Climate Change Adaptation Series: Document 10

VILLAGE VULNERABILITY ASSESSMENTS AND CLIMATE CHANGE ADAPTATION PLANNING (V&A) JAMBIANI AND PAJE, ZANZIBAR, TANZANIA

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Prepared for the Pwani Project
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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
6. Livelihoods, Climate and Non-Climate Threats and Adaptation: Pangani District Coastal Villages
7. Livelihoods, Climate and Non-Climate Threats and Adaptation: Bagamoyo District Coastal Villages
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9. Village Vulnerability Assessments and Climate Change Adaptation Planning (V & A): Kitonga and Mlingotini Villages, Bagamoyo District (Summary Report)
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Contents

1.0 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. Changes in wind speed and seasonality
4. Sea level rise
5. Increased sea surface and ambient air temperatures
6. 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 in partnership with researchers from the Institute of Marine Science (IMS), University of Dar es Salaam, 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.

As a small island, Zanzibar is more vulnerable and faces greater climate change risks—particularly those related to coastal and shoreline impacts—than does the mainland. This is illustrated in the 2010 document "Adaptation to Climate Change: Preparation of an Adaptation Programme of Action for The Revolutionary Government of Zanzibar" that was prepared by the Sustainable Management of Land and Environment (SMOLE) project. This document, endorsed by the Ministry of Water, Construction, Energy and Land, Zanzibar and the Ministry of Agriculture, Livestock and Environment, Zanzibar, highlights the need for climate change data; strengthened disaster management and reduction capabilities; ICM; and a focus on coastal and marine resources at risk, as well as other major economic sectors at risk—e.g., tourism, fisheries, seaweed farming, and agriculture.

The Revolutionary Government of Zanzibar (RGOZ), with United Nations Development Programme (UNDP) assistance, is dedicated to improving governance systems and institutional frameworks for climate change. This includes formation of a National Climate Change Steering Committee composed of Principal Secretaries (PS) from all relevant agencies, led by the PS for Environment in the Office of the Zanzibar First Vice President. In

addition, a technical committee comprised of Department Directors has been launched, and the formation of working groups on specific climate change issues has been approved. In January 2011, the RGOZ launched a comprehensive study on the economics of climate change on Zanzibar. The full draft, which is currently under review, provides a basis for the formulation of a Zanzibar Climate Change Strategy and a Zanzibar-specific NAPA. This vulnerability assessment document contributes to this larger effort.

The USAID/Pwani project in Paje and Jambiani is rooted on an earlier project of a regional programme for the sustainable management of the coastal zones of the countries of the Indian Ocean (ReCoMap), which was conducted at Jambiani and Paje villages, along the eastern coast of Unguja Island, Zanzibar. The ReCoMap project was a two year (2009-2010) European Union funded project whose main goal was to empower the coastal communities to plan for sustainable coastal livelihoods using GIS and modeling decision support tools. It collected scientific knowledge on the major causative factors of shoreline changes along the Jambiani/Paje coastal section for the purpose of developing future adaptation strategies.

At the completion of the ReCoMap project all the GIS data results and the modeling data results were synthesized but the project had ended before disseminating and sensitizing the important aspects of the results to local stakeholders. In view of this, the TCMP Pwani project followed-up was for the purpose of climate change vulnerability assessment and development of climate change adaptation strategies.

The specific objectives of the TCMP Pwani project for vulnerability assessments include the following:

1. To develop awareness and understanding of the concept of climate change.

2. To develop awareness and understanding on the natural factors that had been contributing to the observed shoreline changes along the coastal sections of Jambiani and Paje villages.

3. To develop awareness and understanding on the human factors that had been contributing to the observed shoreline changes.

4. To promote the good human practices on shore management and discourage bad human practices on shore management as part of future climate change adaptation strategy.

2.0 CLIMATE CHANGE PROJECTIONS AND TRENDS

The overall observations for climate trends in Zanzibar indicates large inter-decadal variations in sea levels, with decreasing trends from the 1980s (Ragoonaden, 2006), and recent rising trends especially after 2004 (Watkis et al, 2012). Analyses of meteorological data reveal strong evidence of rising air temperature over the last 30 years with strong increases in average and maximum temperatures in December to May. There are also indications of rainfall variability, change of wind and wave climate regime and extreme weather events, with higher rainfall intensity events, increasing wind speeds and wave heights and increase of extreme weather events in recent years (Shaghude Dubi, 2008; Watkis et al, 2012). The sea will become more acidic from carbon sequestered in the sea which then forms carbonic acid, and areas with bimodal rainfall patterns) will experience increased rainfall. These are the trends suggested by existing models and research.

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, village level V&As seek 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.

Global climate change is one of the greatest challenges that humans will face in this century (Mcleod *et al.*, 2006). Although geological records show climatic changes throughout history, the present rate of global warming threatens the survival of entire ecosystems (Mcleod *et al.*, 2006). Small islands and low lying coastal areas are especially vulnerable to climate change. Zanzibar also has seen some changes in wind patterns. (See for example Figures 1 and 2).

According to Tilya (2012), climate of a location encompasses the statistics of weather taken over longer period of time, say 30 years, and this is affected by its latitude, terrain, and altitude, as well as nearby water bodies and their currents and climate change ooccurs when changes in climate elements mean or variance or both distribution are observed.

While the degradation of the coastal environment and ecological resources together with loss of coastal settlements due to the problem of shoreline changes has always been a major issue of concern along the east coast of Unguja Island, earlier approaches to manage the degrading coastal environment and the ecological resources for sustaining the livelihoods of the local coastal communities were not successful. The failure of these approaches has been attributed to the lack of scientific knowledge on the causative factors of the problem of shoreline changes and the associated degradation of the coastal environments and loss of ecological resources, as well as sufficient stakeholder participation to fully engage local residents and

institutions. The vulnerability assessment presented in this report was carried out in a way that aims to correct this imbalance.

It is known that the abundant natural wealth and scenery of the coast of Jambiani and Paje villages have provided livelihoods for many years to coastal communities. The key livelihoods are fisheries, burying coconut husks and some agriculture. Seaweed farming and tourism started in the last 20 years. With most of the population living directly along the coast, greater pressure is placed on it from human uses. Global climate change will intensify that pressure. Also with rising sea levels, increased storms and higher temperatures predicted, the challenge will be to manage coastal activities in a sustainable way whilst ensuring the health of coastal ecosystems (Mazilli *et al.*, 2010).

Some of these activities put pressure along the coast e.g. the cutting of sea grass in seaweed areas, mining of live corals, and dragging activity of collecting seaweed, contribute to various negative natural and socio-economic impacts along the coast. These include increased coastline erosion, declines in abundance of fish and the consequent impact on fisheries and livelihoods, changes in the composition of fish communities, loss of aesthetic value to reefs and shoreline that are important for tourism, and reduced forest cover (Mazilli *et al.*, 2010).

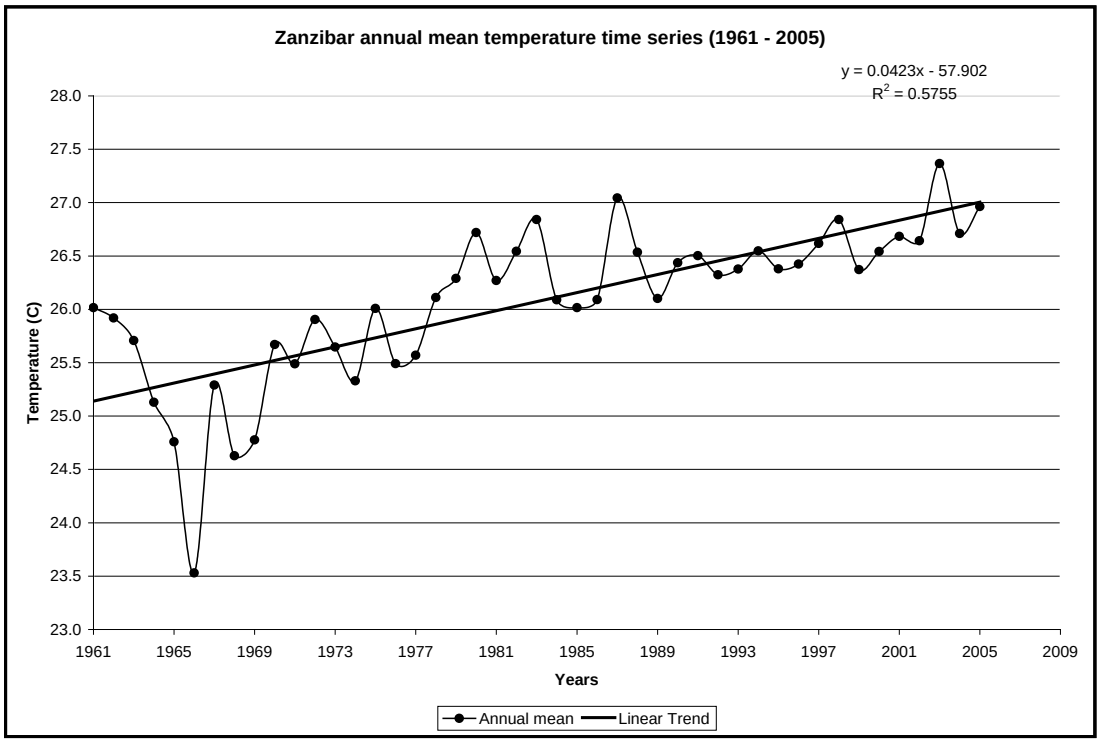

Figure 1. Rise in average temperature Zanzibar 1961-2005 (+1.9°C). Source: Tanzania Meteorological Agency

Looking forward, The UK DFID funded "Economics of Climate Change" project developed some scenarios of future climate change for planning purposes. Temperature increases are expected to accelerate, rainfall patterns will change, although exactly how is not certain, an intensification will occur in rainfall events leading to flooding. While sea level rise is increasing, the relative rise is not clear due to uncertainty about subsidence and uplift. Acidification of sea water is also expected to intensify. The following two graphics from the report help frame the basic expectations for Zanzibar:

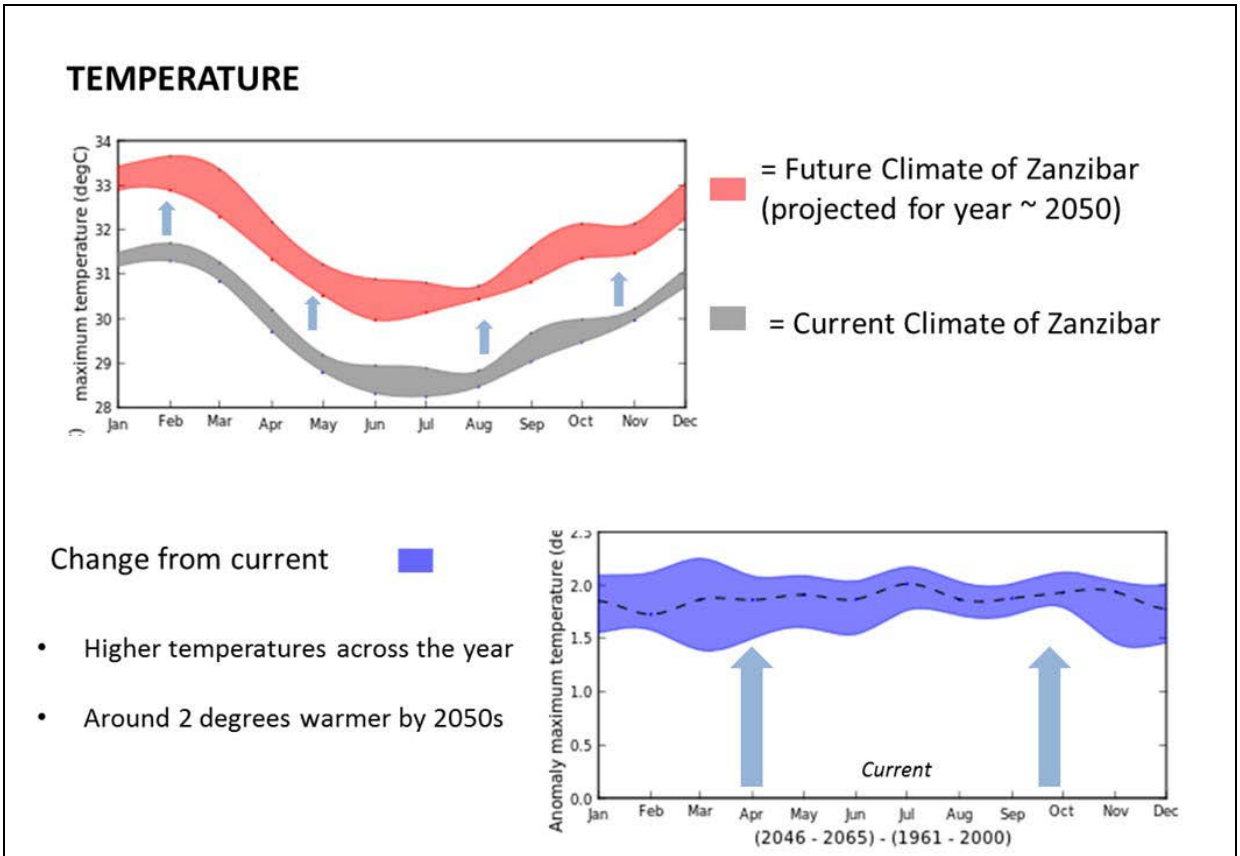

Figure 2. A2 Scenario, Downscaled projections and anomalies of monthly daily maximum temperature (2046-2065) – for Zanzibar (Unguja). Grey envelope shows the current modeled climate and the pink envelope shows the future period. The bottom box shows the change from the (modeled) current climate in blue, where the range reflects the variations across ten different GCM models. Source of data: Climate Systems Analysis Group (CSAG), University of Cape Town, SA. Source of graphic: Watkiss et al., 2012.

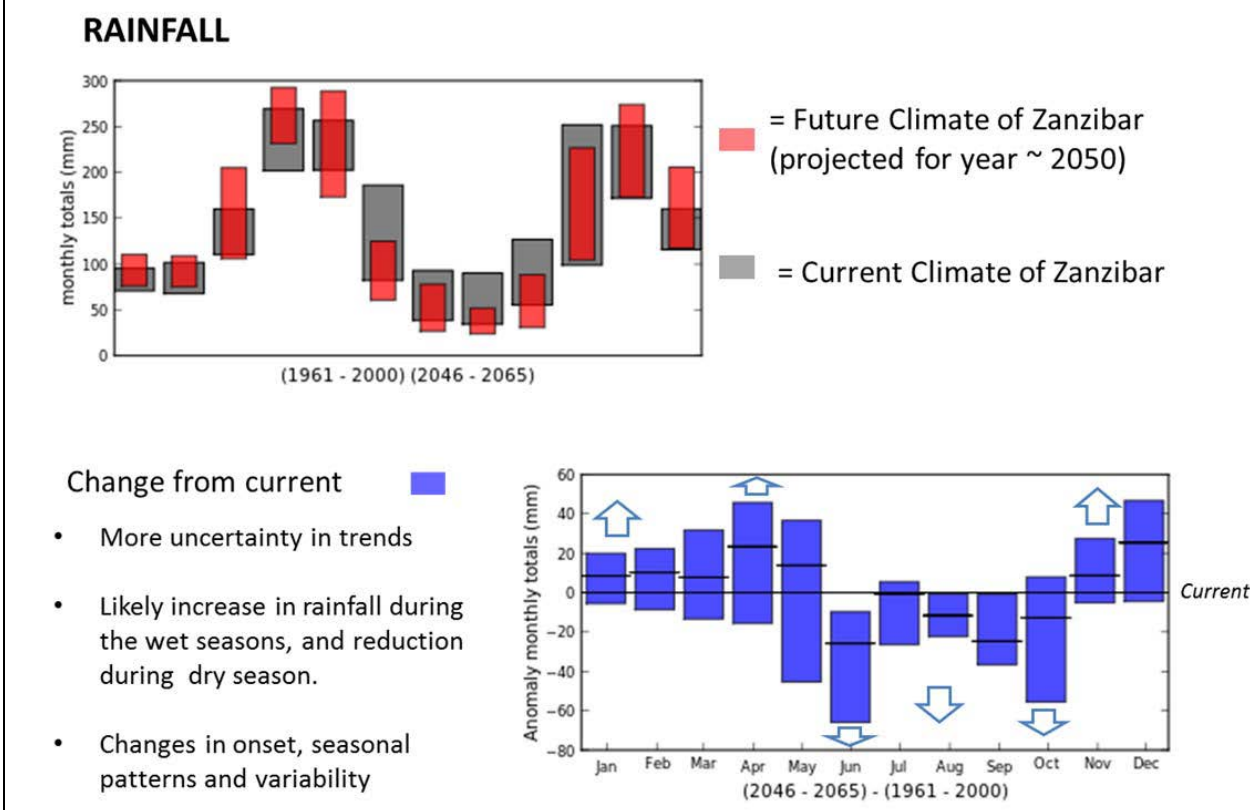

Figure 3. A2 Scenario, Downscaled projections and anomalies of monthly precipitation temperature (2046-2065) – for Zanzibar (Unguja). Grey envelope shows the current modeled climate and the red envelope shows the future period. The bottom box shows the change from the (modeled) current climate in blue, where the range reflects the variations across ten different GCM models. Source of data: Climate Systems Analysis Group (CSAG), University of Cape Town, SA. Source of graphic: Watkiss et al., 2012.

3.0 VULNERABILITY ASSESSMENT METHODOLOGY

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**).

Paje and Jambiani are situated on the east coast of Unguja Island (Figure 4), The methodology used to achieve the aims of the assessment began through a series of sensitization meetings (Figure 5), followed by field practical demonstrations and sharing of experiences from amongst the local communities. Also a questionnaire based on what changes have been observed by the community to determine their understanding on climate change and what should be done was given to about 64 people and the results are presented in Appendix 1 (Figures 10 and Figure 11)

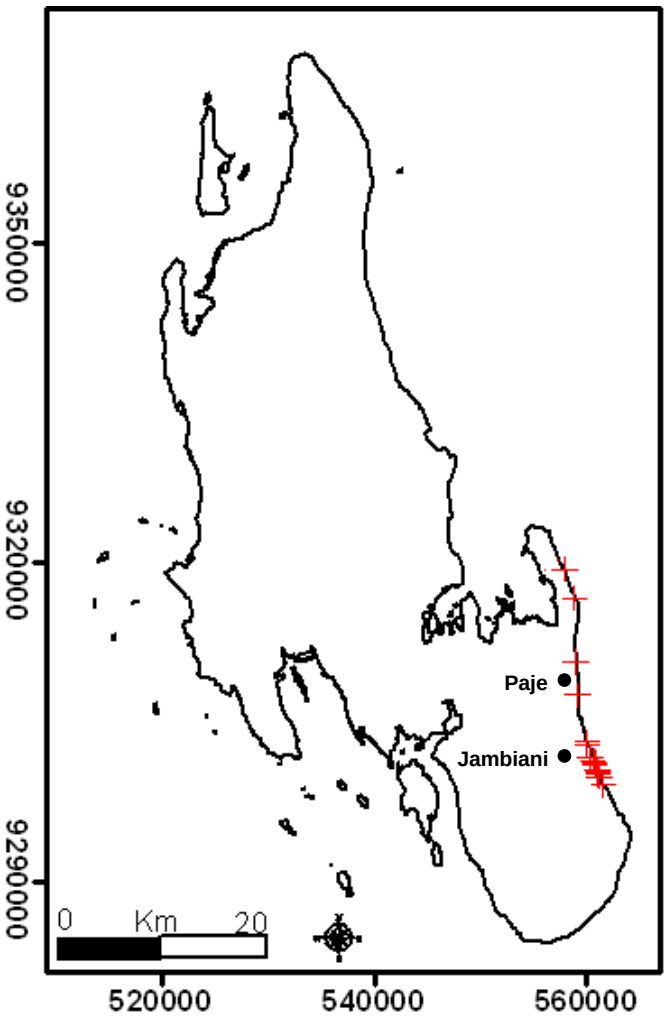

Figure 4. The Map of Unguja Island, Zanzibar showing the location of the Jambiani village. Note that the red plus symbols were the sites where magnitude and rates of erosion were estimated during the ReCoMap study.

3.1 Sensitization Sessions

At least two meetings in each village were used to gather information from villagers on vulnerability and adaptation options. The sensitization meetings were conducted in Jambiani and Paje between June and December 2011. The participants of both meetings included: village leaders, representatives from various local community groups, fisherfolks, school teachers, local non-governmental organizations, and representatives from different age groups.

Some definitions used during the sensitization meetings include the following: (Know climate change, 2012)

> ***Vulnerability*** is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. It is the degree to which a system is susceptible to, or unable to cope with, the adverse effects of climate change, including climate variability and extremes
>
> ***Adaptive capacity:*** The capacity for natural or human systems to adjust in response to actual or expected climatic changes or their impacts, so as to reduce harm or exploit beneficial opportunities.
>
> ***Coping Range*****:** Coping range represents the magnitude or rate of disturbance various systems like communities, enterprises, or ecosystems can tolerate without significant adverse impacts or the crossing of critical thresholds.

3.2 Stakeholder Analysis

During these meetings each community was asked to mention the key stakeholders in their areas. Stakeholder analysis is a methodology used to facilitate institutional and policy reform processes by accounting for and often incorporating the needs of those who have a 'stake' or an interest in the reforms under consideration. With information on stakeholders, their interests, and their capacity to oppose reform, reform advocates can choose how to best accommodate them, thus assuring policies adopted are politically realistic and sustainable.

Four major attributes are important for stakeholder analysis: the stakeholders' position on the reform issue, the level of influence (power) they hold, the level of interest they have in the specific reform, and the group/coalition to which they belong or can reasonably be associated with.

The following stakeholders were identified as having a stake on the coastal zone of Jambiani/Paje (Table 1):

Table 1. Summary of stakeholders identified

Villagers
Fishermen
Seaweed farmers
Hotels
NGOs
Woman gleaners
Investors
Tourists
Village heads and councilors
Women burying coconut husks
Traditional use as sacred sites (mzimu)

Community from Zanzibar town who come for swimming, exercise, and recreation
NGOs
Bait collectors
Fish mongers
Marine research institutions (IMS, SUZA)
Government institutions
Department of Lands
Department of Environment
Department of Fisheries
Woman and youth

Meetings at Paje and Jambiani	
	
	

Figure 5: Sensitization meetings at Jambiani and Paje villages (Photo credit: N.S Jiddawi)

4.0 VULNERABILITY ASSESSMENT, PAJE AND JAMBIANI VILLAGES

The basic elements of a vulnerability assessment are identifying the extent to which the villages and their economic activities are exposed to climate and non-climate hazards and impacts, the degree to which important areas or assets are sensitive to likely impacts, how adaptable the community members and businesses are likely to be.

The participatory approach reveals this information often in indirect and interactive ways, rather than in simply filling out pre-determined questionnaires and applying a mathematical formula to compute some number representing overall vulnerability. The dialogue in Paje and Jambiani was already ongoing before the current assessment was initiated. The assessment presented in this section reflects the ebb and flow of this ongoing discussion.

4.1 Introduction of the Concept of Climate Change

During the first meetings, Dr. Shaghude presented the scientific concept of climate change. Important concepts covered during the presentation included:

- The green-house gases and the concept of global warming
- The influence of human activities on the global climate change

During the second meetings, presentations were given of the main results of the ReCoMap project to raise awareness and understanding on the natural factors contributing to climate change at Jambiani and Paje coastal areas. The presentation was made during a plenary session constituting of a total number of participants of 34 (in Jambiani) and 32 (in Paje), represented by various community groups. From the presentation of the results, it was learned that:

The entire coastal section along the southern coast of Zanzibar between Jambiani and Paje is currently highly threatened by coastal erosion.

The magnitude and rate of erosion at Jambiani coastal area was relatively higher than at the neighboring Paje village located to the north of Jambiani (Figure 6).

4.2 Information on Physical Impacts from Climate and Non-climate Stresses

The tidal currents along the Jambiani – Paje coastal section vary from north to south, shore to offshore and also on monthly bases with strongest currents in March, May and June. The tidal currents were also strongest at the edge of the fringing reefs and sluggish inside the lagoon suggesting that the reefs were playing a significant role in protecting the shores.

The wave climate regime inside the lagoon is controlled by the sea bottom topography and wind fetch (the distance that wind can move unblocked). The observed higher magnitudes and rates of erosion on the southern lagoon (Jambiani coastal section) have been attributed to longer wind fetch and relatively deeper waters (Fig. 4) compared to the shorter wind fetch and shallower lagoon characterizing the Paje coastal section located to the north of Jambiani.

During the meeting the community clamed that fish are declining. They were informed that this could be attributed to many factors such as over fishing, increase in number of fisher due to increase in demand, use of destructive fishing gears, use of destructive gears and possibly one of them being climate change. According to Combes, (2005) fish are increasingly threatened by global warming. Greenhouse gases released mainly by humans burning coal, oil, and natural gas have led to a sharp rise in mean global temperatures over the last 50 years. Warmer waters, as well as changes in rainfall, currents, are already affecting the world's fish and fisheries. While slightly warmer water may not sound so bad to many of us, its effect on fish and aquatic ecosystems, and ultimately on the global food supply and economic stability, could be severe. This is because fish are more sensitive to temperature than many animals. They cannot maintain a constant body temperature like we do. In most cases, their body is exactly the same temperature as the water they are swimming in (Combes, 2005).

The GIS data used for the ReCoMap project consisted of three aerial photo images (1977, 1989 and 2004) all obtained from the Department of Lands and Survey, Zanzibar. Each of the three sets of images was ortho-rectified and superimposed on the topographic map containing the villages along the investigated coastal section. Using this dataset, the magnitude and rates of erosion/accretion at specific points within the two villages were then estimated. The GIS assessments of the rates and magnitudes of erosion were later confirmed by the local communities during the stakeholder's workshop.

Such involvement of the local communities from the early beginning of the project was considered to be an important aspect of coastal management as the intended future management plan would require a bottom-up participatory approach.

Mapping of the of the existing coastal protection methods was accomplished using a digital camera and a hand held GPS. The information gathered was then documented in a field logbook, classified with final creation of the GIS inventory of the major generic classes.

The modeling tool on the other hand used a number of oceanographic, meteorological and hydrological parameters such as the field measurements of tidal currents, sea water levels, wind velocities, bathymetry and beach profiles to estimate the seasonal pattern of the tidal currents and bed level changes (i.e. sediment transport processes).

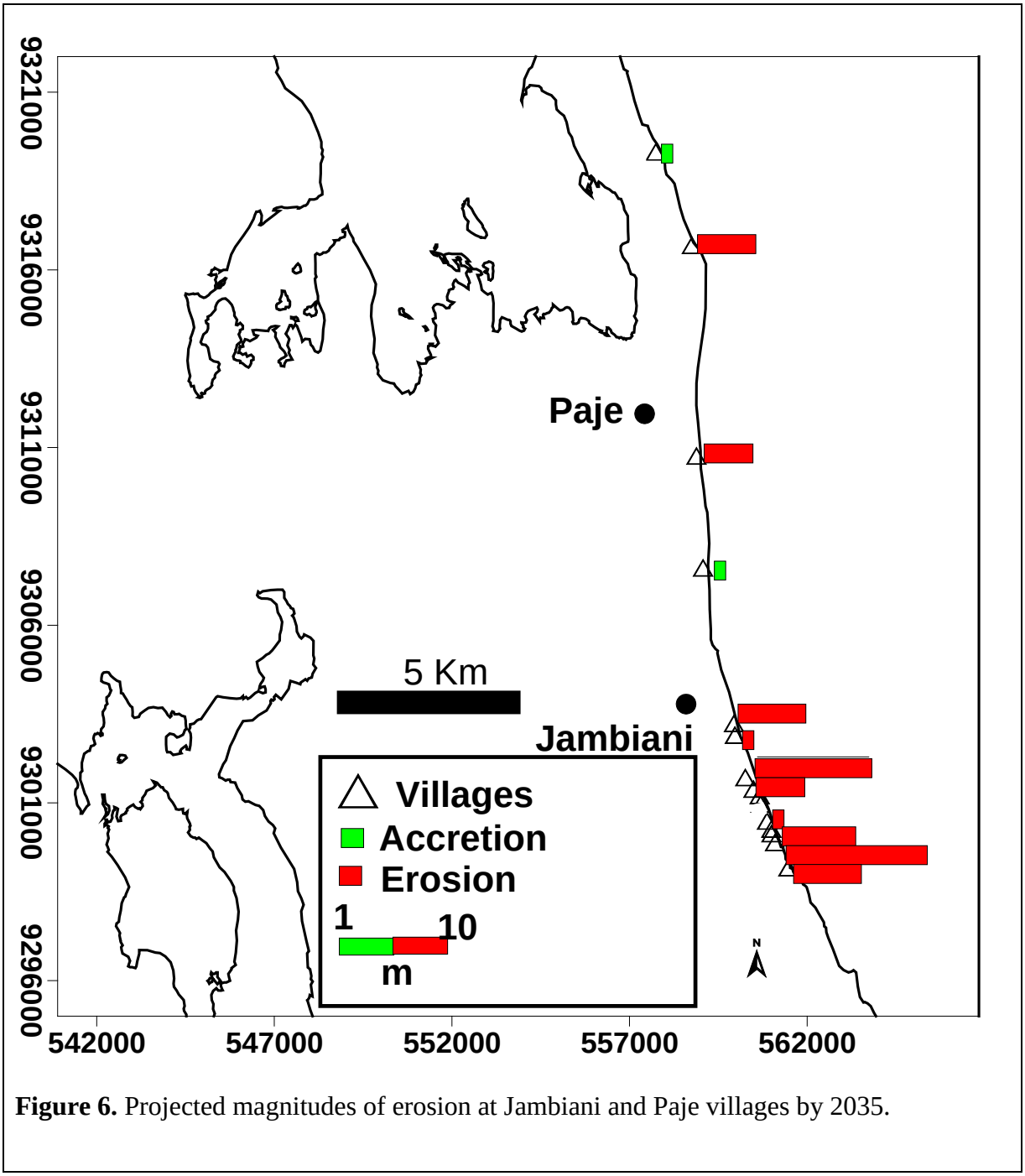

Figure 6. Projected magnitudes of erosion at Jambiani and Paje villages by 2035.

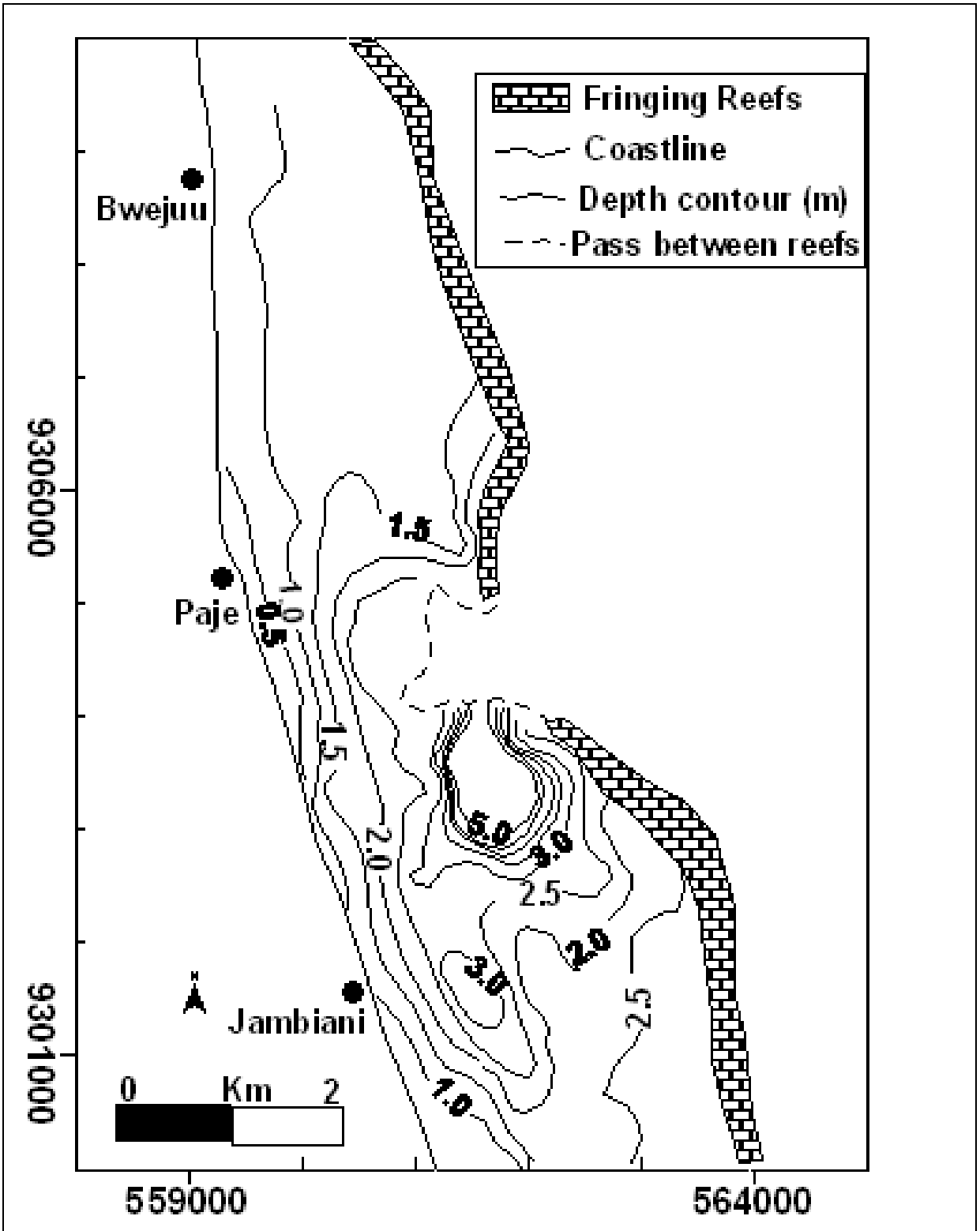

Figure 7. The Map of the Eastern coast of Unguja Island showing the sea bottom topography inside the lagoon.

4.3 Climate Impacts and Sensitivities Identified by the Communities

The communities made a great number of observations of their own about changes they have already seen, and identified those that they believe might be associated with the climate change. The observed changes are outlined below.

Fisheries

- Resources have declined due to overfishing, increase in number of fisher due to increase in demand, use of destructive fishing gears, change in types of fish caught, and possibly due to changes in sea temperature and other climate effects.

Shoreline uses and coastal processes

- Increasing eroded beaches brought by removal of rocks along the beach and cutting the *Ipomea* plants
- Rampant building, especially building too close to the shoreline (not adhering to the setback line regulation which prohibit building permanent structure in front of the 30 m setback line
- Community drying seaweed on top of the *Ipomea* plants resulting in their death
- Removal of seagrass from the intertidal area. Communities believe that the seagrass acts as buffers against the waves and slow tidal currents and protect the beaches from erosion, they also believe that the seagrass trap the sediments thereby enhancing sedimentation in the intertidal area.
- Sweeping of the beach in front of hotels to remove leaves of seagrass and other algae materials brought by the swash waves during high tides
- Driving of motorbikes along the beach by tourists. The local communities believe that motor biking destabilizes the beach sand and enhances erosion
- Sand mining for filling the Hotel's pavement and for building
- Installation of coastal structures, such as jetties and vertical seawalls are also believed to accelerate erosion either by blocking longshore sediment transport or enhancing cross –shore sediment transport flow, thereby starving the beach areas from having enough sand
- Most people were of the opinion that significant shoreline change has occurred during the last five years. The most obvious evidence of these changes include uprooting of coconut trees and other coastal vegetations, increasing salt water intrusion in underground water (drinking water) and collapse of some of the coastal settlements (houses), especially in Jambiani

Storms

- During the north east monsoon seasons, a lot of seagrass and algae mixed with cyan bacteria is washed along the beach and this cause itching and rashes among the seaweed farmers

Fresh water supply

- Underground wells are the main source of domestic water both for local communities and tourist hotels. This water which used to be fresh in the past is increasingly becoming salty due to salt water intrusion (from the sea) in wells. The excessive

pumping which has led to salt water intrusion is probably due to increased water usage associated with tourism developments over the past two-three decades

- Apart from the above observations from the local coastal communities, other related phenomena potentially impacting the Jambiani-Paje coastal area include:

Acidification of the ocean

- Corrosion of reefs. This occurs if the acidity of the water increases. The entire coastal section between Jambiani and Paje is fringed by coral reefs, which are composed of carbonate rocks. The fringing reefs help to protect the beaches from erosion. With the increasing threats of acidification of ocean waters the carbonate rocks may slowly disappear and this would increase the vulnerability of the coast to erosion.

Socio-economic related issues

- According to Yanda (2011) women and men are affected differently by altering roles and tasks they perform. Women may for instance need to travel long distances searching for water and firewood. The degrading of freshwater supply due to sea water intrusion would likely have significant impacts to women than to me. Furthermore, with the increasing threats of people losing their assets and becoming poorer from various natural hazards such as floods, drought and erosion along the beach the women are expected to be mostly affected.

Summary of observed changes

In view of the presented findings (gathered from the scientific point of view and local community perceptions), shoreline erosion is one of the biggest environmental problem facing the two villages (Jambiani and Paje).The shoreline erosion problem is both naturally induced and human induced (Table 2; Appendix 2).

Table 2. Summary of Problems facing the Paje and Jambiani coastal zone from both natural and human impacts

Human Impacts	Natural Causes
Seagrass degradation	Hurricanes
Increase in sea urchins	Spring Tides
Cutting trees along the coast and removal of grass for drying seaweed	Increase in Rain
Passages on the sea bed through trampling	Strong Waves
Biodiversity reduction	Strong Winds
Destruction of reefs from bad fishing practices	Tsunami
Uncontrolled building along the coast or building too close to the coast	Disappearance of some type of fish and elasmobranches e.g. manta ray
Digging holes for garbage disposal	Salt intrusion in wells
Sand mining	Sea level rise
Seaweed farming	Increase in water temperature
Over collection of some gastropds e.g. *Capreacassis ruffa*	Coral bleaching Predation. Coral diseases
Lack of environmental education	Sedimentation
Bait digging	Floods
Failure to abide by laws and regulations	Too much rain causing floods in certain areas
Cleaning the natural grasses (by hoteliers) brought in by waves	
Throwing of garbage in the ocean	
Increase in number of tourists	
Unawareness of the laws and regulations by villagers	
Diving, fishing and passenger boats	
Dumping of waste along the coast and nutrient enrichment	

The general physical setting of the two villages and common socio-economic activities in the two villages are summarized in Table 3.

Table 3. Physical and socio-economic setting of the two villages Jambaini and Paje, Zanzibar

	Jambiani	**Paje**
Length of Beach:	About 6 km	About 2.5 km
Beach Facing:	Open sea	Open sea
Backshore Faces:	Sandy, rocky cliffs, residences, vegetation	Sandy, rocky cliffs, residences, vegetation
Foreshore Faces:	Sandy and silty sediments, open sea, reef	Sandy and silty sediments, open sea, reef
Morphology:	Shallow sea bottom with a number of depressions (>3m depths)	Shallow sea bottom with no depressions
Protective Structures:	One jetty. Many poorly constructed seawalls.	No jetty, some protective structures
Vegetation:	Some vegetation, coconut trees, casuarinas trees and a few mangroves to the south	Some vegetation, coconut trees, casuarinas trees.
Falling Trees:	Yes	Yes
Abandoned houses from erosion	Yes	No
Seaweed Farming:	Yes	Yes
Coconut Burying:	Yes	Yes
Mangrove Cutting:	No	No mangroves
Sand Mining:	Yes	Yes
Fish Landing Site:	No	No
Settlements in Vicinity of Beach (within 30m of high tide mark):	Yes	Yes
Beach Used for Recreation or Tourism:	Yes	Yes
Hotels	Yes	Yes
Fisheries	Yes	Yes

4.4 Adaptive Capacity of Paje and Jambiani Villages

Climate change is considered to be one of the most serious threats to sustainable development, with adverse impacts expected on the environment, human health, food security, economic activity, natural resources and physical infrastructure. While mitigation has traditionally been the pivotal issue for many climate change experts, adaptation to the effects of climate change is now acknowledged as necessary for responding effectively and equitably to the impacts of both climate change and climate variability. Although the capacity of individuals to adapt to climate change is a function of their access to resources, the adaptive capacity of societies depends on the ability to act collectively in the face of the threats posed by climate variability and change. In Paje and Jambiani there are several activities on going to enhance the adaptive capacity of the communities in both Paje and Jambiani through various awareness programmes. Also the community has mobilized themselves to form committees to manage their coastal resources through replanting of *Ipomea* as well as mangroves as a first step to reduce the observed impacts.

Adaptive Capacity Questions	**Paje and Jambiani (similar in both villages)**
How well do community members work together on coastal development planning and coastal management, including coastal hazards?	Each village has community based organizations responsible for overseeing various activities e.g. mangrove management committee, environmental committees, and fisheries committees. Work is done on a volunteer basis.
What practices are currently employed to cope with natural hazards? Who is responsible for developing and implementing such measures?	There is a Department of Environment which is responsible on proper control of the environment. Also there is the National Adaptation Programme of action (NAPA) run from SMOLE (Lars, 2010). They provide training in preparedness and resilience initiatives There is also the Disaster Management Department (2nd Vice Presidents Office) mandated to coordinate national efforts in response to emergence situations. The Department plays vital role in ensuring community protection against natural hazards.
Are decision-makers and the community in general informed and engaged?	There are preparedness plans against disasters in several of the government policies. Also there are some community based NGOs like the Zanzibar Disaster Control Protection and Management Organization which seeks to provide awareness and education with quality services and preparedness on disaster issues that will satisfy the government and people's needs and to promote awareness, knowledge, education to the people on matters concerning natural and human induced disasters and develop protection and rehabilitation models and establish sustainable disaster response capabilities among societies. The Zanzibar government has also launched a Technical Committee on Climate Change in order to face global challenges on climate change.

Adaptive Capacity Questions	Paje and Jambiani (similar in both villages)
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?	Most people have more than two livelihood activities. Most fishers are also farmers. Most seaweed farmers also do other activities when they can not go into the oceans during neap tides.
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?	There are good communication and transporting systems in most areas having quick links to various places
How healthy are the ecosystems and how well are natural resources managed?	The major ecosystems such as corals, mangrove and seagrass in these areas are partially destroyed but in most cases they are still in good condition. One example is the seagrass which has been mostly affected through seaweed farming activities.

5. ADAPTATION OPTIONS AND RECOMMENDATIONS

5.1 Key Actions Suggested by the Communities

Each village formed special committees were to address follow-up actions. The committees took on the responsibility for overseeing the planting of *Ipomea* along the beach to control erosion. Also other recommendations were provided as follows. The overarching emphasis by the communities was on actions they could carry out within their own abilities and efforts.

- Awareness programmes need to be conducted to inform the community on the issue of climate change and exchange experiences
- Laws and regulations should be revised to consider the issue of climate change
- Improve enforcement of building rules and regulations along the coast
- Meetings involving hoteliers, relevant government institutions and the community need to be held as these people rarely have an opportunity to meet. The aim of the meetings would be to discuss how together they can tackle the problem of erosion.
- Encourage planting of *Ipomea* along the coastal strip
- Find alternative drying techniques for the seaweed farmers to eliminate drying on the *Ipomea* grass
- The local government needs to find alternative inland locations for sand mining so as to promote the elimination of beach sand mining
- Put in place government preparedness measures to address disasters

5.2 Promotion of Good Shore Management Practices

The GIS inventory of the existing coastal protection measures along the entire Jambiani – Paje revealed that masonry seawalls were the most common coastal protection measures (Figure 8). The masonry seawalls were generally vertical and either without any other supplementary protection or with additional supplementary protections such as quarried rock aprons or indigenous plants. Other less common protection measures were natural protection, erected poles and piled boulders. Plants and revetment protection were rare.

Acceleration of wave shore erosion due to wave scouring and wave run-up and over-toppings are among the major negative impacts of vertical seawalls (CIRIA, 1996; Shaghude et al., 2010). The other negative effects of vertical seawalls include beach flattening and acceleration of wave erosion in adjacent un-protected coastal sections. It was therefore evident that, apart from the above discussed natural factors contributing to the observed erosion at Jambiani coastal section, there was also a human dimension to the erosion problem. On the other hand, it was learned that the use of indigenous vegetation stabilized the beaches while at the same time maintaining the aesthetic value of the beaches for recreational purposes. These key points were therefore emphasized during the second awareness meetings. During the presentation, examples of good and bad shore management practices

were demonstrated (Figure 9). Committees of 10 and 13 people were formed at Paje and Jambiani respectively for promoting good shore management practices.

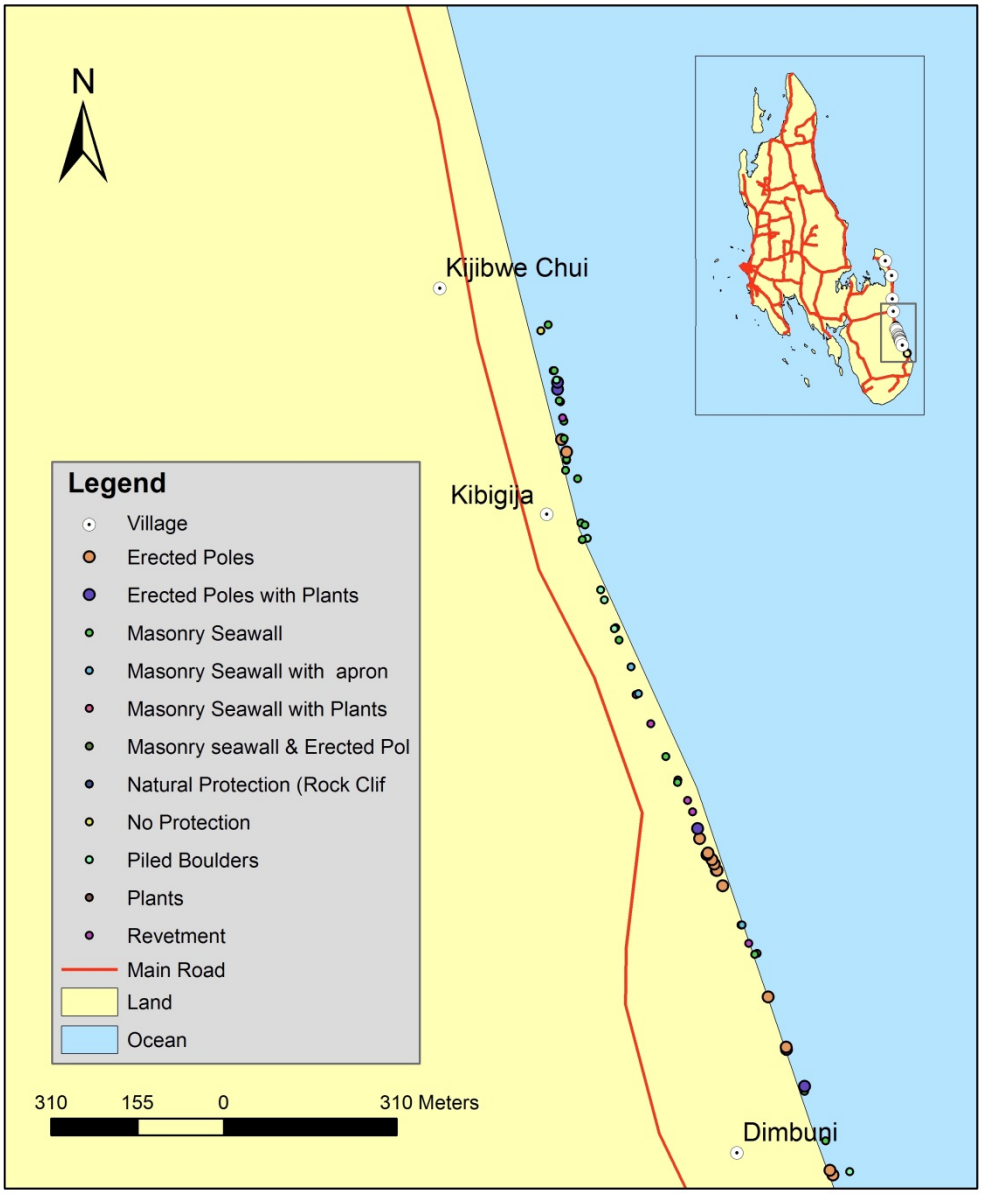

Figure 8 (a). Protection measures at Jambiani-Paje coastal villages (Kibigija – Dimbuni)

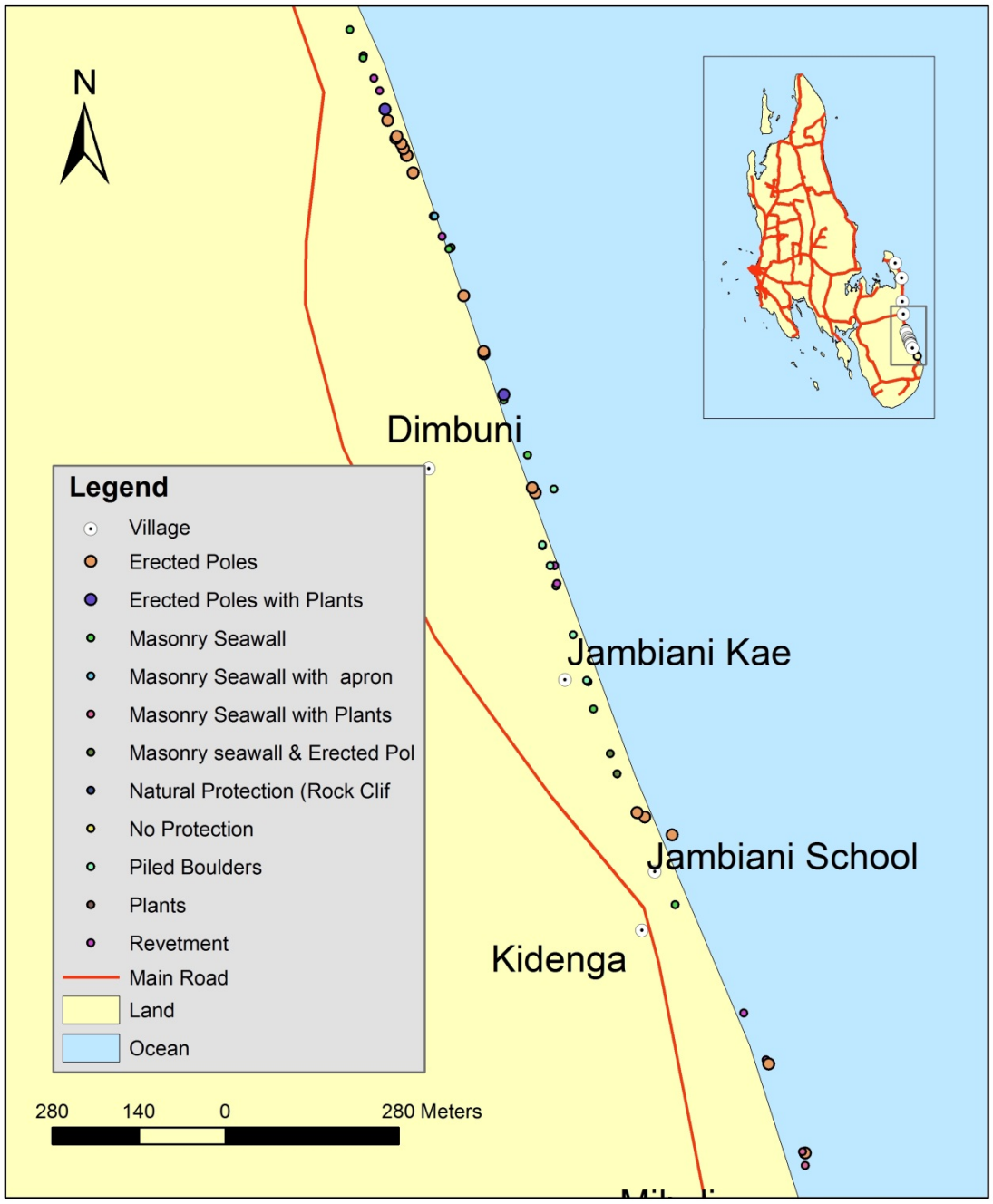

Figure 8 (b). Protection measures at Jambiani-Paje coastal villages (Dimbuni – Mihuli)

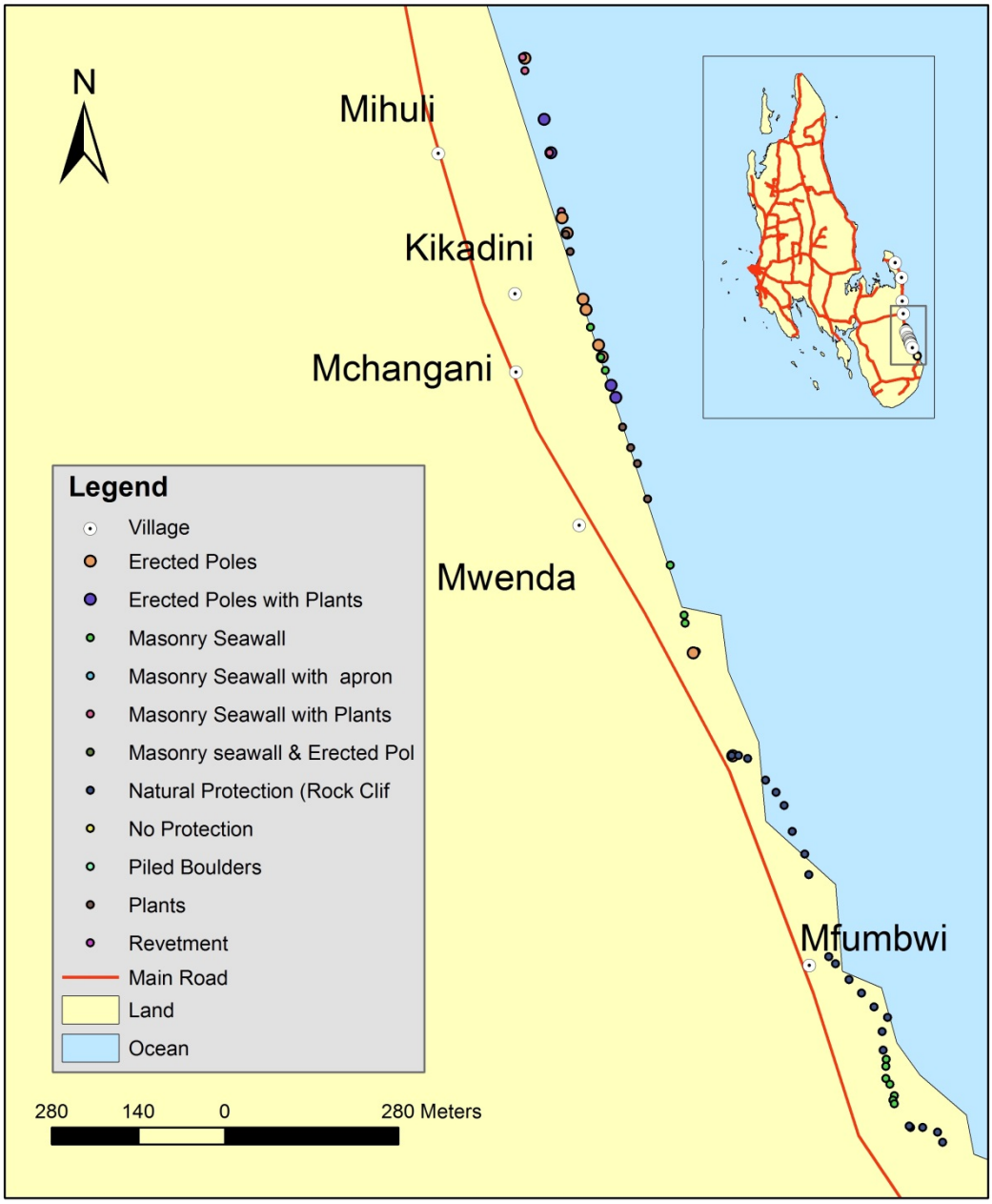

Figure 8 (c) : Protection measures at Jambiani-Paje coastal section (Mihuli – Mfumbwi)

EXAMPLE	TYPE OF PRACTICE
	(a) = a vertical masonry seawall (one of the observed bad shore management practice),
	(b) = revetment (one of the two observed good shore management practices)
	(c) *Ipomea* creeping plants (one of the two observed good shore management practices)

Figure 9. Bad and good shore management practices; (a) = a vertical masonry seawall (one of the observed bad shore management practice), (b) = revetment and (c) *ipomea* creeping plants (two of the observed good shore management practices). (Photo credit: Dr. Shaghude)

6. CONCLUDING OBSERVATIONS

There have been several benefits of doing coastal management work prior to the vulnerability assessment in the case of Paje and Jambiani. The IMS assessment team became familiar with the site, and it was easy to plan and organize meetings because the communities already knew the team. It was also easy to meet with the community since they already knew what they wanted from us, they understood us, and could talk with us. The village head had also built trust with the assessment technical team. We had already become familiar with the area. So when they mentioned the names of certain areas it was easy for us to picture what they were talking about.

In the previous coastal management planning, IMS worked with the scientists and the community separately to gather information. But what we found was that there was a high degree of convergence between the observations of both groups, one using its life experience and the other using the tools of science and scientific data. The community has very detailed and accurate information on the environment. One of the implications of this is when working in new villages along the coast it would be wise to bring some community members along with the technical team, to speed up the process of orienting a new village to the issue of climate change and the methods for doing the assessment. It would be expected that understanding and confidence would emerge much more quickly when peers are sharing their ideas and experiences.

In Paje and Jambiani, most understood that there are ongoing changes in climate. Some people knew about climate change and vulnerability because they were able to talk about observed changes in temperature of sea water, disappearance of some fish species, and changes in fish distribution. Also, they knew that salt water intrusion is occurring in some wells. However, there are invariably some who mix up weather and climate, noting perhaps that since it was windy two days ago that it was attributable to climate change.

The villagers in Paje and Jambiani opted for early adaptation actions that they could do on their own, emphasizing the importance of local determination and effort. However, some of the recommended actions do need to be addressed by District and Regional authorities, thus it is essential to include not only a wide spectrum of resource users but also a solid representation of local authorities during the assessment process. Each has official duties that might help advance the implementation of particularly adaptation actions, for example the tourism authority may be more successful in working with hotel owners to change some of their beach “cleaning” and sand excavation practices.

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Appendix 1: Questionnaire Results, Perception of Environmental Change

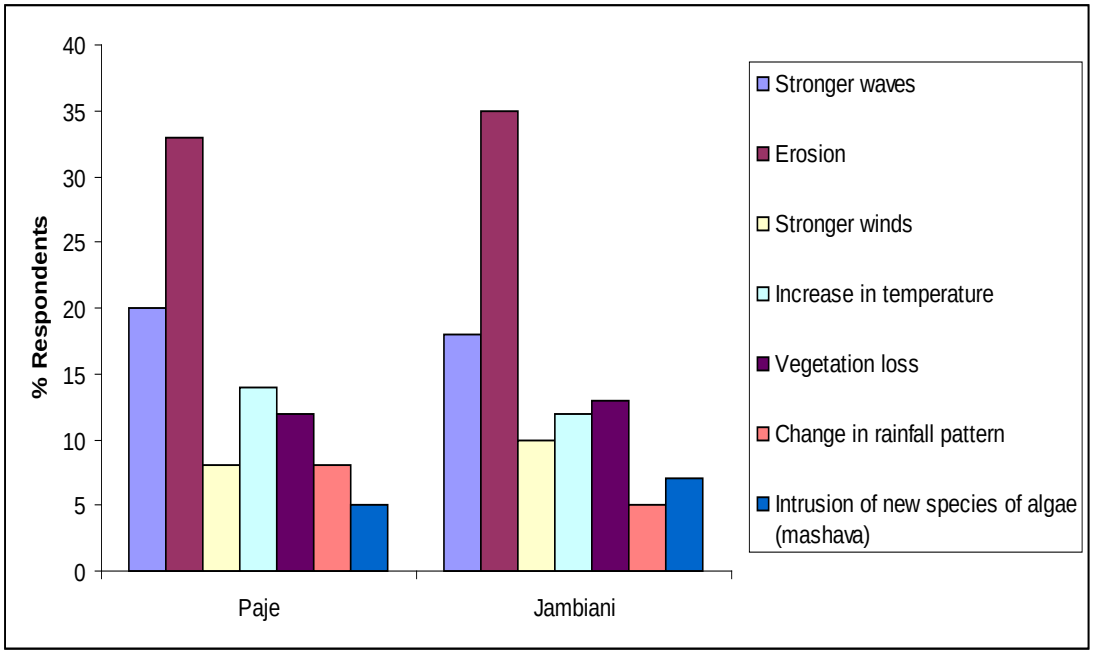

Figure10. Perceived environmental changes by the communities (n= 64)

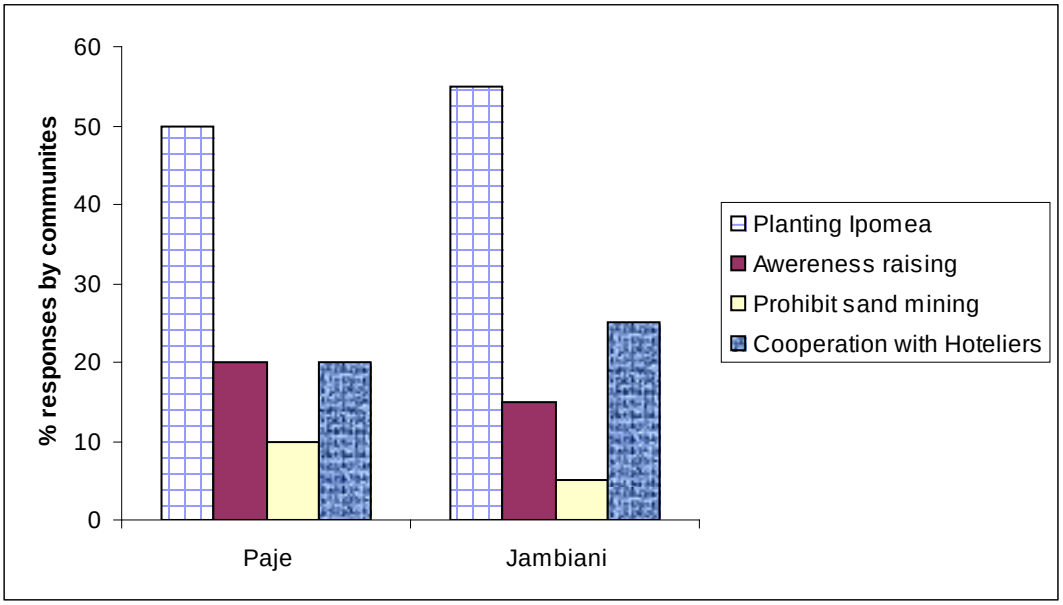

Figure 11. Responses on what should be done by the community in relation to the changes along the beach (n= 64)

Appendix 2: Photos Depicting Erosion and Coastal Activities at Paje and Jambiani

<table>
<tr><td colspan="2">Erosion and coastal activities at Paje and Jambiani</td></tr>
<tr><td> 
Large stones from a fallen wall at Jambiani</td><td> 
Eroded beach at Jambiani</td></tr>
<tr><td> 
Trees falling along the beach at Jambiani</td><td>  </td></tr>
</table>

Erosion and coastal activities at Paje and Jambiani	
 Seaweed farming at Paje	 Women busying coconut husks at Jambiani
 Planting of *Ipomea* grass to control erosion at Paje beach	 A layer of seagrass mixed with algae washed from the sea

(Photo credits: Dr. Narriman Jiddawi)