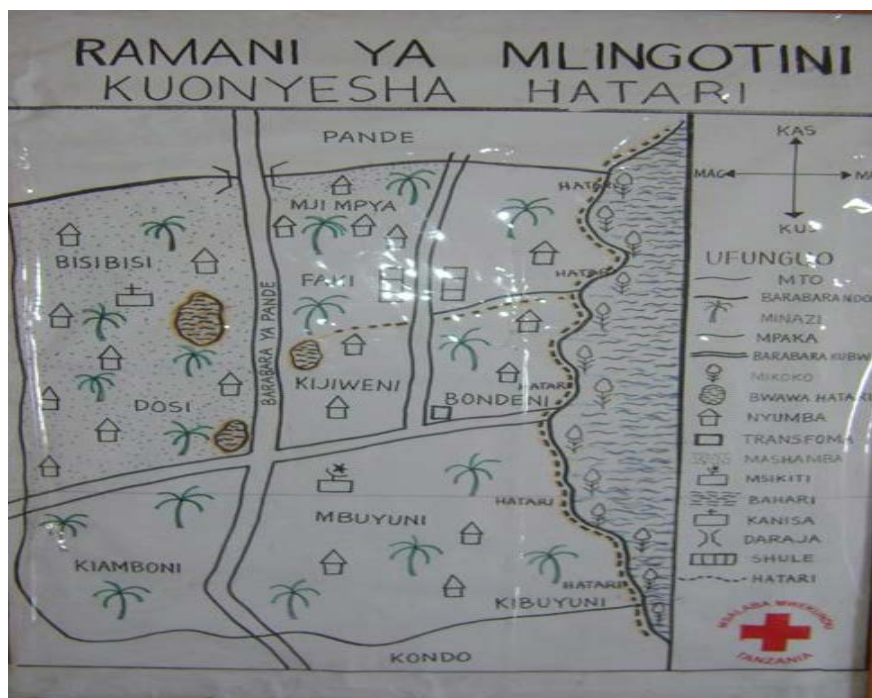


Figure 6 Mlingotini Village Land Use Plan

The primary impacts of concern, which the groups believed are tied to anthropogenic causes of global climate change, are floods and drought.

Although the climate models predict areas with bimodal rainfall patterns will experience increased rainfall, the observation of the Focus Group is that there is an increasing tendency for both floods and drought. It seems that while there is more intense rain during periods of the rainy season, there is less rain at other times. Mlingotini village has records and remembrance of incidences of climate change in terms of floods and drought which occurred dating back from 1945.

“Birds used to sing songs which indicated that the rainy season was near. Today, the songs of these birds suggest nothing at all. The birds can no longer predict the timing of rainy season.”

Mlingotini Focus Group

In Mlingotini, notable changes highlighted by the Focus Group included the following observations.

The timing and intensity of the long and short rains are no longer reliable. In the past, rains early in the primary rainy season were heavy and these were followed later by small continuous rains which resulted in a good soaking of the soil. Presently rains early in the season are heavy and these are followed by dry conditions, which are not conducive to crop growth. For example, the drizzle that used to fall at the end of the rainy season has disappeared. This drizzle helped cassava to grow well. Now, yield and quality of cassava has diminished. Rains in the smaller rainy season in October are now of short duration (barely not more than two weeks) and they are usually of low intensity compared with the past. Without predictable primary rainy season precipitation and smaller rainy season, agricultural planning under rain fed agriculture is difficult and food security is endangered.

Sea level rise has resulted in **salt water intrusion** in the water table contaminating what was first fresh water and formation of saline soils. The sea was in past known to be very far from Mlingotini village but now it has reached the point of inundating wells which were used by people for decades. Public fresh water wells have been lost to salt water intrusion and diminished agricultural productivity. Bananas no longer grow well and are vanishing in Mlingotini village. “Mabwiki” and pumpkins have disappeared. Contamination of fresh be grown and changed the diet of the people. Coconuts, mangoes, and paddy rice all have lower yield now. For example, the Focus Group explained that one coconut tree used to produce up to 100 coconuts fruits, but now it is less than 10 coconuts fruits. In one area which was previously a dense forest that had a number of beautiful species of birds is currently a bare football playground for youths. According to the Mlingotini villagers the vegetation dried up and this is probably linked with saline water intrusion.

Sea level rise and severe flooding events are thought to cause shoreline erosion. However, it is not certain if erosion is mainly sea level rise induced or is part of the inherent dynamics of coastal processes. For whatever reason, the coast is being washed away. For example, the coconut farm is now very close to the sea as if trees were planted on the beach with others already eroded and laying on the beach with exposed root balls. Some areas with mangroves are less eroded motivating villagers to continue with a campaign of planting mangrove.

- Marine areas where seaweeds were once grown no longer support seaweeds that are sensitive to changes in water temperature and salinity
- Drought was experienced in 1997, 1998, 2000-2004, 2008 and 2009
- The direction and strength of seasonal prevailing sea winds are no longer predictable. This affects fishing and safety at sea, but also agriculture. In previous years, prevailing winds were used as indicators of crop planting season. Now, the prevailing winds have changed making the planting season very uncertain.

The seasonal calendar for Mlingotini village falls within four periods, namely December to April, April to May, June to September and October to November respectively.

- In December to April both men and women are equally busy with agricultural activities including planting, weeding, transplanting, scaring birds, and seaweed cultivation. Specifically men do fishing and at this time of the year the water is warm and fish is abundant. However, this period coincides with the period of food shortage and low income for the families. The period falls in the period of the end of the short rains and beginning of the long rains.
- April to May is the long rains (Masika rains) period. The main activities of women rice cultivation. The activities in rice cultivation include weeding, transplanting and harvesting and scaring birds. The other activity in which women are involved is seaweed cultivation. Joint men and women activities at this period of the year include procurement of seeds and harvesting paddy. Men continue carrying out fishing in this period. Food is still scarce and a low income prevails in families.
- June to September is the period when short rains start. Joint activities for men and women include: Land preparation, hoeing, planting and weeding. Specifically women are engaged in cassava cultivation whereas men are involved in fishing. At this time

fish is very scarce due to cold water conditions. On the other hand, food is abundant in village.

- October to November falls within the short rains season. Joint activities for men and women include cassava harvesting. However, women continue cultivating cassava in different locations, such that there is sufficient cassava all year round. On the other hand men continue with fishing activities, in spite the fact that at this period of the year fish is very scarce.

5. VULNERABILITY ASSESSMENT

Sensitivity to climate stresses

Participatory rural appraisal methods used in the assessment process to capture issues that members of the community were concerned with:

- 1) increased food insecurity due to drought, plant pests and diseases and floods;
- 2) inadequate water for domestic uses as a result long distances one has to walk to get water and hire cost of purchasing water from water vendors;
- 3) destruction of houses due to frequent floods;
- 4) decrease in income due to lack of employment and lack of differentiated products;
- 5) Animal diseases outbreak as a result of inadequate fodder and water in the dry season; and
- 6) Pests and diseases outbreaks.

The participants further analysed their concerns and identified potential opportunities for addressing them.

Figure 7 Concerns and opportunities of Mlingotini villagers

Concerns (Problems)	Opportunities
Increased in food insecurity as the results of: <ul style="list-style-type: none"> • Floods and drought, for example rise in oceans causes dams to be swollen, also the farms are swallowed • Loss of some fishes e.g. Mahongwe • Animals lost • Salts intrusion • Land infertility as the result of drought 	<ol style="list-style-type: none"> a) Well-constructed dams for keeping water and also for fish production. b) Reserve water catchment areas by planting trees c) Irrigated agriculture should be improved.
Decrease in income, due to: <ul style="list-style-type: none"> • Decrease in production, for example one coconut tree used to produce up to 100 coconuts fruits but now less than 10 coconuts fruits • Loss of some fishes such as Mahongwe • Loss of sea blessing. • Heavy winds destroyed the cashew nut plants (2010) 	<ol style="list-style-type: none"> a) Production diversification, for example the production of seaweed. b) Government sets reasonable price for seaweeds producers c) Processing industry for seaweeds to add value d) Use of advanced equipment in production processes to increase productivity.
Changes in nutrition due to: <ul style="list-style-type: none"> • Decreased in production, other crops cannot grow on drought, also flooding of crops, salt intrusions 	<ol style="list-style-type: none"> a) Crop diversification by planting drought resistance crops. b) Irrigated agriculture.
Destruction of houses, people remains shelter less and sometimes death occurs	<ol style="list-style-type: none"> a) Building of brick houses with good foundation
Salt intrusion (2005) due to: <ul style="list-style-type: none"> • Submerging of salt islands in the sea • Sea level rise 	

As described earlier, vulnerability factors are the degree to which the particular area and people are impacted (**sensitivity**), the types and amount of assets at risk (**exposure**), and the ability to cope with actual or expected changes (**adaptive capacity**).

Usage of Natural Resources in Mlingotini Village

Mlingotini is rich in natural resources, with about 28 wild species of trees, 16 different species of animals, 22 species of birds, 33 species of fish and 25 species of cultivated plants. The number of plant and animal species identified in Mlingotini, compared to that of a small village on the Ruvu River near the coast is shown in Figure 3.

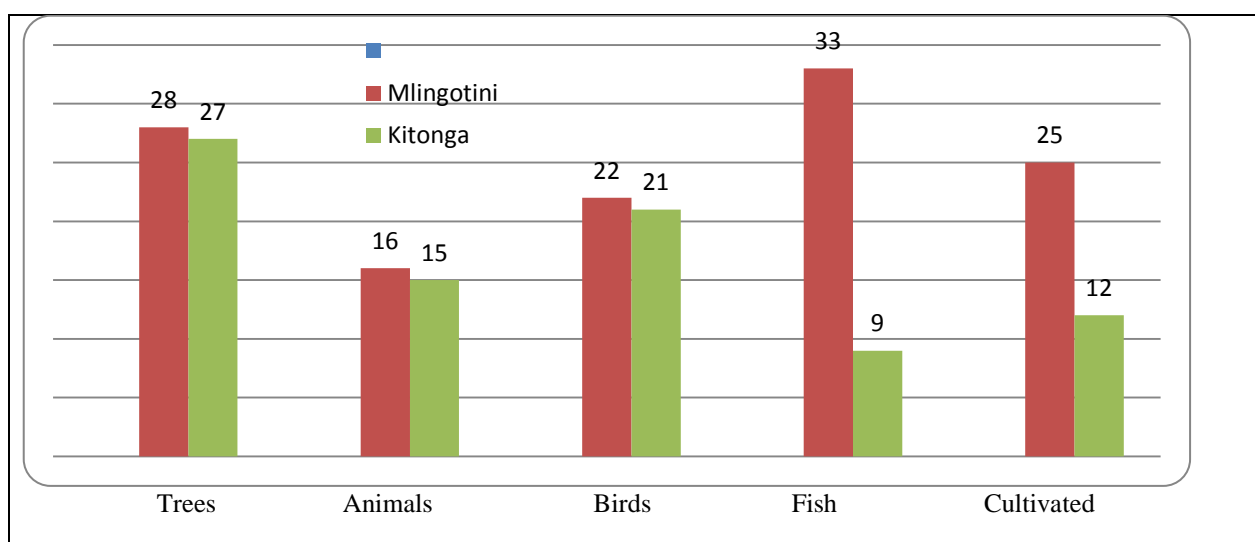


Figure 8 Existing Plants and Animal Species in Mlingotini and Kitonga Villages (value indicates number of species)

- **Fruits:** *Annona spp (Mtopetope)*, *Citrus sinensis (Mchungwa)*, *Citrus aurantifolia (Mdimu)*, *Mbwiki*, *Carica papaya (Mpapa)*, *Mangifera indica (Mwembe)*, *Coconuts (Mnazi)*, *Annona muricata (Mstafeli)*, *Morus alba (Mfenesi)*, *Mbungo*, *Ngora*, *Mapara*, *Syzygium spp (Mzambarau)*, *Vitex ferruginea (Mfuru)*, *Mkomamanga*, *Mbilimi*.
- **Food Crops:**
 - *Zea mays* (Maize),
 - *Manihot esculentus* (Cassava),
 - *Adansonia digitata* (Mbuyu),
 - *Vigna unguiculata* (Kunde).
- **Medicinal Plants:**
 - Kivumbisi, *Azadirachta indica* (Mwarobaini),
 - Kikulagembe, *Adansonia digitata* (Mbuyu),
 - Mpambawake,
 - Mpatakura,
 - Mlingajini,
 - Mjaremajani,
- Magango,
- Mzikanyuma, Mtiimkuu, *Euclea divinorum* (Mdaa),
- *Heritiera littoralis* (Mkungu).
- **Construction:**
 - *Rhizophora spp.* (Mkoko),
 - *Coconuts (Mnazi)*,
 - *Mgovu*,
 - *Mtete*,
 - *Eucalyptus spp* (Mkaratusi),
 - *Moringa oleifera* (Mlonge),
 - *Annona spp* (Mtopetope)
 - *Annona spp* and
 - *Strychnos spp.* (Mtonga).

Assets at risk and climate impacts on Mlingotini

Table 2. Potential Impact of Climate Change – Mlingotini

Asset at risk	Degree of impact
Property and Infrastructure	
Fresh water wells	Some wells are abandoned due to salt water intrusion, especially those that are sensitive to salt intrusion because they are now close to the shore as a result of shoreline erosion. One example is Mpenzi Well that previously was important for fishermen in this fishing village for bathing on return from the sea before going back to their homes. The amount of fresh water available to meet domestic demand has declined as a result of salt water intrusion.
Roads and property	Flooding eats away at roads and damages homes, vegetation and livestock at times of floods along the main water flow routes. Roads and homes are sensitive to flooding as they have not been designed with this in mind. Houses do not have foundations resistant to floods.
Shoreline	There is a loss of land and property due to receding shoreline. Most of Mlingotini homes and infrastructure are not right on the shoreline, and are not therefore as sensitive as they otherwise would be to this problem.
Ecological Assets	
Agricultural land and crops	Sea level rise is believed to be the cause of the formation of saline soils that is one of the causes of significant losses in agricultural productivity and even the loss of some culturally important crops. Like most of Tanzania, coastal soils are sandy and have low fertility to begin with. Soil salinization makes the situation for food security worse.

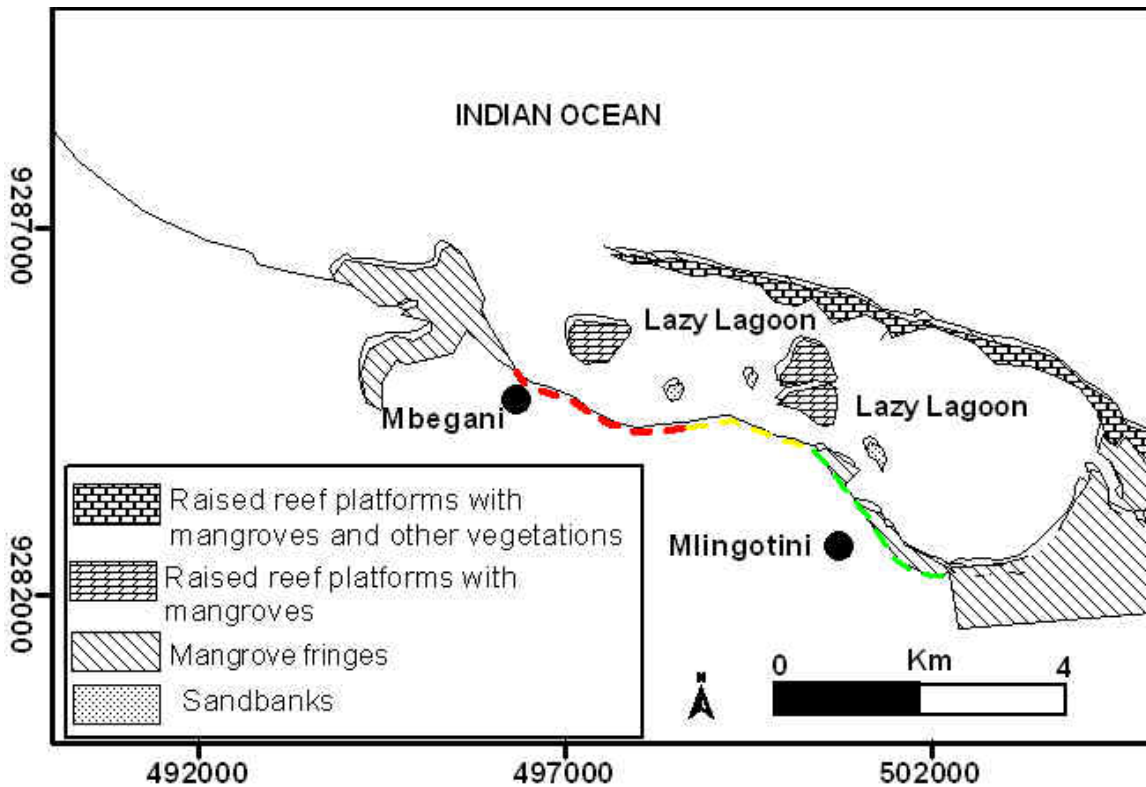


Figure 9 Map showing the status of coastal erosion along the coastal stretch between Mbegani and Mlingotini, Bagamoyo.

Note: The red dotted line (between 5-10 incidences of eroding coastal sites encountered), Yellow dotted line (Less than 5 incidences of eroding coastal sites encountered), Green dotted line (No erosion observed).

Field investigations of the coastal stretch from Mbegani to Mlingotini revealed that mangrove vegetation formed one of the prominent features of the shoreline (with relatively denser mangrove thickets on the eastern side towards Mlingotini, than on the western side towards Mbegani), and to large extent the mangrove vegetation had played a significant role in shore stabilization and protection of the shore against wave erosion. This exemplifies the concept of ‘living shoreline’ and is a good illustration of the environmental services provided by mangroves.

Exposure of tree roots, incidences of uprooting of mangrove trees as well as actual collapse of cliffs was common features along a 2-3 km coastal stretch on the western side of the Lagoon, but less common on the coastal stretch proximal to Mlingotini. The erosional features were generally absent along the coastal stretch fringed by dense mangrove thickets east of Mlingotini fish landing site.

The presented results indicates that the vulnerability to wave erosion of the coastal stretch between Mbegani to Mlingotini differs from west to east, with highest vulnerability on the western coastal stretch and lowest vulnerability on the eastern coastal stretch.

Adaptive capacity

This refers to the ability of society to change in a way that makes it better equipped to manage its exposure and/or sensitivity to climate influences. A community with the capacities to adapt is likely to be more resilient or able to recover from stressful events and conditions.

A broad range of factors reflect adaptive capacity:

- Political leadership and commitment
- Systems of local government
- Resource availability (e.g., human, physical, technological, and financial)
- Social capital
- Communication systems
- Health of the environment

On a practical level, the aim of assessing adaptive capacity is to answer key questions:

Adaptive Capacity Questions
How well do community members work together on coastal development planning and coastal management, including coastal hazards?
What practices are currently employed to cope with natural hazards? Who is responsible for developing and implementing such measures? How effective are they?
Are decision-makers and the community in general informed and engaged?
Do most people rely on the same activity for their livelihoods? For example, does everyone rely on fishing or agriculture, such that a single event could destroy their livelihoods of many in the community?
In an emergency, are there multiple means of communicating or transporting people and supplies? Or will damage to a single road or bridge isolate the community?
How healthy are the ecosystems and how well are natural resources managed?

Assessing adaptive capacity of a place helps in understanding why vulnerability exists in the first place. To reduce vulnerability, stakeholders must understand its root causes. Root causes might include poverty, natural resource dependency and strong dependence on single livelihoods, weaknesses in local governance, degraded resources, and insecure or inequitably distributed property rights. Adaptive capacity can be strengthened through policies and actions that address the root causes.

On many levels, adaptive capacity in Mlingotini is weak. Pervasive **poverty**, **inadequate funds** and **lack of rules for effective water management** were identified as root causes of vulnerability. Also it is the case that most people rely on the same activity for their livelihoods (fishing, agriculture, or seaweed farming). The health and resilience of the ecosystems has been compromised by overfishing and destructive fishing. Finally, the community is dependent on a single road.

Mlingotini has a long history of coastal management planning and implementation. Village government is well structured; there are organized fishing livelihood groups, seaweed farmer group, savings and credit group, and an eco-tourism office. Village leaders are well aware and informed of climate change risks. In this sense, adaptive capacity is good.

6. ADAPTATION OPTIONS

The vulnerability assessment identified numerous climate change risks and potential impacts. It showed some of the root causes for weak adaptive capacity. In both villages, there are more climate change risks than can be acted upon based on local funding availability, and institutional and technical capacity.

The villages and district government need to look for adaptation measures that are doable with concrete benefits, or actions that increase the adaptive capacity and reduce the sensitivity of assets to climate change. Given these criteria, the initial discussion and brainstorming of opportunities to adapt to climate change included the following:

- Form a Committee with District assistance and in cooperation with the Wami-Ruvu Water Basin Office to set rules for effective water management
- Plant mangroves and resilient shrubs and grasses along the beach to reduce erosion and to form a green barrier to flooding
- Seek assistance from District agricultural extension officers on drought resistance crops and to identify more saline soil resistant crops
- Apply good practices in rice production to increase harvests and food security, and reduce climate change impacts. These include appropriate spacing and density of seeds, water retention techniques, and use of drought resistant seed.
- Develop a local education program to raise awareness on the importance of forest conservation among the community
- Seek assistance on energy efficient technologies to reduce consumption of wood
- Seek government or donor assistance to develop rainwater storage systems and adequate water tanks for water storage

Some of these opportunities can be done with existing local resources and skills, others require outside assistance, but require modest funding, so could be part of a short-term climate change response strategy.

Other options were listed during brainstorming sessions on opportunities that are longer term and would require major outside investments, such as construction of wells/dams, protection of catchment areas and embarking on irrigated agriculture; diversification in their production endeavours, increased price for their produce, processing seaweeds and use improved production equipment; and use of concrete blocks for the construction of houses.

It is important to note that the coastal stretch between Mbegani and Mlingotini is still underdeveloped in terms of tourism infrastructures. However, with the increasing pace of Dar es Salaam City expansion, coastal encroachment of this coastal stretch is anticipated in the near future. Constructions of buildings close to the shoreline should be discouraged by the land planners so as to ensure that there is always a buffer zone between the beach and the backshore areas where developments are allowed. Thus, future studies on this area should focus on technical groundwork and sensitization programmes leading to the improvement on the stakeholders understanding of the

values and functioning of the lagoon, including its adjacent shoreline and the backshore biological resources, sand dunes and other components.

A characteristic of the short-term responses listed above is that they are all “**no-regrets.**” This means that they yield benefits independent of climate change. These measures address current vulnerabilities and focus on increasing the ability of ecosystems and communities to cope with current environmental pressures and climate variability. They provide a benefit now, a benefit in the future, and potentially provide a benefit whether or not the projected climate changes become reality.

7. EARLY ADAPTATION ACTIONS

Study tour exchange

On two different days, the Focus Group members from Kitonga and Mlingotini made study tours to each other’s villages. The aim was to increase each village’s awareness of the global issue of climate change impacts, vulnerability and adaptation options. In the climate change exchange visit between villages, Bagamoyo district staff also participated. The involvement was an opportunity for the district to understand in depth the climate change problems in the community with the result that district plans mainstream adaptation measures needed in villages vulnerable to climate change.

The study tour visits were also an opportunity for district extension staff to offer suggestions for change to reduce climate change vulnerability. For example, during the visit, Bagamoyo district staff provided technical assistance regarding good practices in rice production to increase harvests and food security, and reduce climate change impacts. These practices include water retention techniques, appropriate spacing of the plants, appropriate quantity of seeds per acre, and consideration of drought resistant seed.



Figure 10 Mlingotini villagers showing Kitonga visitors a popular well affected by salt water intrusion



Figure 11 Kitonga visitors discussing shoreline issues in Mlingotini

Mangrove bee-keeping and energy efficient ovens

A Climate Change Committee of twelve members in Mlingotini village agreed on adaptation and mitigation measures: integrated bee-keeping and mangrove conservation and replanting. Training in construction and maintenance of modern beehives was done in collaboration with the District's apiculture expert. Using locally available materials at the village, 24 beehives were constructed and placed in mangrove forest islands accessible by boat (Figures 10 and 12). Assistance and training was also given to an entrepreneurial group in the village to improve livelihood resilience and reduce consumption of firewood (Figures 11 and 13).



Figure 12 Beehive on mangrove tree at Mlingotini village



Figure 13 Energy efficient baking



Figure 14 Community members and Pwani project staff visiting beehive islands



Figure 15 Energy efficient bakery oven with products inside

8. CONCLUSIONS AND RECOMMENDATIONS

The V&A exercise demonstrated that with appropriate PRA exercises and local knowledge, it is possible to conduct a vulnerability assessment and identify response options. Once strategically selected adaptation measures are implemented, their effectiveness and impact needs to be tracked, and improved approaches or new responses selected based on changing circumstances and new information.

Having completed this exercise with the villages, it raises some questions and information gaps. These questions and gaps can help focus the District, donors, and researchers on work in the future. For example, basic scientific information is needed on the inherent dynamics of the natural environment (e.g. coastal processes of sand movement, erosion and accretion), sea level monitoring, and time series data on rainfall to better evaluate trends in high precipitation/flooding events, drought, and seasonality. Without such information, it is difficult to determine whether the observed climate changes are evidence of global climate change or not.

Also, to aid in assessing vulnerability and adaptation planning, it would be helpful to have remotely sensed land use/land cover maps to visualize climate change scenarios and biophysical impacts (e.g. maps of the shoreline to visualize erosion and maps of potential flooding or inundation from sea level rise and storm surge).

Another important finding from this work is that the problems being faced in these two villages are similar throughout Bagamoyo District, and that some of the problems cannot be solved at the village level. They require concerted action at the District as well as Water Basin level.

REFERENCES

This report is an updated and expanded edition of material originally presented in the following documents:

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Notes:

The PRA tools are described in length in the document "Climate Change Vulnerability and Adaptation Planning Template," manuscript, September 2010, available on request from James Tobey (Tobey@crc.uri.edu).

A full description of climate trends that were revealed in the two villages is available in a report prepared by the Centre for Energy, Environment, Science and Technology (CEEST), available on request (hemeena@yahoo.com).