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**Village Vulnerability Assessment and Climate Change  
Adaptation Planning (V&A)  
Mlingotini and Kitonga  
BAGAMOYO DISTRICT, TANZANIA**

**June 2011**

**Pwani Project**

**Tanzania Coastal Management Partnership**

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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. 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 “Lazy Lagoon” embayment. Livelihoods are predominantly resource based: traditional fishing, seaweed farming, small scale agriculture and more recently the beginnings of small-scale ecotourism. By contrast, Kitonga is not directly on the coast, but is in the flood plain of the Ruvu River. Here, people are also very dependent on the natural resource base for agriculture, especially rain fed rice farming, vegetables and fruits. In these rural villages 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 is impacting their lives.

The Pwani Project, in partnership with District government staff and 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

## 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 and Kitonga were selected because of their 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, whereas Kitonga village is located close to the Ruvu River and is influenced by river flooding events. Mlingitini 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). Kitonga village was formally a sub village of Kidogozero village but now is a registered village with 5 sub villages (these are Mtambani, Shuleni, Msawanga, Mji Mpya and Kaiiwani). Both Mlingotini , Kitonga, and their sub-villages are relatively small in population size, in the order of 2,000 residents each.

Qualitative focus group meetings were used to gather information from villagers on vulnerability and adaptation options in both locations in August 2010. There was one focus group for each of the selected villages with both being comprised of 12 individuals, and each 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.

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, particularly those in Mlingotini, were already aware of climate change and how menacing it can be. In Mlingotini, this was due to exposure to other climate change researchers that have previously visited the village.

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:<sup>1</sup>

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<sup>1</sup>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).

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.



Focus Group Discussion, Mlingotini Village



Focus Grop discussions at Kitonga Village



### **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 and Kitonga) will experience increased rainfall. These are the trends suggested by existing models and research.<sup>2</sup>

Sea level rise causes habitat inundation, shoreline erosion, and saline intrusion to groundwater and soil. Ocean acidification can weaken corals and other marine animals that have shells or skeletons made of calcium carbonate (such as shellfish and starfish). 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 animals, 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 two villages 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**

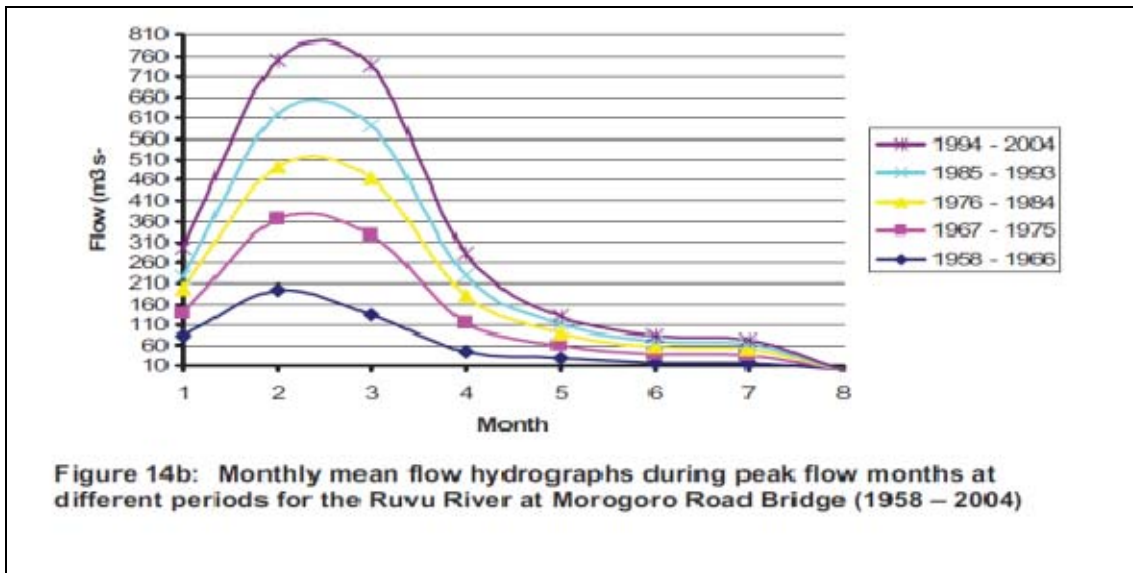
The use of the Participatory Rapid Appraisal tools with the focus groups in both villages resulted in information on seasonal changes, historical trends, and changes in plant and animal biodiversity that could be partly caused by global climate change and climate variability. Both locations have been 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.

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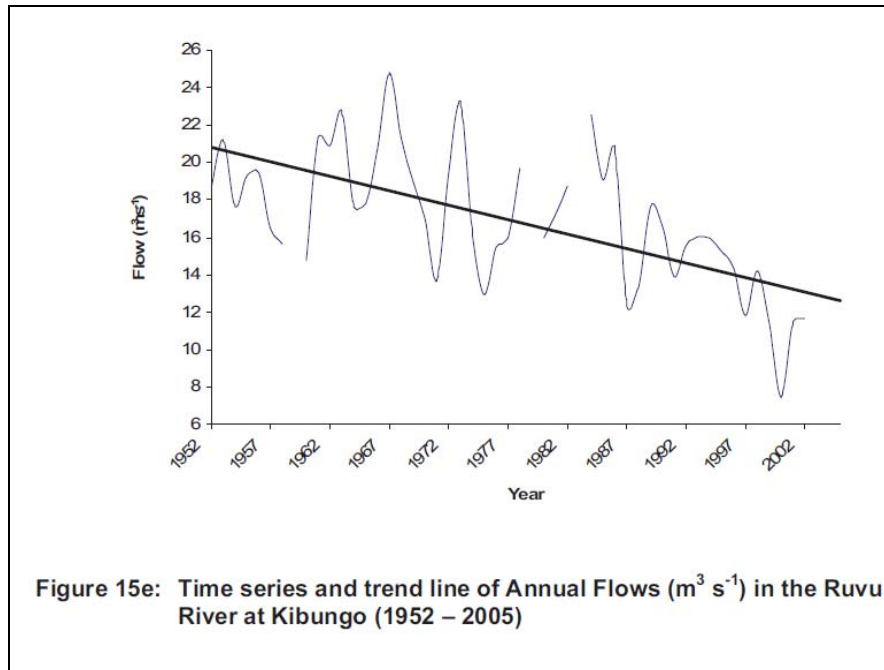
<sup>2</sup> See: S.B. Mahongo 2009 The Changing Global Climate and its Implication on Sea Level Trends in Tanzania and the Western Indian Ocean Region. Tanzania Fisheries Research Institute (TAFIRI) Western Indian Ocean J. Mar. Sci. Vol. 8, No. 2, pp. 147 - 159, 2009.

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 two villages is available in a report prepared by the Centre for Energy, Environment, Science and Technology (CEEST), available on request (hemeena@yahoo.com).

Although the climate models predict areas with bimodal rainfall patterns will experience increased rainfall, the observation of the Focus Groups 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. These trends are validated by historical data on Ruvu River mean flow. The two figures below show that flow during rainy season has increased significantly in the past 50 years while there is a declining trend in mean annual flow.<sup>3</sup>



<sup>3</sup> Source: “Hydrologic and Land Use/Cover Change Analysis for the Ruvu River Watershed,” Prof. P. Z. Yanda, Institute of Resource Assessment, University of Dar es Salaam, and Prof. P. K. T. Munishi, Faculty of Forestry & Nature Conservation, Sokoine University of Agriculture Morogoro, prepared for WWF/CARE Dar es Salaam, Tanzania, March, 2007.



In Mlingotini, notable changes highlighted by the Focus Group included:

- 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.

“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

- 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 water in the village has also resulted in the decline in other crop varieties that can

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.

In Kitonga the primary impacts of concern, which the Focus Group believed are tied to anthropogenic causes of global climate change, are floods and drought. In 1996 and again in 2006, floods destroyed all food crops resulting in wide spread hunger in the village. Drought was experienced in 1997, 1998, 2000-2004, 2008 and 2009.

## 5. VULNERABILITY

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**).

Assets at risk include property and infrastructure, ecological assets, and social assets. In Mlingotini, these assets and degree of impact are summarized in the Table below.<sup>4</sup>

### Potential Impact of Climate Change – Mlingotini

Asset at risk	Degree of impact
<b>Property and Infrastructure</b>	
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.
<b>Ecological Assets</b>	
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. Changing

<sup>4</sup> A full presentation of the results of PRA exercises in the two villages related to vulnerability assessment is available in the report prepared by the Centre for Energy, Environment, Science and Technology (CEEST), available on request (hemeena@yahoo.com).

<b>Asset at risk</b>	<b>Degree of impact</b>
	precipitation patterns are also having a dramatic impact on crop productivity.
Mangroves and other coastal habitat	Sea level rise has been responsible for the inundation of mangroves, forest, sand/mud flats, and seasonal swamps.
Seaweed farming	Warming sea surface temperature and fluctuations in precipitation causes mortality in some species of cultivated seaweed.
<b>Social Assets</b>	
Health and education	<p>The health of people in Mlingotini village has been affected directly by sea level rise through the rise of water tables. This has resulted in the volume of water in toilets to rise, creating health hazards. Floods also result in overflow of toilets and cause contamination of domestic water supply in wells and the environment as a whole.</p> <p>The reduction of income from agricultural activities due to saline soil and changing precipitation patterns affects families' ability to financially support children in school.</p>

Assets at risk and the community impact in Kitonga are shown below.

**Potential Impact of Climate Change –Kitonga**

<b>Asset at risk</b>	<b>Degree of impact</b>
<b>Property and Infrastructure</b>	
Roads and property	Flooding eats away at roads and damages homes, vegetation and livestock along the main inundation and water flow routes.
<b>Ecological Assets</b>	
Agricultural land and crops	Changing precipitation patterns and both flood and drought events have a dramatic impact on crop productivity and in some cases total loss of production.
Mangroves and other coastal habitat	Flooding of the Ruvu River has been responsible for the inundation of riparian habitat.
<b>Social Assets</b>	
Health and education	The nutritional health of people has been affected directly by variability in precipitation and seasonality, flooding, and drought. Reduced income affects families’ ability to financially support children in school and may lead to pulling children out of school.

An important ecological asset projected to be possibly severely affected by climate change is coral reefs. Increased sea water temperature causes bleaching and mortality of reef systems. This would be a significant loss for fishing communities that are primarily near shore, coral reef based fisheries. The focus groups may not have identified this impact because they do not understand the causes of coral bleaching.

**Adaptive capacity** 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 question such as:

<b>Adaptive Capacity Questions</b>
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 both Mlingotini and Kitonga is weak. In both villages, 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 (Mlingotini), and deforestation for charcoal making (Kitonga). Finally, both communities are dependent on a single road.

On the positive side, 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.

Kitonga has the benefit of fertile soil for agriculture and a permanent water source as it is located in the Ruvu River flood plain. Flooding is damaging to food crops, but there is land further from the river where agriculture can be practiced. Moreover, rice paddies need a substantial amount of water to grow.



## 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 (both villages)
- ✓ Plant fruit trees to generate an alternative source of income to reduce food insecurity (Kitonga).
- ✓ Plant mangroves and resilient shrubs and grasses along the beach to reduce erosion and to form a green barrier to flooding (Mlingotini)
- ✓ Seek assistance from District agricultural extension officers on drought resistance crops (both villages) and to identify more saline soil resistant crops (Mlingotini)
- ✓ Improve or introduce the use of efficient irrigated agriculture from Ruvu River (Kitonga). Seek assistance and permits from the Wami-Ruvu Water Basin Office.
- ✓ 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 (both villages)
- ✓ Seek assistance on energy efficient technologies to reduce consumption of wood (both villages)
- ✓ Seek government or donor assistance to develop rainwater storage systems and adequate water tanks for water storage (both villages, but Mlingotini especially)

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 (e.g. building or improving health or educational facilities, improved home construction, road improvements, well construction, and water delivery systems).

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. STUDY TOUR EXCHANGE

On two different days, the Focus Group members from one village made a study tour to the other village. 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.



Kitonga villagers showing Mlingotini study tour members the effect of climate change to rice production



Kitonga villagers showing Mlingotini study tour members the effect of climate change to rice production

Also in Kitonga, the study tour was able to see the early adaptation action of fruit tree planting that was one of the recommendations emanating from the V&A assessment.



Assisted by the agricultural officer are the villagers preparing the plantation for fruit tree planting

## **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 can not be solved at the village level. They require concerted action at the District as well as Water Basin level.