PERCEPTIONS, VULNERABILITY AND COPING STRATEGIES TO CLIMATE CHANGE IMPACTS BY MANGROVES DEPENDENT COMMUNITIES IN BAGAMOYO AND UNGUJA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN MANAGEMENT OF NATURAL RESOURCES FOR SUSTAINABLE AGRICULTURE OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

The study was conducted in Bagamoyo and Unguja to assess the perceptions, vulnerability and coping strategies to climate change impacts by mangroves dependent communities. The specific objectives of the study were to examine and compare the perceptions of the locals to climate change, to compare meteorological data with community perceptions, to analyse the vulnerability of the mangroves dependent communities to climate change and to examine the coping strategies of mangroves dependent communities to climate change impacts. Six study villages from the two sites were purposively sampled while systematic random procedure was used to select 207 households for questionnaire interview. Results showed 67% of respondents strongly agreed rainfall has declined while 51% strongly agreed air temperature has increased over the last two decades. Analysis of 30 years climate data showed rainfall has declined and temperature has increased by 1.23°C and 0.9°C in Bagamoyo and Unguja respectively. The results indicated local communities' perceptions to concur with climatic data analysis. Results indicated 89% of households were vulnerable to the changing climate and variability, the highest level being in Bagamoyo and most experienced hazard was drought. More than 30% of respondents explained to do nothing to cope with climate change hazards. Few respondents explained to change the crops, opt for non-farming jobs, planting trees, buying water, shift the location of settlement and use mosquito nets to cope and adapt with climate change hazards. The study recommends documentation of the current coping and adaptation strategies practiced by the locals against climate change hazards. Also to combine the local coping methods with new innovations to enhance adaptations to climate change hazards in the study sites.

DECLARATION

I, Deogratius Nicholaus Ndelolia, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

04. 11. 2013

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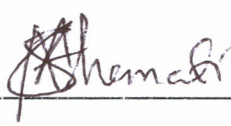

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DEDICATION

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LIST OF ABBREVIATIONS AND SYMBOLS

CEEPA	Centre for Environmental Economics and Policy in Africa
CO_2	Carbon Dioxide
ENSO	El Nino Southern Oscillation
FAO	Food and Agriculture Organization
FGD	Focus Group Discussion
GHG	Green House Gases
HH	Household
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
MNRT	Ministry of Natural Resources and Tourism
NAPA	National Adaptation Programme of Action
NGOs	Non Governmental Organizations
Ppm	Parts Per Million
SIDS	Small Islands Development States
SNAL	Sokoine National Agricultural Library
SPSS	Statistical Package for Social Science
SUA	Sokoine University of Agriculture
TAS	Tanzanian Shilling
TASAF	Tanzania Social Action Fund
TMA	Tanzania Meteorological Agency
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

URT	United Republic of Tanzania
USAID	United States Agency for International Development
USD	United States of American Dollar
WWF	World Wide Fund for Nature
ZNZ	Zanzibar

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Climate change refers to any change in climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (IPCC, 2001). For the purpose of this study this definition has been adopted.

There is no doubt that human-induced climate change is happening (Nelson and Agbey, 2005). However, it still remains difficult to clearly distinguish human-induced climate change from natural variation in climate at small scales (Adger *et al.,* 2003). Nevertheless evidence of long-term geophysical and biological changes is now apparent in many parts of the world, such as increase in average global temperature (global warming), changes in cloud cover and precipitation particularly over land, the retreat of mountain glaciers and reduced snow cover, and the earlier arrival of spring (IPCC, 2001; UNFCCC, 2007). Other evidences include increase in ocean temperatures and ocean acidity due to seawater absorbing heat and carbon dioxide from the atmosphere (UNFCCC, 2007). The main driver for climate change is the increase in CO_2 from human activities.

Globally over the last century, atmospheric concentration of CO_2 has increased from a pre-industrial value of 278 parts per million (ppm) to 379 ppm in 2005, causing an increase of global temperature by 0.74^{o}C. According IPCC (2007) this is the largest

and fastest warming trend that it has been able to discern in the history of the Earth. An increasing rate of warming has particularly taken place over the last 25 years, and 11 of the 12 warmest years on record have occurred in the past 12 years (IPCC, 2007). Further, the temperature is expected to rise between 2°C and 4.5°C during the next century (IPCC, 2007; Adger *et al.,* 2003). Moreover, over the last century the sea level has rised between 10cm and 25cm (Adger *et al.,* 2003) while precipitation level has increased by 1% as a result of climate change (IPCC, 2007).

Africa has been claimed to be one of the most vulnerable continents to climate change and variability (IPCC, 2007) and that by the year 2050s, 350–600 million population will be at risk for increased water stress, predominately in the northern and southern parts of the continent. Over the course of last century Africa has experienced a 0.5°C rise in temperature with some areas warming faster than others (Eriksen *et al.,* 2008). Predictions show that annual mean surface air temperatures are expected to increase between 3°C and 4°C by 2099, roughly 1.5 times average global temperatures (Boko *et al.*, 2007; IPCC, 2007). There is considerable variation in precipitation projections in Africa. According to IPCC (2007) Africa annual rainfall is expected to decrease in much of Mediterranean region and the northern Sahara, with a greater likelihood of decreasing rainfall as the Mediterranean coast is approached. In southern Africa rainfall is expected to decrease in much of the winter rainfall region and western margins while in East Africa annual mean rainfall is expected to increase (ibid)

The convergence of multiple stressors, including infectious disease, economic turbulence from globalization, resource privatization, and civil conflicts, combined with the lack of resources will present critical challenges for african communities struggling to adapt to climate change effects (Fields, 2005). In Africa climate change impacts are expected to disproportionately affect different groups of people such as the poor, young, elderly, sick, and marginalized populations. With regard to the location, the coastal areas of Africa are projected to be exposed to increasing risks of climate change, including coastal erosion and sea level rise (IPCC, 2007).

Over the last 100 years Tanzania has experienced a warming of its climate between 0.4°C - 0.8°C and this is likely to continue, if not accelerate, in the decades ahead (Adger *et al.,* 2003). For this particular model, the country will warm by further 1–2°C over the next 50 years, the rate of warming partly depending on the future growth rate in global greenhouse gas emissions (IPCC, 2001). Rainfall regime has changed due to what is thought to be climate change (Sallema and Mtui, 2008) although the degree and direction of the change is uncertain (URT, 2011). Annual precipitation over the whole country is projected to increase by 10% by 2100, although seasonal declines of 6% are projected for June, July, and August, and increases of 16.7% for December, January, February (Agrawala *et al.,* 2003). Given variations in altitude, topography, vegetation, and coastal proximity, changes in rainfall patterns and temperature are expected to vary considerably from one part of the country to another (URT, 2003).

Moreover, Tanzania is experiencing rise in sea level along the coast of Pangani and Bagamoyo Districts (Shaghude, 2004). The intrusion of sea water into fresh water wells along the coast of Bagamoyo and Pangani and the inundation of Maziwe Island in Pangani District, off the Indian Ocean shores are the evidence of the threats of climate change (URT, 2007). In the coasts of Tanzania mainland and Zanzibar islands already there have been rise in sea water temperature which is associated with El-Nino/Southern Oscillation (ENSO) (Agrawala *et al.,* 2003). A study by Muhando (1999) reported that during the 1997/1998 ENSO event the water temperatures around many of the Tanzanian coral reefs was about 2°C higher compared to the previous year. Agrawala *et al.* (2003) further estimated that by the year 2100, the mean annual temperature may rise by up to 2.2°C. Climate change related disasters have already affected different coastal and marine resources including availability of freshwater for domestic use, fish and mangroves (IPCC, 2007). Country's coastal tourism infrastructure and the human settlements have as well been threatened by coastal erosion and sea level rise (Sallema and Mtui, 2008).

1.2 Problem Statement and Justifications

The majority of rural population including those of the coastal areas mainly depends on agriculture and marine resources (mangroves and fishes) for their livelihood (Allison *et al.,* 2005). Already these resources to the large extent have been affected by climate related hazards such as drought, sea level rise, unpredictable rains, increase in surface and water temperature and acidification of the sea water (Sallema and Mtui, 2008). Ecosystem degradation by human being continues to be a persistent feature in reduction of mangroves forests (Torell *et al.,* 2006). The total

area occupied by mangroves in Tanzania is 111,817 ha (Wang *et al.,* 2003). However, mangrove forests are in a state of decline throughout their range (Faunce and Serafy, 2006) due to both, climate change impacts and human influence (Torell *et al.,* 2006). Increase in fishing efforts both in term of number of fishermen and vessels associated with unsustainable fishing practices of using poison, dynamite and beach seine nets have resulted into decline in fish stocks (Torell *et al.,* 2006). Human influence has been responsible for further exacerbation of the impacts of climate change on coastal resources.

The perceptions of mangroves dependent communities to climate change in the Bagamoyo and Unguja are not well studied. Further the vulnerability of these communities to climate change is not well documented. Maddison (2006) suggested that studying local communities' perceptions enables to determine the ability of the locals to detect climate change they believe has occurred. Some of the literatures on climate change argue that with the adaptation, local communities vulnerability can be significantly reduced (Odekunle *et al.*, 2007; Gbetibouo, 2009). In Tanzania, local communities coping strategies and adaptation which are relevant to curb with the impacts of climate change are not sufficiently studied nor incorporated into national level climate change adaptation plans and policies (Lema and Majule, 2009).

To date there has been few scientific researches carried out to assess, vulnerability, coping and adaptation strategies against climate change. For example Lema and Majule (2009) studied the impacts of climate change and adaptation strategies on

agriculture in the central Tanzania. Mngale (2009) studied climate change coping strategies for household food security in Singida, Tanzania. However, all these studies focused on climate change in agriculture. Studies which have been done on the coastal mangroves of Tanzania so far have focused on aspects of changes in distribution and total area, adaptation of coastal and marine resources to climate change impacts, socio-economic potential, structure, ecology and coverage of mangroves (Sallema and Mtui, 2008; Makota *et al.* 2004; Wang *et al.* 2003; Semesi, 1999; 1991).

None of the previous studies however focused on perceptions, vulnerability, coping and adaptation strategies of coastal communities to climate change impacts. Therefore, there is limited information which exists on perceptions, vulnerability, coping and adaptation strategies of these communities to climate change, especially at household level. This study aimed to bridge that information gap through assessing the perceptions, vulnerability and coping strategies of mangroves dependent communities to climate change impacts. The end result of this study including practicable recommendations will be helpful to the policy and decision makers, planners, NGOs and other stakeholders to understand the factors contributing to vulnerability of mangroves dependent community to climate change impacts. The community and other stakeholders may also use the findings to take appropriate measures and actions against those factors responsible to climate change.

1.3 Objectives

1.3.1 Overall objective

To assess the perceptions, vulnerability and coping strategies of mangroves dependent communities to climate change impacts in Bagamoyo and Unguja, Tanzania.

1.3.2 Specific objectives

Specifically the study intended to:

(i) Examine and compare the perceptions of mangroves dependent communities to climate change impacts in Bagamoyo and Unguja,

(ii) Compare meteorological data and community perceptions to climate change, in Bagamoyo and Unguja,

(iii) Analyse the vulnerability of mangroves dependent communities to climate change impacts in Bagamoyo and Unguja,

(iv) Examine the coping strategies of mangroves dependent communities to climate change impacts in Bagamoyo and Unguja.

1.4 Research Questions

(i) What are the perceptions of the mangroves dependent communities to climate change impacts in the study areas?

(ii) What is the climate trend (rainfall and temperature) of the study areas over the last 30 years?

(iii) How vulnerable are mangroves dependent communities to climate change impacts in the study areas?

(iv) What strategies are used by mangroves dependent communities to cope with climate change impacts in the study areas?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Definition of the Key Concepts

2.1.1 Climate change

In this study definition by IPCC is adopted. IPCC (2001) defines climate change as any change in climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

2.1.2 Vulnerability

In this study definition by IPCC is adopted. IPCC (2007) defines vulnerability to climate change as the degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change, including climate variability and extremes.

2.1.3 Coping strategy

In the context of this study the definition by Adger *et al.* (2003) is adopted. The authors define coping strategy as the adjustment of a system or community to moderate the impacts of climate change, to take advantages of new opportunities or to adapt with the consequences.

2.1.4 Adaptation

In the context of this study the definition of adaptation by IPCC is adopted. IPCC (2007) defines adaptation to climate change as initiatives or measures taken to

reduce the vulnerability of natural and human systems against actual or expected climate change effects. Various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned.

2.1.5 Mitigation

In the context of this study the definition of mitigation given by IPCC is adopted. IPCC (2007) define mitigation as a process which aims at reducing greenhouse gases (GHG) emission by sources and/or enhance carbon removal by sinks. Mitigation therefore, reduces the effects of the factors which accelerate climate change such as GHG emission but does not protect the communities from the effects of climate change.

2.1.6 Resilience

Resilience refers to the ability of socio-ecological systems to cope with and adapt to change (Carpenter *et al.,* 2001). Resilient systems are adaptable, flexible, and prepared for the change and uncertainty while none resilient systems are prone to irreversible or catastrophic change and are at risk of shifting into another, often undesirable state (Dolan and Walker, 2004).

2.1.7 Mangroves dependent communities

Mangroves dependent communities refers to coastal communities which live close to and have a long association with mangroves and depends on these forests for services and products for their well being and economic livelihood both through non-market and market based exploitation (Wang *et al.,* 2003).

2.2 Theoretical Analysis of Vulnerability and Adaptation to Climate Change

2.2.1 Climate change vulnerability

Vulnerability is determined by three main factors; exposure, sensitivity to a hazard and capacity to adapt (Dolan and Walker, 2004). Exposure is defined as the degree or extent to which an individual or social group faces a change in climate (IPCC, 2001). It is directly related to position of human settlements and ecosystem of which they depend in relation to the region prone to the occurrence of climate related disasters such as sea level rise and extreme weather events e.g. temperature and rainfall (Smit and Wandel, 2006).

Sensitivity refers to the degree to which a system responds to a change in climatic conditions. It is also defined as the degree to which a society or a system is influenced by changes in climate (IPCC, 2001; Hahn *et al.,* 2008). This can be measured, by a proportional change in ecosystem productivity as a result of perturbations in temperature or precipitation. Sensitivity to climate change depends on the number of people, the infrastructure, the extension of the ecosystem exposed to the hazard, and the level of dependency on the climate sensitive resources of the considered population (Tuler *et al.,* 2008). Adaptive capacity is the ability of the system to evolve in order to accommodate climate change or to expand the range of which it can cope (Allison *et al.,* 2005). Adaptive capacity is the ability of the system to withstand or recover from the exposure (Hahn *et al.,* 2008). In case of ecosystem, adaptive capacity can be treated equivalent to ecological resilience, which is the capacity of the system to recover after a disturbance while maintaining its function.

Global climate changes are expected to affect coastal communities around the world, many of which are already considered vulnerable to ongoing climatic variability (IPCC, 2001). Of these changes, accelerated sea level rise has received much attention and may entail elevated tidal inundation, increased flood frequency, accelerated coastal erosion, rising water tables, increased saltwater intrusion, and a suite of ecological changes (Dolan and Walker, 2004). These biophysical changes are expected to cause various socio-economic impacts on various sectors such as water resources, agriculture, forestry, fisheries, human settlements/ properties and infrastructure, coastal resources /ecological systems and human health (Monirul and Mizra, 2003).

In the assessing the world's ability to cope with the impacts of climate change IPCC, (2000) found that the impacts are unevenly distributed among people and those who will be exposed to the worst are the ones least able to cope with the associated risks. Vulnerability to climate change differs substantially across the globe and regions due partly to the fact that changes in temperature and precipitation occur unevenly and that climate change impacts will be unevenly distributed (IPCC, 2001). It is also due to the fact that resources and wealth are distributed unevenly across the globe and regions. Even within a country, a social group or within individuals vulnerability to climate change varies (IPCC, 2001). This is due to the fact that vulnerability of a country or social group depends to a great extent on its wealth, and that poverty limits adaptive capabilities (IPCC, 2007).

Developing countries are the most vulnerable to climate change due to lesser capacity to adapt to the impacts just as they are to other stresses (IPCC, 2007). Vulnerability of developing countries to climate change is further attributed to rapid population growth, much of it concentrated in coastal areas (ibid). Other reasons making developing countries vulnerable to climate change impacts include; high dependency on climate sensitive sectors such as fisheries, agriculture and tourism, degraded natural resources base, weak administration and governance systems, and poor transportation and communication infrastructures (UNFCCC, 2007). According to IPCC (2007) vulnerability also depends on the level of economic and institutional development. Therefore, socio-economic systems typically are more vulnerable in developing countries where economic and institutional circumstances are less favourable. The authors further, add that vulnerability is highest where there is greatest sensitivity to climate change and the least adaptability.

Relative to other areas, coastal low-lying, Small and Developing Islands (SDI) states are more vulnerable to the impact of climate change because they have relatively scarce natural resources e.g. water resources, construction materials and physical space to cope with the changes (Sallema and Mtui, 2008). Small islands have also limited and high cost of transportation options and little scope of adaptation and hence vulnerable to sea level rise and storm surges (USAID, 2009). Maharjan *et al.* (2011) further suggested that poor people are highly vulnerable to climate change impacts as they have lowest capacity to deal with such changes in terms of assets, food stock and financial savings.

Vulnerability depends critically on background, and the factors that make a system vulnerable to a hazard i.e. the nature of the system and the type of hazard in question (Brooks *et al.,* 2005). For example, the factors that make a rural community in semi-arid Africa vulnerable to drought will not be same as those make areas of a wealthy industrialized nation such as Norway vulnerable to flooding, wind storms and other extreme weather events. Isolation and income diversity might be important determinants of vulnerability to drought for rural communities in Africa, whereas the dominant factors mediating vulnerability to storms and floods in Norway might be the quality of physical infrastructure and the efficacy of land use planning (Brooks *et al.,* 2005).

Developmental factors such as poverty, health status, economic inequality and elements of governance, are the factors likely to influence vulnerability to a wide variety of hazards in different geographical and socio-political contexts (Brooks *et al.*, 2005). These factors are referred to as generic determinants of vulnerability, as opposed to specific determinants relevant to a particular context and hazard type, such as the number of storm shelters available for the use of a coastal community, or the existence of regulations concerning the robustness of buildings.

2.2.2 Climate change adaptation

The current climate change scenarios demand adaptation to temperature increases, changing amounts of available water, climatic instability, increased rises in sea level and saline intrusion in the coastal zones (Rabbinge, 2008). Given the uncertainties about future climate under various scenarios, adaptation to current climate can be a

useful as step in reducing vulnerability (Olmos, 2001). Adaptation is widely recognized as an important component of any policy response to climate change (Gbetibouo, 2009). According to Smit and Skinner (2002) without adaptation, climate change is generally detrimental to various sectors including agriculture; but with adaptation, vulnerability can largely be reduced.

Adaptation to climate change requires that communities first to notice that the climate has changed, and then identify useful adaptation methods and implement them (Maddison, 2006). The adaptation to climate change encompasses a wide range of scales (local, regional, global), actors (farmers, firms, government), and types: (a) micro-level options, such as crop diversification and altering the timing of operations; (b) market responses, such as income diversification and credit schemes; (c) institutional changes, mainly government responses, such as provision of subsidies and improvement in agricultural markets; and (d) technological development such as the development and promotion of new crop varieties and advances in water management techniques (Kurukulasuriya and Rosenthal, 2003).

The extent to which an ecosystems or a community is vulnerable to climate change impacts depends both on *exposure* and on the ability of the impacted system to adapt (Olmos, 2001). Adaptations vary according to the system in which they occur, who undertakes them, the climatic stimuli that prompts them, and their timing, functions, forms, and effects. The adaptation greatly depends on the adaptive capacity or adaptability of an affected system, region, or community to cope with the impacts and risks of climate change. Further, the adaptive capacity of the communities is determined by their socioeconomic characteristics.

According to Lema and Majule (2009) local communities tend to implement different adaptation measures in order to respond to the impacts associated with climate change and variability. The adaptation to climate change may take the form of reducing dependence on vulnerable systems such as diversifying food production away from a limited number of drought-prone crops, or decreasing sensitivity by avoiding building settlements and infrastructure in high-risk locations (ibid).

2.3 Climate Change Impacts on Coastal Resources

Climate change is now a global issue posing challenges to the survival of mankind and sustainable development. The adverse impacts of climate change are now evident almost everywhere (URT, 2007). Climate change poses a serious risk to poverty reduction efforts and threatens to undo decades of development efforts. It is widely accepted that the impacts of climate change are, and will continue to be more pronounced in poor countries and the ones least able to cope with the impacts, even though their contribution to the problem is least (URT, 2007). The United Republic of Tanzania is among the countries that are continuing to suffer from the impacts of climate change and related hazards (URT, 2007). The adverse impacts of climate change including; floods, drought and unpredictable rains and seas level rise are already having their toll in the livelihoods of people and in the sectors of the economy in the country (Sallema and Mtui, 2008).

The recent severe droughts which hit most parts of the country led to severe food shortages, food insecurity, water scarcity, hunger and acute shortage of power signify the vulnerability of the country to impacts of climate change (URT, 2007).

For example, between 2004 and 2005 drought has caused poor crop yield in many parts of the country and have negatively impacted the efforts to address poverty and ensure food security. Climate change related floods hazard have substantially affected economic performance of the country and undermined poverty reduction efforts (URT, 2007). In order to reduce such impacts, there is a necessity of developing appropriate plans and programmes that constitute the local community adaptation strategies at both local and national levels.

2.3.1 Climate change impacts on mangroves

Mangroves are salt-tolerant forests or swamp ecosystems that occur along tropical and subtropical coastlines, usually in sheltered bays and around river mouths (Wang *et al.,* 2003). Globally, about 75% of low-lying tropical coastlines receiving freshwater drainage support mangrove systems (Wang *et al.,* 2003). Globally there are 9 orders, 20 families, 27 genera and roughly 70 species of mangroves occupying a total estimated area of 18 million ha (Spalding *et al.,* 1997) which is just about 0.45% of the world forest and woodland (Kathiresan and Bingham 2001). Mangroves along the Tanzania coast occur on gently sloping shores, and around river estuaries, creeks, and bays (Wang *et al.,* 2003). In Tanzania mainland, mangroves cover a total area of 115 500 ha, the Rufiji river delta being the largest single mangroves forest in eastern Africa, occupying an area of about 50 000 ha (Wang *et al.,* 2003). Mangroves forests of Bagamoyo and Pangani coast occupy an area of about 12 219 ha (Semesi, 1991). Those in Zanzibar Islands cover 18 000 ha, Unguja island mangroves being 6000 ha (Shunula, 1998).

There are nine species of mangroves found in Bagamoyo and Zanzibar coastal area: *Rhizophora mucronata* and *Avicennia marina*, which form dominant species. Others are *Ceriops tagal, Bruguiera gymnorrhiza, Sonneratia alba, Heritiera littoralis, Xylocarpus granatum and Lumnitzera racemosa* (Semesi, 1991). The ninth species of mangroves *Xylocarpus mulleccensis* is uncommon (ibid). All mangrove forests in Tanzania are gazetted as forest reserves whereby conservation and management of these forests are guided by forest policy and ordinances of the Tanzania government (Wang *et al.*, 2003).

Coastal mangroves of Tanzania have great socio-economic and ecological values (Torell *et al.,* 2006). The forests supply local communities with fuel such as charcoal and firewood, wood suitable for house building and construction purposes such poles, timber, logs and thatch (Wang *et al.,* 2003). Mangroves also provide fishing material such as floats, fish baits and herbal poison. Coastal communities also derive food from mangroves such as fish, shrimp, crabs, mollusks and honey (Agrawala *et al.,* 2003; Barua *et al.*, 2010). Other direct products of mangroves to locals include synthetic fibres, tannins and resins for dying, medicines and fodder for livestock (Hossain, 2009).

Further, mangroves provide various services to coastal communities such as coastal region integrity maintenance, maintaining coral reefs communities (which are also important for local fisheries), and protection of coastal areas against storms, floods, shoreline erosion, cyclone and waves (Alongi, 2002). Mangroves vegetations are retainers of carbon, nutrients, sediments and pollutants (Agrawala *et al.,* 2003). The

ecosystems furthermore offer tourism opportunities through maintenance of the seascape and protection of wildlife resources (ibid). Despite of significant contribution of mangroves to the local communities' livelihood, mangroves are facing great threat of extreme temperature and relative sea level rise associated with saline water influx due to climate change (USAID, 2009). In the Americas, an estimated 38% of mangroves areas have been lost, at an annual rate of 3.62% due to combined effects of climate change and human influence (Valiela *et al.*, 2009). The effects of global climate change, especially sea-level rise pressure the frontward margin of mangroves, causing erosion, trees mortality and loss of forest area (IPCC, 2007). The situation is intensified by human occupation which limits available space for landward migration of mangroves (Faraco *et al.*, 2010).

According to Gilman *et al.* (2008) temperature above 35°C affects mangroves roots and seedlings establishment due to thermal stress. Decrease in rainfall slows the growth of mangroves and reduce area coverage (Fields, 1995). Study done by Magrin *et al.* (2007) showed that mangrove forests located in low-lying coastal areas are particularly vulnerable to sea level rise, increased mean temperatures, and hurricane frequency and intensity, especially in Mexico, Central America and Caribbean continental regions and if not properly managed they can disappear.

Sallema and Mtui (2008) reported that in the coast of Tanzania wave surge currents have been responsible for weakening the coastline and uproot the shoreline-stabilizing coastal mangroves. It is further noted that mangroves tend to be more vulnerable to wave erosion after being deforested than those areas which have not

been deforested (Faraco *et al.,* 2010). Multiple pressures are threatening the remaining 15-18 million hectares of mangroves worldwide which include; pollution, fuel wood collection, land clearance for aquaculture and coastal development and natural disasters (Sallema and Mtui, 2008).

In Tanzania, recently the rate and variety of human influences on the mangroves have increased (Kelbessa, 2007). In the coast of Bagamoyo uncontrolled cutting of mangroves for various purposes is still a problem (Torell *et al.,* 2006). Mangroves in Unguja Island have been heavily utilized for construction materials harvesting and for production of charcoal, lime and salt (Ngoile and Shunula, 1992). These activities have been responsible for further exacerbation of the effects of climate change on mangroves.

2.3.2 Climate change impacts on water resources

Globally increase in average temperature and unpredictability of precipitation have resulted into decreasing water availability in mid-latitudes and dry low-latitudes areas (UNFCCC, 2007). This has resulted into hundreds of millions people being exposed to increase in water scarcity. Over the next decades it is predicted that billions of people, particularly those in developing countries will face shortages of water which will be associated with greater risks to health and life as the result of climate change (Lema and Majule, 2009).

Climate change through its effects on temperature has resulted into increased warming throughout the continent and in all seasons as compared to global average. This has resulted into increased water stress to many countries (UNFCCC, 2007).

The projections show that by the year 2050s, 350 to 600 million people in Africa will be at risk of increased water stress predominantly in the northern and southern part of the continent. This is mainly due to increase in annual surface air temperature and variation in rains where in the Tropical Africa the rainfall is expected to decline, particularly in cold months (June to August) (IPCC, 2005).

The number of countries in water crisis is expected to increase in the future years (Kelbessa, 2007). According to UNEP (2005) currently 14 countries in Africa are subjected to water stress or water scarcity due to increase in mean annual temperature and ever decreasing rainfall trend and further 11 countries will join them in the next 25 years (ibid). Water supply shortage in Small Islands Developing States (SIDS) is likely to be exacerbated by future climate change as fresh water bodies are predicted to be reduced in size due to reduced rainfall (UNFCCC, 2007). Tanzania is facing a threat to water supply partly due to climate change. Declining rainfall and increasing temperature have significant impact on surface run-off water. Fischer *et al.* (2002) reported that changes in rainfall amount and patterns, in addition to shift in thermal regimes, influence local seasonal and annual water balances.

Further, the supplies of fresh water in coastal areas are threatened by saltwater intrusion due to storm surges and sea level rise (Mimura *et al.*, 2007). In the coast of Bagamoyo, sea level rise due to climate change has caused saline water intrusion into fresh water wells, the most important source of domestic water to local community (Sallema and Mtui, 2008). The problem of water shortage due to

climate change has been further exacerbated by population and economic growth associated with environmental/catchment forests degradation, water contamination due to polluted returns flows from agricultural, domestic, mining and industrial consumption (Turpie *et al.,* 2003).

2.4 Climate Change Impact to Livelihoods

The majority of coastal rural population in developing countries heavily depends on climate sensitive sectors such as agriculture, forest and fisheries as the most important source for livelihood (Nelson and Agbey, 2005). However, increase in greenhouse gases in the atmosphere and the consequent pressures related to climate change are having significant impacts on the coastal and marine resources on which much of Tanzania's coastal population depends (Sallema and Mtui, 2008). Global warming has caused various climate related disasters thereby adversely affecting agriculture, food security, water resources and biodiversity (mangroves, corals, seagrass and fishes) as a whole (Sallema and Mtui, 2008; Dhaka *et al.,* 2010).

Climate change has been one the key components influencing agricultural production in the Tropical countries and had has large-scale impacts on food production and overall economy (Dhaka *et al.,* 2010). Nelson and Agbey (2005) noted that limited use of irrigation facilities and high dependence on favourable climatic conditions for the realisation of good harvest tend to worsen the problem and introduce huge instability in the standards of living of the rural communities.

Temperatures and rainfall changes in drought-prone areas have shifted the populations of insect pests and other vectors and changed the incidence of existing vector borne diseases in both humans and crops (FAO, 2007). Climate change and variability have forced people to change crops e.g. paddy has been replaced by maize while maize has been replaced by sorghum, millet or cassava since they are more suited to dry environment (Lema and Majule, 2009). This implies that climate change and variability has resulted into changes in plants and crops in certain agro-ecological zone to suit the prevailing conditions. This has impacted peoples' livelihood and economy as a whole (ibid).

The current trend of both rainfall and temperature has further raised the frequency of occurrences and impacts of diseases (URT, 2007). UNFCCC (2007) indicated malaria to be endemic in the lowlands but unstable in the highlands. However, there is creeping up of the disease towards the highlands of East Africa due to climate change related warmed condition which favours mosquitoes breeding (Yanda *et al.*, 2005). In Tanzania malaria is the largest cause of loss of lives, and accounting for about 16% of all reported deaths (URT, 2007). Apart from malaria cases speed up, climate change has been responsible for the expansion in the range, frequency and severity of diseases such as dysentery, cholera, meningitis, schistosomiases, diarrhoea and Rift valley fever (ibid).

Studies done in Tanzania, indicate that climate change is expected to raise mean annual temperatures by 3-5°C, and average daily temperatures by 2-4°C by 2075 (Ehrhart and Twena, 2006). Rise in temperature will be greater during cooler

months (June to August) than warmer ones (December to February) (Agrawala *et al.,* 2003). The research also points out that increases will be most marked in central and western regions, where temperatures may rise by up to 4°C and less striking in north-eastern areas, where there may be a warming of up to 2.1°C.

Slowly changing climatic conditions and more frequent extreme events (i.e. drought, floods and sea level rise) is likely to pose threat to water supply to local communities and hence affecting livelihood security (Ehrhart and Twena, 2006). The changes in climate has already resulted into glacier retreat on Mount Kilimanjaro (Agrawala *et al.,* 2003) which is an important source of water for local ecosystem and supports the livelihoods of over a million local inhabitants (Ehrhart and Twena, 2006). Inundation of low-lying coastal areas and saline intrusion in fresh water bodies as a result of sea level rise has already deprived coastal communities with fresh water for domestic use (Sallema and Mtui, 2008).

Global warming has caused melting of the polar ice caps, resulting into rising in sea level (Ehrhart and Twena, 2006). Further, the sea level is predicted to rise between 8 and 96cm by 2100 (IPCC, 2003). With an 800 km coastline, and a coastal population of 16 percent, sea-level rise is likely to have a considerable impact on Tanzania's coastal communities and the ecosystems they depend on for their livelihoods (Ehrhart and Twena, 2006). Due to their population size the hardest hit among the coast regions will be Dar es Salaam and the Coast Region (Ehrhart and Twena, 2006).

Damages in Dar es Salaam alone are estimated to reach USD 48-82 million (based on sea-level rise between 0.5m and 1m respectively). Other impacts will include; land loss of 247 - 494 km^2 (based on the same sea-level rise of 0.5 and 1m respectively). Coastal erosion due to sea level rise will further affect the livelihood of the coastal communities through damage to coastal structures, properties and loss of coastal and marine ecosystems (e.g. mangroves, corals and sea grasses) (Sallema and Mtui, 2008).

2.5 Climate Change Adaptation in Coastal Areas

Coastal areas are crucial to life on earth, as they support livelihoods, and are vital to the global economy in many ways. Coastal ecosystems exist at the interface between terrestrial and marine environments and they include some of the most diverse and dynamic environments on earth (USAID, 2009). Thus coastal areas attract human populations because it is a focal point for economic growth, accounting for a majority share of humanity's transportation and trade, energy processing, tourism, and recreation. Thus, the socio-economic and ecological importance of the coastal zone is virtually unparalleled.

However, global climate change have already impacted and will continue to impact coastal communities, ecosystems, and many facets of people's lives in the coastal zone where approximately 2.7 billion people over 40% of the world's population live (USAID, 2009). Even without climate change, coastal areas face a litany of problems associated with population growth, habitat change, resource over exploitation and degradation, water pollution, and changes in freshwater flows.

Climate change is expected to amplify many of these and other stresses on coastal areas. This in turn increases the need and urgency to include coastal adaptation as part of effective coastal management. As a consequence of these realities, climate change is considered to be one of the most important challenges of the 21st century and a priority for immediate action for coastal areas.

2.5.1 Global climate change adaptation

Sea-level rise and extreme water levels are important components of climate change, and have significant implications to coastal environments and ecosystems including low-lying coastal plains, islands, beaches, mangroves, corals, coastal wetlands and estuaries (Dolan and Walker, 2004). Climate changes have already impacted coastal communities and the impacts are anticipated to intensify in the future, resulting in significant alteration of coastal and marine ecosystems, and increased coastal hazards in low-lying areas (USAID, 2009). This has affects to fishers, coastal communities and resource users, recreation, tourism, and coastal infrastructure.

Several research studies on climate change have been undertaken in the world. For example IPCC (2001) studied the climate change impacts, adaptation and vulnerability in Developing countries. Overseas Development Institute (ODI, 2008) produced a framework on the gap between climate change adaptation and poverty reduction. Brooks *et al.* (2005) studied the determinants of vulnerability and adaptive capacity at the national level and its implications for adaptation.

In the context of climate change worldwide, most of the developing countries have undertaken vulnerability and adaptation studies in their countries (Mngale, 2009). However, these studies did not focus on the how coastal communities are impacted and how they adapt to these changes. There is a significant gap which exists in terms of capacity and availability of resource to produce vulnerability assessment and coping strategies although these assessment and strategies forms the first stage of any sustainable policy for coping with the climate change and variability.

2.5.2 Climate change adaptation in Africa

Coastal areas of Africa represents region prone to potential impact of climate change (Kebede *et al.,* 2010). The coasts are undergoing rapid population growth, urbanisation, coastward migration, and associated socio-economic growth, which significantly contributes in increasing the exposure of people and assets to sea-level variability and long-term rise. A number of studies have been undertaken on Africa continent regarding to climate change adaptation. The majority of these studies focused on the projection of the future climate change and its impacts on the continent, particularly the sub-Saharan Africa as it is assumed to be most vulnerable part of the continent. IFPRI (2007) conducted the Micro-level analysis of the farmers' Adaptation to climate change in Southern Africa. IPCC (2001) conducted study on Climate change and Agriculture Vulnerability in South Africa. Other studies include Farmers' perceptions and Adaptations to Climate Change and Variability in Limpopo Basin in South Africa by Gbetibouo (2009).

2.5.3 Climate change adaptation in Tanzania

Climate change hazards such as sea level rise in the nation will have major impacts namely land losses of between 247- 494 km^2 (based on sea-level rise of 0.5 and 1m respectively), coastal erosion, saline intrusion in fresh water bodies (e.g. the Rufiji delta), extreme weather events, inundation of low-lying coastal areas and small islands, coral bleaching, damage to coastal structures and properties, loss of coastal and marine habitats and ecosystems e.g. mangroves and fishes (URT, 2007). For example, Maziwe Island in Pangani district is already submerged as a direct result of climate change (Kebede, 2010).

In Tanzania several studies on climate change adaptation have been carried out by different researchers and institutions. The major studies which have been conducted so far include; Vulnerability to climate change in Tanzania sources, substances and solution (Paavola, 2003). Mngale (2009) studied Climate Change Coping Strategies for Household Food Security in Singida District. Impacts of climate change, variability and adaptation strategies on agriculture in semi arid areas of Tanzania a case of Manyoni District by Lema and Majule (2009). Sallema and Mtui (2008) studied the adaptation technologies and legal instruments to address climate change impacts to coastal and marine resources in Tanzania. However, none of these studies attempted to include the context of the coping, perceptions and vulnerability of communities living in coastal areas of Tanzania to climate change and its impacts.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Areas

3.1.1 Location

The study was conducted in Bagamoyo District, Coast Region and Unguja Island. Bagamoyo is one of the six administrative districts in Coast Region. The district is relatively large covering an area of about 10 000 km^2 with 78 villages, 9 villages lying along the Indian Ocean coast including Bagamoyo town which recently became upgraded to township. The district is located between latitude 6° 26'S and longitude 38° 54'E and about 75 km north of Dar es Salaam, on the coast of Indian Ocean. It is bordered to the north by Pangani District, to the west by Mvomero and Morogoro Rural Districts of Morogoro Region, to the east by Indian Ocean and to the south by Kibaha District (Torell *et al.*, 2006)

Zanzibar is part of the United Republic of Tanzania (URT), which consists of two main islands, Unguja and Pemba. The islands lie in a north-south direction from 4°50'S to 6°30'S and in east-west direction from 39°10'E to 39°50'E and between 30 to 50 km off the shore of the Tanzanian mainland. The islands cover a total area of 2332 km^2 whereas Unguja covers 1462 km^2 and Pemba covers 868 km^2 (Mohamed, 2009; Silima, 2010) (Fig. 1).

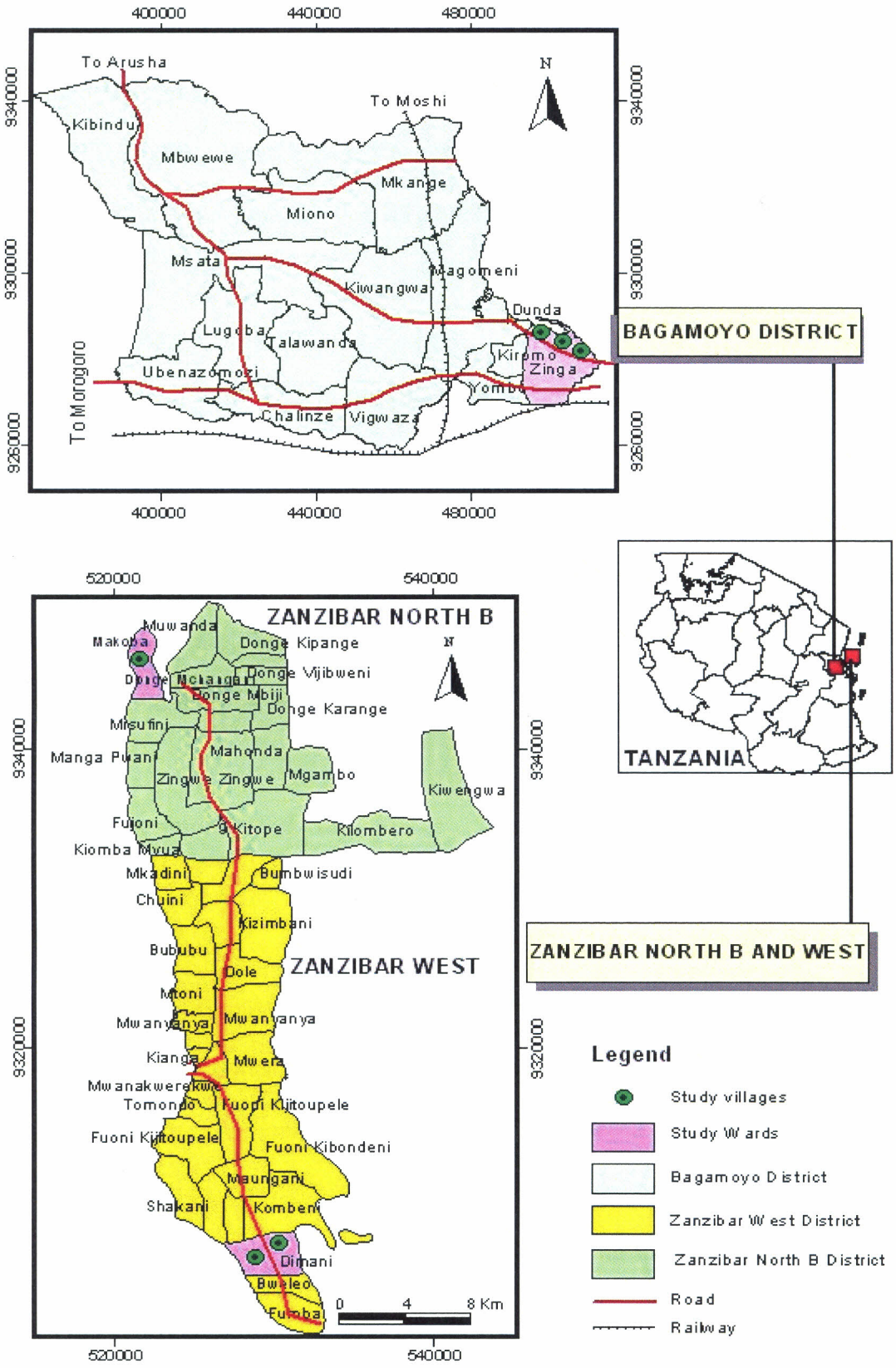

Figure 1: Maps of Bagamoyo and Unguja showing the location of the study villages

3.1.2 Population

Bagamoyo District has total population of 230 164 with an annual growth rate of 3.9% (URT, 2002). Unguja Island has total population of 676 200 with annual growth rate of 3.1% (Silima, 2010; URT, 2002).

3.1.3 Ethnicity and culture

The main ethnic groups living in the villages along Bagamoyo coast and Unguja are the Swahili of mixed origin; the Bondei, Wadoe, Digo, Kwere, Makonde, Zigua, Zaramo, Rufiji, Yao, and Shirazi (Semesi, 1991). The mobility of these populations is very high. In many of these coastal villages, inhabitants are a mixture of these tribes with also Arab, Shirazi and other influences. There are strong cultural and religious belief links with Islam.

3.1.4 Socio-economic activities

The main socio-economic activities in Bagamoyo District (Tanzania mainland) and Unguja Island include; small scale fishing (artisan fishing), farming, small scale salt harvesting and lime making, handcrafts including wood carving, straw thatch and mates weaving, stone quarrying, cooked food vending and sea weed farming which are most important for women. Other activities include sea shells and other marine souvenirs collection, charcoal making, livestock keeping, tourism support services including hotels services and tour guiding, petty trading and traditional medicine collection (Torell *et al.*, 2006; Azzan and Ufuzo, 2009).

3.1.5 Climate

The climate in the study areas (Bagamoyo District and Unguja Island) is typical tropical with high temperatures and humidity and dictated by two distinct seasonal Monsoon winds. Precipitation ranges between 1000 mm and 1500 mm annually. However, the rainfall in the island is relatively higher than in the mainland (Bagamoyo). The climate in the study areas is associated with two seasons of rains (Bimodal) although the seasons can be unpredictable and with considerable variation within years. The long rains season is between March and May (*Masika*), and the short rains season is between November and December (*Vuli*). The period between June and August is normally cooler while the period between January and Mid March is hot (Mligo, 2011).

The relative humidity is high with a monthly average ranging from 87% in April (long rains) to 76% in November (short rains) and a minimum at 60% during the dry season. Generally, there is no month in a year which is absolutely dry. The average annual temperature in these areas is 25.8°C, the maximum and minimum average monthly temperatures are 19°C and 30°C respectively. The hottest period on the coast is during the Northeast Monsoon (*Kaskazi*) from November to March. It is typified by low wind speeds, maximum about 5m/s blowing from northeast direction. The Southeast Monsoon (*Kusi*) is from May to October and typically has higher wind speeds of average velocity up to 8m/s, which blow from the southwest direction. The Southeast Monsoon period is normally associated with cooler weather (Mligo, 2011).

3.1.6 Topography, Geology and Soils

The terrain of Bagamoyo District rises gradually from the coastal mudflats to about 30-40m above mean sea level at the western part of the area. The large rivers (Wami and Ruvu) normally form extensive flood plains. The area is associated with poor moisture-holding and low fertility soils, characterized by sand dunes, with grey sandy soils on the main central areas, falling away to alluvial sands and clays along the Wami and Ruvu rivers (Blosch and Klotzli, 2004).

Topographically, Unguja Island is more or less flat with several undulating slopes. The island is dominated by low ridges running in a north-south direction. In the middle of island the highest point reaches over 90m above mean sea level. The soils can be grouped into two major categories namely; deep, rich, fertile soils in which most permanent agriculture take place. The second category is covered by coral rag soils which are characterized by a thin layer of soil pockets in coral outcrops. In general the soils in Unguja are deeper and richer in the western side and become shallow towards the eastern side (Silima, 2010)

3.1.7 Vegetation

The vegetation in Bagamoyo District consists of evergreen coastal forest, woodland characterized by thickets, riverine vegetation, scrublands, bushes and grasslands which provide a variety of habitats which support various large and small mammals (Mligo, 2011). Unguja Island is endowed with natural forests with quality and unique ecosystems of high biodiversity values. Generally the vegetation in the island is categorized into forests, coral rag thickets and mangrove forests. As other

coastal forests, the vegetation shelters high number of endemics and forms an important part of the global biodiversity hotspots and the Eastern Africa Coastal Forests Eco-region.

3.2 Data Collection Methods

3.2.1 Research design

A cross-sectional research design was used in this study as recommended by de Vaus (1993) and Benard (1994). This design allows the collection of data on different groups of respondents at a time. The method is suitable for a descriptive study as well as determination of the relationship between variables.

3.2.2 Sampling procedures

A purposive sampling method was employed to select the study villages (Kondo, Mlingotini and Pande) in Bagamoyo District, (Kisakasaka, Mafufuni and Nyamanzi) in Unguja, based on following reasons: First, the proximity of the local communities to coastal/ marine resources (mangroves and fishes) and the extent these resources are being exploited and subjected to human pressure. Secondly, the extent of which local communities in these areas depends on marine/coastal resources for their livelihood. According to (URT, 2007) marine resources and agriculture are among the most sensitive sectors to climate change and variability. Thirdly, the areas provide an opportunity to study climate change, based on the level or degree of already reported adverse effects of climate change on these resources.

Sampling units for this study were households. World Bank (1995) defines a household as a unit consisting of one or more persons, related or unrelated who live

together in one or more than one housing/dwelling and have common catering and living arrangement. Mbwambo (2000) defined a household as a group of people living together and identifying the authority of one person, the household head, who is the decision-maker for a household. Average sample size for questionnaire survey exercise was 8.5% i.e. 207 out of 2435 households in all six villages under study, as indicated in Table 1. According to Boyd *et al.* (1981), a recommended and reasonable representative sample size for particular population under the study should be at least 5%.

Table 1: The number of households sampled and interviewed

Village	Total number of households	No. of sampled households	Sample size (%)
Kondo	595	37	6.2
Mlingotini	737	55	7.5
Pande	278	28	10.1
Mafufuni	250	31	12.4
Kisakasaka	213	25	11.7
Nyamanzi	362	31	8.6
Total	**2435**	**207**	**8.5**

Source: Village Government Offices (2012)

The households were selected from the village register books (sampling frame) in which all members of the village and the households were listed. The first household was randomly selected followed by systematic sampling in selecting subsequent households. Systematic random sampling was used in this study due to its simplicity and also the researcher is guaranteed that the population will be evenly sampled. Sampling interval (I) between households was established systematically using the formula below.

$I = N/n$ ..... (i)

Where N = Total number of households in the village (as per village register)

n = Sample size

I = Interval between households

3.3 Data Sources

3.3.1 Primary data

The primary data were gathered from selected study sites through the use structured questionnaires (Appendix 1) with both open and closed ended questions in order to allow flexibility of asking questions and seeking clarification during interview. The questionnaire collected data on socio-economic characteristics of the respondents as well as perceptions and coping strategies of local communities to climate change impacts. Focus Group Discussion (FGD) was also used as a tool to collect primary data. FGD were conducted in 3 randomly selected villages because of the shortage of time and finance. Several questions on production systems, climate variability, vulnerability to climate changes, adaptation and coping strategies were adopted to form the basis for discussion (Appendix 2). The study further used participant observation to collect primary data from the study sites. The method involved observation of the community and household activities so that to tie together more discrete elements of data collected by other methods.

3.3.2 Secondary data

Long term (30 years) i.e. 1981 – 2011 meteorological data on temperature and precipitation for the Bagamoyo District and Unguja Island were obtained from Tanzania Meteorological Agency (TMA). The data were used for analysis of actual

climate trend in the study sites. According to (Kahya and Kalayci, 2004) meteorological records of 30 years are considered to be long enough for a valid mean statistic. Moreover, Burn and Elnur (2002) state that a minimum record length of 25 years ensures statistical validity of the trend results in climate change research.

Other secondary data were obtained throughout the study by reviewing various literatures, both published and unpublished mainly from Sokoine National Agricultural Library (SNAL). Previous data were also gathered from government offices particularly from Districts Natural Resource Offices, NGOs as well as from the internet. The literature provided information on general and specific issues such as records on crops production, fisheries, weather/ climate change related phenomena and the roles of institutions and local communities in management of natural resources (water resource, forest, mangroves ecosystems, fishery and wildlife).

3.4 Qualitative Data Analysis

Data collected through FGD were analyzed with the help of participants and the results were communicated back to them for verification. Content and Structural--functional Analysis techniques were employed to analyze qualitative data and information. Content analysis is a set of methods for analyzing the symbolic content of any communication. The basic idea is to reduce the total content of communication to some set of categories that represent some characteristic of research interest (Singleton *et al.*, 1993).

By using this method, the information collected through verbal discussion with key informants were analyzed in detail whereby the recorded dialogue were broken down into smallest meaningful units of information and themes. Structural-Functional Analysis technique was used to explain the way social facts related to each other in a social system and the manner in which they related to the physical environment. This type of analysis helps the researcher to distinguish between obvious and concealed functions. Obvious functions are those whose consequences are 'intended and are recognized by actors in the system' whereas the concealed functions are those whose consequences are neither intended nor recognized (Katani, 1999).

3.5 Quantitative Data Analysis

Both descriptive and inferential statistical analyses were carried out for quantitative data. The completed questionnaires were coded and later entered into the SPSS version 16 computer software. Descriptive statistics; based on measures of central tendency and measures of dispersion such as means, frequency counts, histograms and standard deviation were used on analysis of variables such as age, sex and education level of the respondents. Cross tabulation was used to test association between different variables and other statistics.

The method was also used for analysis of household wealth status and socio-economic activities. Further the method was employed to analyse data on local communities coping strategies to climate change. The perception of the mangroves dependent communities to climate change impacts was analysed through

construction of Likert scale. The constructed Likert scale consisted of 10 sentences. A five level scales of strongly agree, agree, neither agree nor disagree, disagree and strongly disagree were employed to measure the perception. Descriptive statistics mainly percentages were used to show respondents' perception.

Household vulnerability was analysed through the construction of vulnerability index. The index was developed using results from household survey and consisted of three main component indicators/categories. Each category was sub divided into subcategories with different weights and variables as follows: 1. Material indicator (i.e. income sources, education level of household members, household assets and household relative distance to the sea). 2. Institutional indicator (i.e. social net-works/extra-local kinship ties and proportion of the dependents in a household). 3. Social services indicator (i.e. access to sanitation, healthcare, transport and communication). The total weight for 3 categories summed up 100 scores/points. Households with more than 50 scores were regarded to be vulnerable to climate change while households with 50 or less scores were regarded as non-vulnerable (Appendix 1).

Inferential statistics was used to provide an idea about whether the patterns described in samples were likely to apply in the population from which the samples were drawn. Multiple regression function was developed to show the contribution of farm factors, socio-economic and demographic factors to household vulnerability to climate change impacts. Total scores of the index were used as a dependent variable as indicated in the following equation.

$Y_i=\alpha + \beta_1 X_1 + \beta_2 X_2 \ldots\ldots\ldots\ldots + \beta_1 X_i + e \ldots\ldots\ldots\ldots$ (ii)

Whereby:

Y_i = Vulnerability to climate change impact

$X_1 - X_i$ = Independent variables (farm factors, socio-economic and demographic factors) considered to influence the vulnerability to climate change impacts.

α = Intercept

$\beta_1 - \beta_i$ = Independent variables coefficients

e = Random error

i = 1, 2.....n. where n is the total number of variables

The independent variables used in the regression equation are indicated in Table 2. The regression coefficient (β) was used to predict the impact of the independent variables on dependent variable. To assess the goodness to fit of the regression model, a coefficient of determination (R^2) was employed. Coefficient of determination shows the strength of relationship between independent variables. Moreover, coefficient of determination acts as index of assessing how much reliance is to be placed on the regression estimates.

Table 2: Variables used in regression equation, definition and indicators

Variable	Operational definition	Measurable indicator	Level of measurement
Farm size	Land which is used for cultivation in acreage	Land size in acres	Ratio
Farm ownership	Ownership of land used for agriculture	Ownership identified	Nominal
Household annual income	Amount of money household head earn per year	Total TAS earned by household per year	Ratio
Occupation	Main socio-economic activity of the household head	Main socio-economic activity identified	Nominal
Household size	All people living in the same compound and depend on one household head for decision making	Number of household members	Ratio
Age	Absolute years since household head was borne	Number of years attained since birth	Ratio
Sex	Being male or female in biological term	Sex of respondents identified	Nominal
Marital status	Being married, single, divorced or widow	Identified marital status	Nominal
Assets	Durable materials possessed by household obtained through purchasing	Number of assets	Ratio
Labour	Household members engaging in production activities	Number of individuals involved	Ratio
Sources of remittance	Number of family members or relatives proving remittance to household	Number of family members or friends	Ratio
Reliance to source of weather information	If respondent trusts the sources of weather information	Identified reliance of the respondent in the source of weather information	Nominal

The household vulnerability to climate hazards was determined through accumulation of four attributes; 1. The frequency climate hazard occurs. 2. The rate of the severity of a hazard, 3. The degree of negative impact a climate hazard has to the household, 4. The level of difficulty in which is faced by households in coping with a hazard. Each of the statement had three level scores which were; 12 for high, 8 for medium and 4 for low. Household vulnerability to a hazard was regarded high

if the total score was 48 while medium and low the total scores were 32 and 16 respectively. Household vulnerability mean score for the four statements were calculated to determine the extent the household was vulnerable to climate related hazards.

Household wealth status was categorized based on criteria such as; household source of income, household farmland size, housing type and accesses to toilet facilities and household assets (Table 3).

Table 3: Household wealth grouping criteria

Attribute	Wealth status category Rich	Normal	Poor	Very poor
Source of income	Several sources of income: e.g. agriculture, business (shops, guesthouse), fishing, cattle keeping and salary	Two or more sources of income earning: e.g. agriculture and small business or fishing	One or two sources of income: e.g. agriculture and fishing/causal labourer	Often one source of income: e.g. fishing, agriculture or causal labourer
Farm size	Own more than 10 acres of coconut, and more than 5 acres of paddy, maize and cassava	Between 2-5 acres of farms growing paddy, maize and cassava.	Between 1-3 acres of maize or cassava or paddy	Less than 2 acres of maize or cassava
Housing and toilet	Blocks house with electricity usually larger than household size. Water flushing toilet or pit latrine or both	Block/ burnt bricks house with iron sheets may have electricity. Pit latrine is available	Mud/mud and poles house, roof is mostly of grasses. Poor pit latrine or none	Mud/mud and poles, roof is of grass/straw. Poor pit latrine and often none
Assets value (TAS)	HH asset value of more than 2 million	HH assets with value between 200 000 to 2 million	HH assets value between 100 000-199 999	Assets value less than 100 000

Source: Mbwambo (2000)

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Characteristics of the Respondents

Table 4 presents the summary of demographic characteristics, where details of each characteristic are given in their respective sub-section.

Table 4: Demographic characteristics of the respondents

	Location	
Descriptive	**Bagamoyo (n=120)**	**Unguja (n=87)**
Sex		
Male	100 (83.3)	64 (73.5)
Female	20(16.7)	23 (26.4)
Education		
Non formal	20 (16.7)	25 (28.7)
Primary	97 (80.8)	31 (35.5)
Secondary	3 (2.5)	31 (35.6)
Age		
≤ 20	4 (3.3)	2 (2.3)
21-40	53 (44.2)	26 (29.9)
41-60	44 (36.7)	40 (46.6)
> 60	19 (15.8)	19 (21.8
Marital status		
Single	10 (8.3)	4 (4.6)
Married	92 (76.7)	73 (83.9)
Widow	10 (8.3)	7 (8.0)
Widower	2 (1.7)	1 (1.1)
Divorced	6 (5.0)	2 (2.3)
Household size		
1-4 members	60 (50.0)	26 (29.9)
5-8 members	53 (44.2)	46 (52.9)
9-12 members	7 (5.8)	15 (17.2)

Source: Field data (2012)

4.1.1 Sex of the respondents

Results in Table 5 show that majority of respondents, 79% were male (n=164) while only 21%, equivalent to 43 respondents were female. This implies that the majority of households in the study sites are headed by males while less than one quarter are headed by females. The results indicate the proportion of the male respondents to be higher in Bagamoyo than in Unguja. However, χ^2 test indicated the difference in sex of respondents between Bagamoyo and Unguja to be statistically not significant ($p > 0.05$).

Table 5: Sex of respondents

	Location		
Sex of respondents	**Bagamoyo (n=120)**	**Unguja (n=87)**	**Total (n=207)**
Male	100 (83.3)	64 (73.6)	164 (79.2)
Female	20 (16.7)	23 (26.4)	43 (20.8)
Total	120 (100.0)	87 (100.0)	207 (100.0)

Key: $\chi^2 = 2.925$, df=1, n=207, p=0.087

Figures in brackets are percentages

4.1.2 Education level of the respondents

Results in Table 6 show the majority of respondents (61.8%) had primary school education while 16.4% had secondary education. The proportion of the respondents with formal education concurs with findings by Efraji (2008) who assessed contribution of TASAF programme to poverty alleviation in Ulanga District, Tanzania. However, the proportion of respondents with primary education was low as compared to the average of national education status (primary education) which was reported to be 69.1% in 2002 (URT, 2006). Generally, the study results indicate

the level of literacy in the study areas to be high as more than three quarters of the respondents had formal education.

Table 6: Education level of respondents

	Sex of respondent		
Education level	**Male (n=164)**	**Female (n=43)**	**Total (n=207)**
No formal	26 (15.9)	19 (44.2)	45 (21.7)
Primary	113 (68.9)	15 (34.9)	128 (61.8)
Secondary	25(15.2)	9 (20.9)	34 (16.4)
Total	**164 (100.0)**	**43 (100.0)**	**207 (100.0)**

Key: $\chi^2 = 19.626$, df= 2; n=207, p = 0.000

Figures in brackets are percentages.

Using χ^2 analysis a significant difference ($p<0.05$) in education level between female and male respondents were observed. Results showed that 69% of male respondents had primary education while only 35% of female respondents had primary education. The results are attributed to socio-cultural and economic environment of the respondents in the study sites which regard women to be inferior to men. Also the culture considers education to girls as a "prestigious" so in case the family face economic problem they prefer to invest their limited resources in the education to boys hence majority of females lack formal education.

4.1.3 Age of the respondents

Results in Table 7 indicate the majority of respondents in both Bagamoyo and Unguja were of age between 41 – 60 years (40.6%) and 21 – 40 years (38.2%). Results indicate the majority of respondents to fall within the labour force age group

which ranges between 20 and 60 years. People in this age group tend to be active, creative and participate in many social and economic activities (Acquah *et al.*, 2011). Chi-square analysis showed no significant differences ($p > 0.05$) between the ages of respondents in Bagamoyo and Unguja.

Table 7: Age of respondents

	Location		
Age group	**Bagamoyo (n=120)**	**Unguja (n=87)**	**Total (n=207)**
≤ 20	4 (3.3)	2 (2.3)	6 (2.9)
21-40	53 (44.2)	26 (29.9)	79 (38.2)
41-60	44 (36.7)	40 (46.0)	84 (40.6)
> 60	19 (15.8)	19 (21.8)	38 (18.4)
Total	**120 (100.0)**	**87 (100.0)**	**207 (100.0)**

Key: $\chi^2 = 4.950$, df, = 3, n=207, p= 0.176

Figures in brackets are percentages

4.1.4 Marital status

Results in Table 8 showed that, out of 207 respondents, 80% were married.

Table 8: Marital status of respondents

	Marital status				
Village name	**Single (n=14)**	**Married (n=165)**	**Widow (n=17)**	**Widower (n=3)**	**Divorced (n=8)**
Mlingotini	8 (14.5)	41 (74.5)	2 (3.6)	0 (0.0)	4 (7.3)
Pande	1 (3.6)	24 (85.7)	2 (7.1)	0 (0.0)	1 (3.6)
Kondo	1 (2.7)	27 (73.0)	6 (16.2)	2 (5.4)	1 (2.7)
Mafufuni	3 (9.7)	26 (83.9)	1 (3.2)	0 (0.0)	1 (3.2)
Kisakasaka	0 (0.0)	23 (92.0)	1 (4.0)	1 (4.0)	0 (0.0)
Nyamanzi	1 (3.2)	24 (77.4)	5 (16.1)	0 (0.0)	1 (3.2)
Total	**14 (6.8)**	**165 (79.7)**	**17 (8.2)**	**3 (1.4)**	**8 (3.9)**

Key: $\chi^2 = 28.197$, df, = 20, n=207, p= 0.105

Figures in brackets are percentages

The fact that more than 80% of respondents were married is an indication that the majority of household heads were matured and responsible people. Household headed by married couples tend to be more stable as couples are likely to be more productive than single person due to labour supply, hence increase wellbeing (Mtuya, 2006). Therefore, household headed by married couples are expected to be more capable to cope with the impacts of climate change more effectively as compared to single headed families. However, there was no remarkable difference in marital status of the respondents between the study villages ($p > 0.05$).

4.1.5 Household size

According to this study the household size was determined by considering one or more persons, related or unrelated who live together in one or more than one housing and have common catering and living arrangement. Results show mean household size to be 5.3 with minimum and maximum of 1 member and 12 members respectively. The majority of households (47.8%) had between 5 and 8 members (Table 9).

Table 9: Household size

	Location		
Household size	**Bagamoyo (n=120)**	**Unguja (n=87)**	**Total (n=207)**
1-4	60 (50.0)	26 (29.9)	86 (41.5)
5-8	53 (44.2)	46 (52.9)	99 (47.8)
9-12	7 (5.8)	15 (17.2)	22 (10.6)
Total	**120.0(100.0)**	**87 (100.0)**	**207 (100.0)**

Key: $\chi^2 = 11.887$, df = 2, n=207, p = 0.003

Figures in brackets are percentages

The average household size of 5.3 was slightly above the national average household size. According to URT (2007) household and budget survey the average size of households for Tanzania was 4.8 members. The size of the households differed significantly between Bagamoyo and Unguja (Chi-square: χ^2 =11.887, df = 2, n=207, p=0.003). For example, 50% of the households in Bagamoyo had 1 to 4 members while only 30% of the households in Unguja had the same size. These results might be attributed to the movement of young men from Bagamoyo to big towns and cities particularly Dar es Salaam in search of job, leaving the household with few members. Results further, show that Unguja had higher proportion (17.2%) of households with 9 to 12 members as compared to Bagamoyo. The results might be attributed to low level of literacy in Unguja which makes the households head to lack awareness and knowledge on family planning methods which are important in reducing the birth rate.

4.1.6 Socio-economic activities and annual income

Main occupation

The respondents in the study area were asked about their main occupation. The purpose of it was to determine their major economic activities. Table 10 presents the main occupations carried in the study area. Results show that majority, 50% of the respondents were farmers and 30% were fishermen. Like in many developing countries, the findings reflect that farming and fishing are the main economic activities of rural coastal communities. Further, the results show that large proportion of respondents, 46.7% in Bagamoyo were farmers. The findings might be attributed to the fact that Bagamoyo District has more suitable land for farming

compared to Unguja. The results might also be attributed to the fact that people in Ungaja mostly opt for fishing due to land scarcity. Results also show high proportion of civil servants in Unguja (9.2%) than in Bagamoyo (2.5%). This might be attributed to proximity to town (Stone Town) which provides employment opportunities to the nearby communities.

Table 10: Main occupation of the respondents

	Location		
Occupation	**Bagamoyo (n=120)**	**Unguja (n=87)**	**Total (n=207)**
Farmer	56 (46.7)	37 (42.5)	93 (44.9)
Fisherman	36 (30.0)	27 (31.0)	63 (30.4)
Petty trader	12 (10.0)	3 (3.4)	15 (7.2)
Civil servant	3 (2.5)	8 (9.2)	11 (5.3)
Others	13 (10.8)	12 (13.8)	25 (12.1)
Total	**120 (100.0)**	**87 (100.0)**	**207 (100.0)**

Key: $\chi^2 = 15.041$, df = 8; n=207, p = 0.058

Figures in brackets are percentages

However, χ^2 test showed the difference in occupation of respondents between Bagamoyo and Unguja to be statistically not significant ($p > 0.05$).

Respondents annual income

Results in Table 11 indicated 47.3% of the respondents were earning between 40000 and 599 999 TAS per year (n=98). The mean annual income of the respondents was 1 133 000 TAS. This amount is higher than what Derksen-Schrock *et al.* (2011) stated to be the average income per capita which is 440 000 TAS. The results might be attributed to presence of Indian Ocean which provides fisheries opportunities to local communities and presence of nearby big town and city (Stone Town and Dar

Town and Dar es Salaam) with large ports which stimulate economic activities and increase circulation of money and hence increase the individuals' income.

Table 11: Household annual income

	Respondent annual income in TAS			
Occupation	**40 000 - 599 999 (n=98)**	**600 000 - 1 499 999 (n=58)**	**≥ 1 500 000 (n=51)**	**Total (n=207)**
Farmer	53 (57.0)	26 (28.0)	14 (15.1)	93 (100.0)
Fisherman	19 (30.2)	21 (33.3)	23 (36.5)	63 (100.0)
Petty trader	10 (66.7)	3 (20.0)	2 (13.3)	15 (100.0)
Civil servant	2 (18.2)	2(18.2)	7 (63.6)	11 (100.0)
Others	14 (56.0)	6 (24.0)	5 (20.0)	25 (100.0)
Total	**98 (47.3)**	**58 (28.0)**	**51 (24.6)**	**207 (100.0)**

Key: $\chi^2 = 21.772$, df = 8; n=207, p = 0.005

Figures in brackets are percentages

Chi-square analysis showed annual income of respondents to differ significantly ($p<0.05$) with respect to occupation. The majority of farmers (57%) were earning between 40 000 to 599 999 TAS per year while 36.5% of fishermen and civil servants (63.6%) were earning more than 1.5 million per year. The findings show fishing to be an important occupation in the study areas as large proportion of respondents 30% (n=63) were fishermen and the majority (36.5%) were earning high income per year.

Household wealth status

The grouping of household wealth status was done by considering attributes such as sources of income, farm size, housing and sanitary facilities and household assets value in TAS (refer to Table 3). Results show that the majority of households,

54.6% in the study areas were in normal wealth status (Table 12). The results imply that at least half of the residents in the study areas have an ability to adapt to changing climatic conditions whether by reducing harm or exploiting beneficial opportunities. Shemsanga *et al.* (2010) noted the ability to adapt, whether to changing climate or other new circumstances, is in part a function of a society's or an individual's wealth status.

Table 12: Household wealth status

	Location		
Household wealth status	**Bagamoyo (n=120)**	**Unguja (n=87)**	**Total (n=207)**
Rich	5 (4.2)	4 (4.6)	9 (4.3)
Normal	57 (47.5)	56 (64.4)	113 (54.6)
Poor	45 (37.5)	19 (21.8)	64 (30.9)
Very poor	13 (10.8)	8 (9.2)	21 (10.1)
Total	**120.0(100.0)**	**87.0(100.0)**	**207.0(100.0)**

Key: $\chi^2 = 6.784$, df = 3; n=207. p = 0.079

Figures in brackets are percentages

Results showed no significant difference ($p>0.05$) in household wealth status between Bagamoyo and Unguja, although the proportion of poor households in Bagamoyo (37.5%) was slightly higher than in Unguja (21.8%). This is attributed to the fact that the majority of households in Unguja were headed by civil servants, who apart from earning salary they have extra sources of income e.g. farming and small business and hence contributing to household well-off. The findings are also attributed to the level of urbanization between the two areas. Unguja is more urbanized than Bagamoyo and therefore, other opportunities of earning income such

as petty business are high. The findings are also associated with modern farming practice (e.g. application of farm inputs) which was reported by large proportion of respondents (52.7%) in Unguja compared to Bagamoyo (Fig. 2).

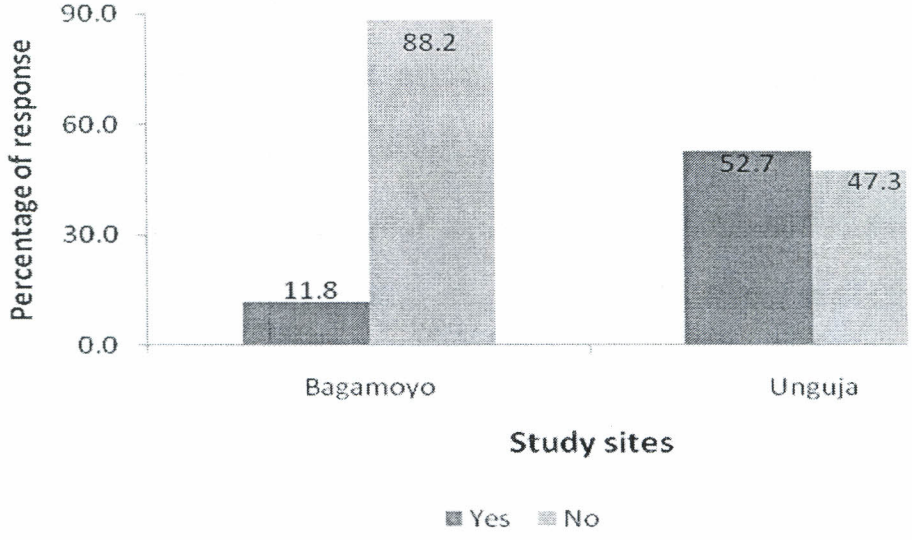

Figure 2: Percentages of households applying agriculture inputs in farms

Sufficient crop production is one of the important factors in reducing household poverty. Field observation also noted farms in Bagamoyo to be less attended as compared to the farms in Unguja. Poor farm care contributes to less crop production and consequently poverty. Therefore, locals in Unguja are assumed to have a better chance of coping with the impacts of climate than in Bagamoyo.

Size of the farmlands cultivated by the household

Results showed that out of 162 households which practiced farming over the last 6 months, the majority 56.7% cultivated between 0.25 and 1.5 acres of land. Results further showed only 6 households (3.7%) cultivated more than 4.5 acres of land

(Table 13). The average farmland size cultivated by the households in the study areas was 1.9 acres. This average farmland size is low as compared to the national average which was reported to be 6.0 acres (Derksen-Schrock *et al.*, 2011). The results might be attributed to the culture of the coastal people which regards fishing to be more important activity than farming, consequently make men to spend most of their time in fishing. Field observation also noted most of adult men in the study areas were not participating fully in economic activities but rather spending most of their time idle or chatting. Moreover, Chi-square test indicated non-significant difference in farm sizes cultivated by the households in the study areas ($p>0.05$).

Table 13: Farmland size cultivated by the household (acres)

	Location		
Farm size (acres)	**Bagamoyo**	**Unguja**	**Total**
0.25-1.5	56 (62.9)	36 (49.3)	92 (56.8)
1.75-3.0	27 (30.3)	22 (30.1)	49 (30.2)
3.25-4.5	4 (4.5)	11 (15.1)	15 (9.3)
4.75-6.0	1 (1.1)	2 (2.7)	3 (1.9)
6.25-7.5	0 (0.0)	1 (1.4)	1 (0.6)
> 7.5	1 (1.1)	1 (1.4)	2 (1.2)
Total	**89 (100.0)**	**73 (100.0)**	**162 (100.0)**

Key: $\chi^2 = 7.955$, df = 5; n=207. p = 0.159

Figures in brackets are percentages

Farmland ownership

During the survey, information on land ownership was collected from every respondent in term of whether the land used for cultivation belongs to the family, communal, rented, government owned or requested from a friend or relative. The results in Table 14 show that the majority of farmlands (72%) were owned by the

family. This might be explained by the fact that the majority the household heads were born within the study villages. Therefore, land for agriculture was mostly inherited from either the parents or grandparents. Bagamoyo had higher proportion of rented farms (20.2%) than Unguja (6.8%). Informal discussion with the respondents revealed that most of the hired farm plots were used for growing paddy because wetlands suitable for paddy cultivation have been limited due to both drought and increase in human population. However, the difference in farmlands ownership between Bagamoyo and Unguja was not statistically significant ($p>0.05$)

Table 14: Household farmland ownership

	Location		
Farmland ownership	**Bagamoyo**	**Unguja**	**Total**
Family	57(64.0)	59 (80.8)	116 (71.6)
Communal	3 (3.4)	4 (5.5)	7 (4.3)
Rental	18 (20.2)	5 (6.8)	23 (14.2)
Requested	7 (7.9)	2 (2.7)	9 (5.6)
Bought	3 (3.4)	1 (1.4)	4 (2.5)
Government	1 (1.1)	2 (2.7)	3 (1.9)
Total	**89 (100.0)**	**73 (100.0)**	**162 (100.0)**

Key: $\chi^2 = 10.155$, df = 5, n=162, p = 0.071

Figures in brackets are percentages

4.2 Local People Perceptions on Climate Change

4.2.1 Perceptions on rainfall decrease

Results in Table 15 showed that more than 68% of respondents strongly agreed that rainfall distribution and intensity has declined in the past 10 – 20 years. Similar results were reported by Lema and Majule (2009) whereby a significant number of respondents perceived changes in onset of rains and decrease in precipitation in Manyoni District, in the central Tanzania. URT (2011) explained precipitation in

the country to change although the direction and degree of the change is not certain. Moreover, Chi-square analysis showed non-significant difference in perceptions between Unguja and Bagamoyo District ($p>0.05$). These results are plausible because of similarities between the two locations.

Table 15: Perceptions on rainfall decrease

	Location		
Response	**Bagamoyo**	**Unguja**	**Total**
Strongly disagree	2 (1.7)	0 (0.0)	2 (1.0)
Disagree	2 (1.7)	0 (0.0)	2 (1.0)
Undecided	2 (1.7)	4 (4.6)	6 (2.9)
Agree	31 (25.8)	27 (31.0)	58 (28.0)
Strongly agree	83 (69.2)	56 (64.4)	139 (67.1)
Total	**120 (100.0)**	**87 (100.0)**	**207 (100.0**

Key: $\chi^2 = 5.055$, df = 4, n=207, p = 0.282

Figures in brackets are percentages

Respondents in Bagamoyo explained that they used to cultivate paddy in larger farms in the past decades. However, due to shortage of rains, paddy farms have contracted and most of them are now used for growing maize or cassava. Fishermen were also complaining about decrease in fish stock due to decline in rainfall amount. Respondents in the study sites further explained that the onset of rainfall has also changed, often coming late and unpredictable.

4.2.2 Perceptions on increase in sea level

Results in Table 16 showed that more than 56% of respondents strongly agreed that sea level has increased over the past 10 to 20 years. According to Sallema and Mtui (2008) sea level rise is one of the adverse impacts of climate change which is already having its toll in the livelihoods of coastal communities. It was further

explained by fishermen that two decades ago they could fish in the sea up to a hundred meters off shore without vessels but now it is difficulty especially during high tides due to sea level increase. The Chi-square analysis also showed non-significant difference in respondents' perceptions on increase in sea level between Unguja and Bagamoyo ($p>0.05$).

Table 16: Perceptions on sea level increase

	Location		
Response	**Bagamoyo**	**Unguja**	**Total**
Strongly disagree	4 (3.3)	0 (0.0)	4 (1.9)
Disagree	2 (1.7)	2 (2.3)	4 (1.9)
Undecided	17 (14.2)	10 (11.5)	27 (13.0)
Agree	33 (27.5)	23 (26.4)	56 (27.1)
Strongly agree	64 (53.3)	52 (59.8)	116 (56.0)
Total	**120 (100.0)**	**87 (100.0)**	**207.0(100.0)**

Key: $\chi^2 = 3.674$, df = 4, n=207, p = 0.0452

Figures in brackets are percentages

4.2.3 Perceptions on decrease in fish landings

Results in Table 17 showed that more than 51% of respondents strongly agreed that fish landings have declined in the past 10 to 20 years.

Table 17: Perceptions on decrease in fish landings

	Location		
Response	**Bagamoyo**	**Unguja**	**Total**
Strongly disagree	4 (3.3)	1 (1.1)	5 (2.4)
Undecided	22 (18.3)	11 (12.6)	33 (15.9)
Agree	38 (31.7)	24 (27.6)	62 (30.0)
Strongly agree	56 (46.7)	51 (58.6)	107 (51.7)
Total	**120 (100,0)**	**87 (100.0)**	**207 (100.0)**

Key: $\chi^2 = 3.695$, df = 3, n=207, p = 0.296

Figures in brackets are percentages

Chi-square analysis also showed non-significant difference in respondents' perceptions on fish landings change between Unguja and Bagamoyo ($p>0.05$). Results are plausible because of similar responses given by respondents in Unguja and Bagamoyo. Discussion with fishermen revealed the catch of some fish species such as jack (*Kolekole*), ray (*Taa*), octopus (*Pweza*) and rockods (*Chewa*) have declined to large extent while fish species such as kingfish (*Nguru*), sword fish (*Nduaro*) and mullet (*Mkizi*) were mentioned to disappear. Among the factors mentioned to be responsible for the decline of fish include increase in fishing efforts, natural/seasonality, weather/climate change and fishing by trawling (Fig. 3).

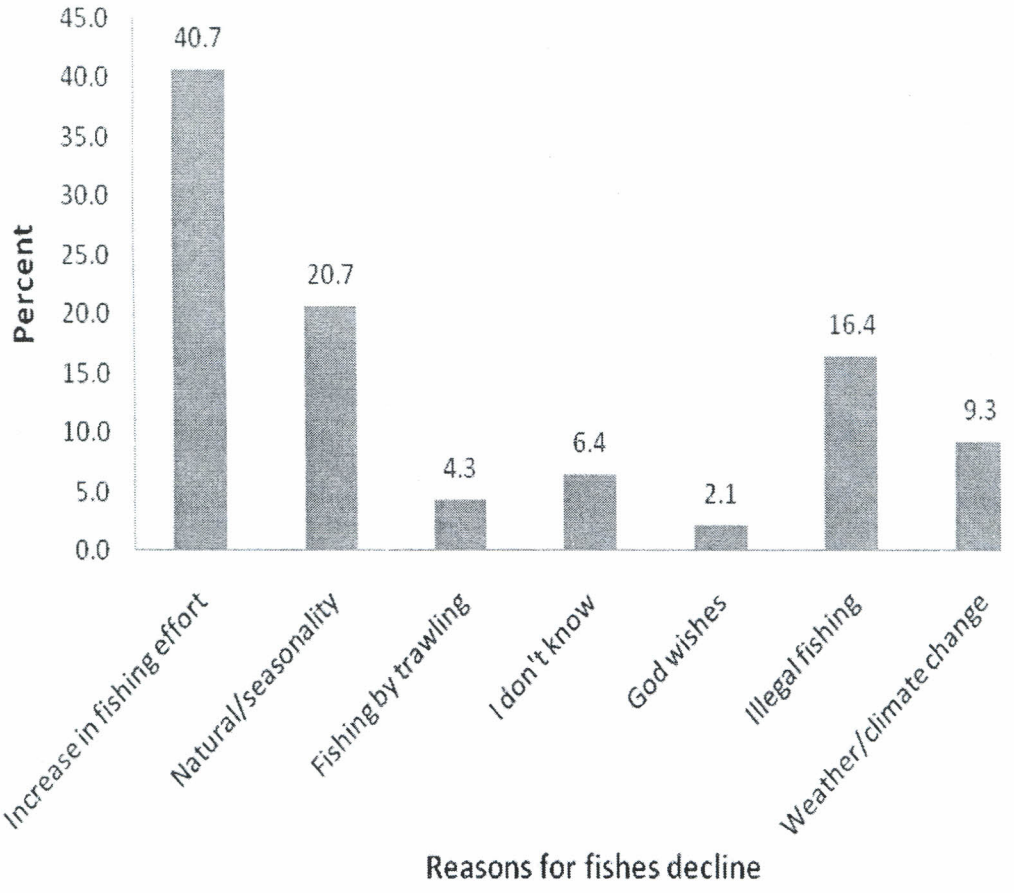

Figure 3: Reasons for fishes decline

It is important to note from Table 17 that about 16% of the respondents were undecided. This can be explained by the fact that the majority of "undecided" are non-fishermen as it is indicated in Table 18. These people are less able to note the changes occurring to fish landings and hence unable to tell if the trend is increasing or declining.

Table 18: Perceptions on decrease in fish landings against respondent occupation

	Respondent occupation					
Response	**Farmer**	**Fisherman**	**Petty trader**	**Civil servant**	**Others**	**Total**
Strongly disagree	4 (4.3)	1 (1.6)	0 (0.0)	0 (0.0)	0 (0.0)	5 (2.4)
Undecided	18 (19 4)	2 (3.2)	3 (20.0)	2 (18.2)	8 (32.0)	33 (15.9)
Agree	26 (28.2)	22 (34.9)	2 (13.3)	2 (18.2)	10 (40.0)	62 (30.0)
Strongly agree	45 (48.4)	38 (60.3)	10 (66.7)	7 (63.6)	7 (28.0)	107 (51.7)
Total	**93 (100)**	**63 (100)**	**15 (100)**	**11 (100)**	**25 (100)**	**207 (100)**

Figures in brackets are percentages

4.2.4 Perceptions on increase in water and air temperature

Results in Table 19 showed that more than 50% of respondents strongly agreed that water and air temperature has increased in the past 10 – 20 years. Lema and Majule (2009) reported that large number of farmers in the Central Tanzania has experienced an increase in temperature over the last 10 years. Mongi *et al.* (2010) indicated the majority of farmers in Uyui District, Tabora have perceived temperature to be hotter relative to old days. It was further explained that much of the changes have occurred during the last 10 years. Moreover, Chi-square analysis showed non-significant difference in respondents' perceptions on water and air temperature increase between Unguja and Bagamoyo ($p>0.05$). The results are plausible because of similarities between the two locations.

Table 19: Perceptions on increase in water and air temperature

	Location		
Response	**Bagamoyo**	**Unguja**	**Total**
Strongly disagree	1 (0.8)	2 (2.3)	3 (1.4)
Disagree	0 (0.0)	2 (2.3)	2 (1.0)
Undecided	14 (11.7)	11 (12.6)	25 (12.1)
Agree	46 (38.3)	26 (29.9)	72 (34.8)
Strongly agree	59 (49.2)	46 (52.9)	105 (50.7)
Total	**120 (100.0)**	**87 (100.0)**	**207 (100.0)**

Key: $\chi^2 = 4.717$, df = 4, n=207, p = 0.318

Figures in brackets are percentages

4.2.5 Perceptions on upwelling pattern change

The major upwellings in the ocean are associated with the divergence of currents that bring deeper, colder, nutrient rich waters to the surface. Upwelling pattern is considered to be an important factor in determining the abundance, distribution and growth rate of fish. Results in Table 20 showed that more than 36% of respondents strongly agreed that upwelling pattern has changed in the past 10 – 20 years. Discussion with fishermen revealed that the upwelling pattern is not consistent as it used to be in past decades. Moreover, Chi-square analysis showed no significant difference in respondents' perceptions on upwelling pattern between Unguja and Bagamoyo ($p>0.05$). These results are plausible because of similar perceptions of respondents between the two locations.

Table 20: Perceptions on upwelling pattern change

	Location		
Response	**Bagamoyo**	**Unguja**	**Total**
Strongly disagree	2 (1.7)	0 (0.0)	2 (1.0)
Disagree	1 (0.8)	3 (3.4)	4 (1.9)
Undecided	34 (28.3)	13 (14.9)	47 (22.7)
Agree	43 (35.8)	36 (41.4)	79 (38.2)
Strongly agree	40 (33.3)	35 (40.2)	75 (36.2)
Total	**120 (100.0)**	**87 (100.0)**	**207 (100.0)**

Key: $\chi^2 = 8.286$, df = 4, n=207, p = 0.082

Figures in brackets are percentages

4.2.6 Perceptions on decrease in river runoff

Results in Table 21 showed that more than 48% of respondents strongly agreed that river runoff has declined over the last two decades.

Table 21: Perceptions on decrease in river runoff

	Location		
Response	**Bagamoyo**	**Unguja**	**Total**
Strongly disagree	1 (0.8)	1 (1.1)	2 (1.0)
Disagree	2 (1.7)	4 (4.6)	6 (2.9)
Undecided	24 (20.0)	10 (11.5)	34 (16.4)
Agree	38 (31.7)	26 (29.9)	64 (30.9)
Strongly agree	55 (45.8)	46 (52.9)	101 (48.8)
Total	120 (100.0)	87 (100.0)	207 (100.0)

Key: $\chi^2 = 4.333$, df = 4, n=207, p = 0.363

Figures in brackets are percentages

Moreover, Chi-square analysis showed no significant difference in respondents' perceptions on river runoff between Bagamoyo and Unguja ($p>0.05$). These results are plausible because of similarities between the two locations. Further, respondents

explained that over the past two decades water used to flow in small rivers and streams for a long period after rain seasons. However, in recent years the flow of water in rivers after rain season has shortened. Similarly, Orindi and Murray (2005) observed 2/3 of the rivers in Tanzania had have reduced water volume in the recent past as a result of decreased rainfall. Further, Mwandosya *et al.* (1998) projected a decrease in water flow in some rivers including Pangani and Ruvu, although Rufiji was projected to have a slight increase in water flow.

4.2.7 Perceptions on increase in storm intensity

Results in Table 22 showed that more than 31% of respondents strongly agreed that storm intensity has increased in the past 10 to 20 years. Discussion with fishermen revealed that although the modern fishing gears have recently increased in use, the number of fishing days missed per month due to bad weather such as storms and heavy rains is still high. Results indicated an average of 7 fishing days missed per month due to bad weather particularly strong winds. Further, fishermen explained their income to be affected by bad weather and hence make them unable to properly provide their family with daily basic needs. Similarly, Macfadyen and Allison (2009) noted that fishing days in the Bay of Bengal to have been greatly reduced due to both increased severity of strong winds and storm surges as the result of climate change.

Table 22: Perceptions on increase in storm intensity

	Location		
Response	**Bagamoyo**	**Unguja**	**Total**
Strongly disagree	14 (11.7)	15 (17.2)	29 (14.0)
Disagree	12 (10.0)	9 (10.3)	21 (10.1)
Undecided	26 (21.7)	16 (18.4)	42 (20.3)
Agree	26 (21.7)	24 (27.6)	50 (24.2)
Strongly agree	42 (35.0)	23 (26.4)	65 (31.4)
Total	**120 (100.0)**	**87 (100.0)**	**207 (100.0)**

Key: $\chi^2 = 3.301$, df = 4, n=207, p = 0.509

Figures in brackets are percentages

Furthermore, Chi-square analysis showed no significant difference in respondents perceptions on increase in storm intensity between the study sites ($p>0.05$). These results are plausible because of similar responses given by respondents in Bagamoyo and Unguja.

4.2.8 Perceptions on increase in frequency of floods

Results in Table 23 showed 28% of the respondents disagreed that frequency of floods has increased in the past 10 to 20 years. The high proportion of respondents who disagreed that frequency of floods has increased validates the floods to be less prominent climate related hazard in the study area.

Table 23: Perceptions on increase in frequency of floods

	Location		
Response	**Bagamoyo**	**Unguja**	**Total**
Strongly disagree	43 (35.8)	12 (13.8)	55 (26.6)
Disagree	32 (26.7)	25 (28.7)	57 (27.5)
Undecided	15 (12.5)	11 (12.6)	26 (12.6)
Agree	15 (12.5)	25(28.7)	40 (19.3)
Strongly agree	15 (12.5)	14 (16.1)	29 (14.0)
Total	**120 (100.0)**	**87 (100.0)**	**207 (100.0)**

Key: $\chi^2 = 16.644$, df = 4, n=207, p = 0.002

Figures in brackets are percentages

Moreover, Chi-square analysis showed a significant difference in the perceptions of the respondents on increase of frequency of floods between Bagamoyo and Unguja ($p<0.05$). Results indicate 35.8% of respondents in Bagamoyo strongly disagreed the frequency of floods has increased while 13.8% of respondents in Unguja perceived the same. However, the precise reason for such difference between the two study sites is unclear. It is important to note from Table 23 that about 13% of respondents were undecided. This as indicated in Table 24 results, from the fact that the majority of "undecided" are respondents aged between 21 and 40 years, who are not able to note the changes which have occurred to floods.

Table 24: Perception on increase in frequency of floods against respondents' age

Response	Grouped age of respondent				Total
	≤ 20	21 – 40	41 – 60	> 60	
Strongly disagree	2 (33.3)	21 (26.6)	20(23.8)	12 (31.6)	55 (26.6)
Disagree	2 (33.3)	20 (25.3)	24 (28.6)	11 (28.9)	57 (27.5)
Undecided	0 (0.0)	12 (15.2)	9 (10.7)	5 (13.2)	26 (12.6)
Agree	2 (33.3)	13 (16.5)	18 (21.4)	7 (18.4)	40 (19.3)
Strongly agree	0 (0.0)	13 (16.5)	13 (15.5)	3 (7.9)	29 (14.0)
Total	**6 (100.0)**	**79 (100.0)**	**84 (100.0)**	**38 (100.0)**	**207 (100.0)**

Figures in brackets are percentages

4.2.9 Perceptions on salt water intrusion into shallow wells

Results in Table 25 showed that more than 31% of respondents strongly agreed that salt water intrusion in shallow wells has increased over the last two decades. Moreover, Chi-square analysis shows significant difference ($p<0.05$) in respondents' perceptions between Unguja and Bagamoyo.

Table 25: Perceptions on increase in salt water intrusion into shallow wells

Response	Location		
	Bagamoyo	Unguja	Total
Strongly disagree	7 (5.8)	1 (1.1)	8 (3.9)
Disagree	7 (5.8)	25 (28.7)	32 (15.5)
Undecided	25 (20.8)	13 (14.9)	38 (18.4)
Agree	38 (31.7)	25 (28.9)	63 (30.4)
Strongly agree	43 (35.8)	23 (26.4)	66 (31.9)
Total	**120 (100.0)**	**87 (100.0)**	**207 (100.0)**

Key: $\chi^2 = 22.468$, df = 4, n=207, p = 0.000

Figures in brackets are percentages

Results indicated 35.8% of respondents in Bagamoyo and 26.4% in Unguja strongly agreed salt water intrusion into shallow wells has increased. Respondents in Bagamoyo revealed to abandon shallow fresh water wells situated nearby the shores due to excessive saline taste as the result of salt water invasion which they explained to have increased over the last two decades. The results are supported by Mwandosya *et al.* (1998) who noted ground water resource in the coast of Bagamoyo to be impaired by salt water intrusion in the coastal based aquifers as the result of climate change.

4.2.10 Perceptions on increase in drought frequency

Results in Table 26 showed that more than 57% of respondents strongly agreed that frequency of drought has increased in the past 10 to 20 years. The high proportion of respondents who strongly agreed that the frequency of drought has increased is an indication that drought is one of the most prevailing climate hazards in the study sites.

Table 26: Perceptions on increase in drought frequency

	Location		
Response	**Bagamoyo**	**Unguja**	**Total**
Strongly disagree	7 (5.8)	1 (1.1)	8 (3.9)
Disagree	3 (2.5)	10 (11.5)	13 (6.3)
Undecided	5 (4.2)	6 (6.9)	11 (5.3)
Agree	29 (24.2)	27 (31.0)	56 (27.1)
Strongly agree	76 (63.3)	43 (49.4)	119 (57.5)
Total	**120 (100.0)**	**87 (100.0)**	**207 (100.0)**

Key: $\chi^2 = 12.643$, df = 4, n=207, p = 0.013

Figures in brackets are percentages

Similarly, results by Mutabazi (2007) indicated the majority of respondents to perceive drought as a severe climate change related problem in Same District, Tanzania. Lema and Majule (2009) found the majority of respondents to perceive increase in frequency of drought in Manyoni District, Singida. Moreover, Chi-square analysis showed no significant difference between Unguja and Bagamoyo. These results are plausible because of similar perceptions of respondents in the two locations.

4.3. Comparison of Meteorological Data and Community Perceptions to Climate Change

The perceptions of mangroves dependent communities based on temperature and rainfall change were compared with actual trend of meteorological data on rainfall and temperature for Bagamoyo and Unguja Island.

4.3.1 Rainfall trends for Bagamoyo and Unguja based on empirical data (1982 – 2011)

SSS

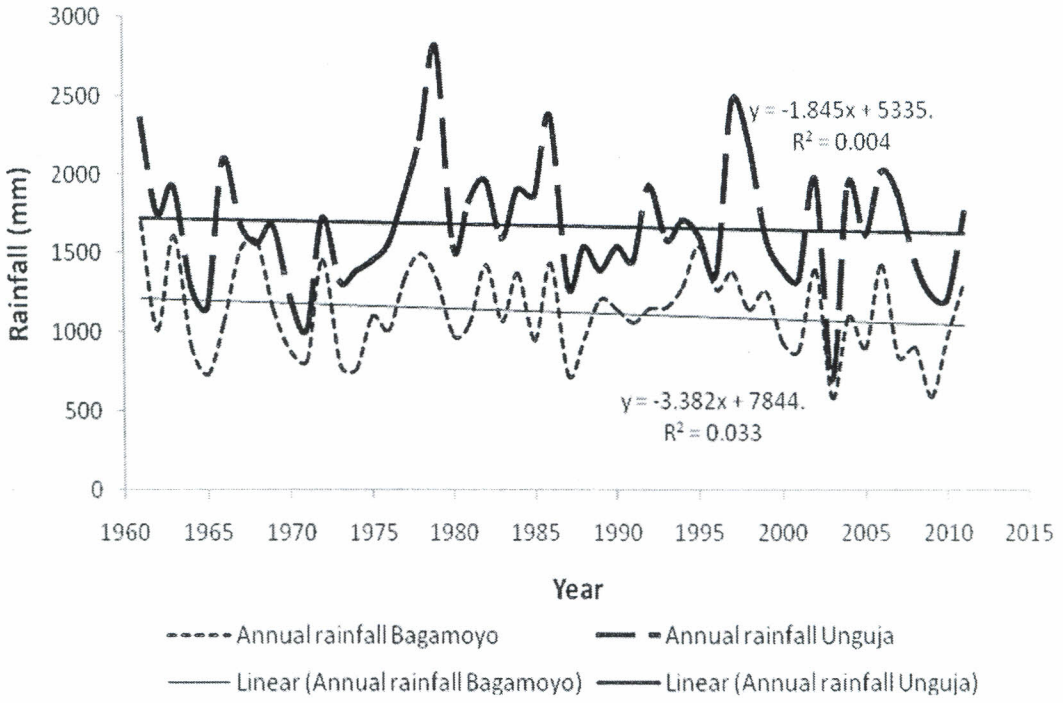

Figure 4: Annual rainfall trend for Bagamoyo and Unguja (1982-2011)

Source: TMA data (2011)

Results indicated Unguja to receive slightly high amount of rainfall over 30 years as compared to Bagamoyo. Over that period there has been a pattern of fluctuations in annual rainfall amount at both study areas. However, the trend showed a general decrease in rainfall amount at both Bagamoyo and Unguja. For the period of 30 years, results of the analysis indicated rainfall amount to decrease by 162.7 mm in Bagamoyo and 176 mm in Unguja (Fig. 4). Local people perceptions on long term change in rainfall indicated more than 67% of respondents strongly agreed rainfall

has decreased over the last 10 - 20 years (refer to Table 15, perceptions on decrease in rainfall). The analysis of the meteorological data on rainfall therefore, concurs with what local communities' perceived on rainfall trend in Bagamoyo and Unguja.

4.3.2 Temperature trends for Bagamoyo and Unguja (1982-2011)

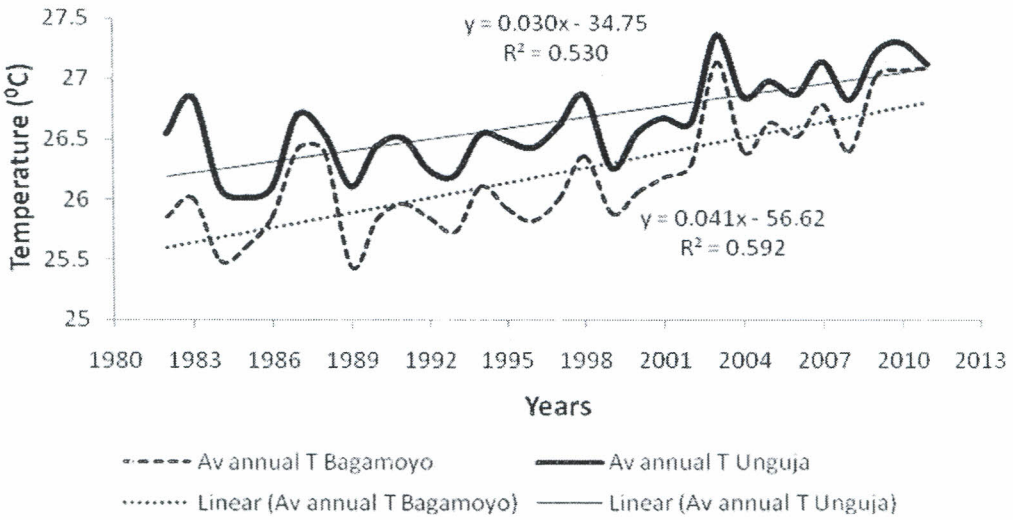

Figure 5: Average annual temperature trend for Bagamoyo and Unguja (1982-2011)

Source: TMA data (2011)

The analysis of meteorological data on average annual temperature for both Bagamoyo and Unguja for 30 years showed a general increase in temperature trend (Fig. 5). Over the period of 30 years the analysis showed an increase of temperature by 0.9°C for Unguja and 1.23°C for Bagamoyo. This warming trend is in line with average annual temperature increase calculated by Lema and Majule (2009) in Manyoni District, Singida. The authors indicated an increase of average annual temperature by 0.7°C over the period of 20 years (1994 – 2004). Yanda *et al.* (2008) showed that the average annual temperature in Zanzibar and Arusha has increased by 1.9°C and by 1.1°C respectively between 1961 and 2005. Such a

change is not surprising but it validate that global warning can be revealed even at local scales. Local community perceptions on temperature change indicated 50% of respondents strongly agreed that air temperature has increased in the past 10 – 20 years. The results of empirical data analysis therefore are in accordance with the perceptions of the majority of the respondents in both Bagamoyo and Unguja.

4.4 Vulnerability to Climate Change Impacts

Household vulnerability to climate change was determined through vulnerability index (Appendix 1). Results in Table 27 showed that 88.9% of the households were vulnerable to climate change impacts. Only 11.1% of the households were found not to be vulnerable to climate change impacts. Moreover, Chi-square test indicated a significant difference in household vulnerability to climate change between Bagamoyo and Unguja ($p<0.05$). Results indicate the proportion of vulnerable households in Bagamoyo (94%) was higher than proportion of vulnerable household in Unguja (82%).

Table 27: Household vulnerability status

	Location		
Vulnerability status	**Bagamoyo**	**Unguja**	**Total**
Vulnerable	113 (94.2)	71 (81.6)	184 (88.9)
Not vulnerable	7 (5.8)	16 (18.4)	23 (11.1)
Total	**120 (100.0)**	**87 (100.0)**	**207 (100.0)**

Key: $\chi^2 = 8.052$, df = 1, n=207, p = 0.005

Figures in brackets are percentages

The results might be associated with household wealth status of which more than 48% of households in Bagamoyo were poor compared to only 30% in Unguja (refer to Table 12, household weather status). Shemsanga *et al.* (2010) found poor households to be more vulnerable to the effects of climate change because of their limited resources and overdependence on natural resources which are threatened by climate change.

4.4.1 Household vulnerability against household income

Results in Table 28 indicated that the majority respondents in all income groups were vulnerable to climate change impacts. Chi-square analysis showed significant difference in vulnerability between income groups ($p<0.05$). Results indicated that the majority of households earn between 40 000 and 499 999 TAS annually (98%) were vulnerable to climate change impacts compared to households which were earning 500 000 TAS and more of income per year.

Table 28: Vulnerability against annual income

	Household annual income in TAS			
Vulnerability status	**40 000-499 999**	**500 000-1 499 999**	**≥ 1 500 000**	**Total**
Vulnerable	99 (98.0)	47 (81.0)	38 (79.2)	184 (88.9)
Not vulnerable	2 (2.0)	11 (19.0)	10 (20.8)	23 (11.1)
Total	**101 (100.0)**	**58 (100.0)**	**48 (100.0**	**207 (100.0)**

χ^2 =16.743.df 2, p=0.000, N=207

Figures in brackets are percentages

The results can be explained by the fact that households which earn high annual income have wide chance of accessing large and suitable land for agriculture e.g. wetlands. Bryan *et al.* (2005) noted land shortage to be the biggest barrier to adaptation to climate change impacts in Ethiopia and South Africa. High income earning households have also the ability to buy food in case of crop failure due climate related hazards such as drought and floods. URT (1999) found income to promote access to basic human needs such as food, shelter and clothing. According to Dolan and Walker (2004) income is an important indicator of the community or an individual adaptive capacity. As the income of an individual increases, so does the potential for preparation, recovery and adaptation to the impacts of climate change (ibid).

4.4.2 Vulnerability against the occupation of household head

Results indicate more than 50% of the households were vulnerable to climate change impact regardless of the occupation of household head (Table 29).

Table 29: Vulnerability against household head occupation

	Household head occupation					
Vulnerability Status	**Farmer**	**Fisherman**	**Petty trader**	**Civil servant**	**Others**	**Total**
Vulnerable	84 (90.3)	57 (90.5)	14 (93.3)	6 (54.5)	23 (92.0)	184 (88.9)
Not vulnerable	9 (9.7)	6 (9.5)	1 (6.7)	5 (45.5)	2 (8.0)	23 (11.1)
Total	**93 (100.0)**	**63 (100.0)**	**15 (100.0)**	**11 (100.0)**	**25 (100.0)**	**207 (100.0)**

Key: χ^2 =14.036.df 4, p=0.007, N=207

Figures in brackets are percentages

However, the vulnerability differed significantly between household heads occupation ($p<0.05$). Results indicate that more than 90% of households headed by farmers, fishermen, petty traders and people engaging in other occupations such as casual labourers were vulnerable to climate change. These results can be explained by the fact that farmers rely on the use of land and fisheries for their livelihood. Nelson and Agbey (2005) noted agriculture and water resources to be among the most sensitive sectors to climate change. Results indicate less proportion (54.5%) of households headed by civil servants were vulnerable to climate change. The results might be attributed to the fact that civil servants have high opportunity to diversify their income as apart from earning salary they can as well engage in other occupations. According to Kurukulasuriya and Rosenthal (2003) income diversification increases the ability of an individual to adapt to climate change impacts.

4.4.3 Vulnerability against household location

Results indicated that more than 71% of households in the study sites were vulnerable to climate change regardless of their location from the sea. Moreover, Chi-square analysis showed significant difference in household vulnerability with respect to distance from sea ($p<0.05$). Results indicated that 95.6% percent of the households located very near to the sea were vulnerable to climate change impacts (Table 30). The results might be explained by the fact that households which are located nearby the sea are more exposed to climate change hazards such as storm surges, sea level rise, coastal erosion and saltwater intrusion in water table. Adger *et al.* (2003) noted that settlements which are located in low-lying and close to coastal areas to be more exposed and hence more vulnerable to climate change hazards.

Table 30: Vulnerability against location

	Household distance to the sea			
Response	**Very near**	**Near**	**Far**	**Total**
Vulnerable	65 (95.6)	99 (89.2)	20 (71.4)	184 (88.9)
Not vulnerable	3 (4.4.)	12 (10.8)	8 (28.6)	23 (11.1)
Total	**68 (100.0)**	**111 (100.0)**	**28 (100.0)**	**207 (100.0)**

Key: χ^2=11.743, df 2, p=0.003, N=207

Figures in brackets are percentages
[1]Very near: Household located less than 50 m from the shoreline
[2] Near: Household located between 50 m – 100 m from the shoreline
[3] Far: Household located more than 100 m from the shoreline.

4.4.4 Vulnerability against household size

Results in Table 31 indicated that 89% of the households with 9 – 12 members were vulnerable to climate change impacts. Moreover, Chi-square analysis showed significant difference in household vulnerability between household size groups ($p<0.05$).

Table 31: Vulnerability against household size

	Household size			
Vulnerability status	**1-4 (n=34)**	**5-8 (n=51)**	**9-12 (n=9)**	**Total (n=94)**
Vulnerable	30 (88.2)	43 (84.3)	8 (88.9)	81 (86.2)
Not vulnerable	4 (11.8)	8 (15.7)	1 (11.1)	13 (13.8)
Total	**34 (100.0)**	**51 (100.0)**	**9 (100.0)**	**94 (100.0)**

Key: χ^2 =7.560, df 4, p=0.023, N=207

Figures in brackets are percentages

The findings can be explained by the fact that large households (9 – 12 members) tend to be poor as they tend to use most of the family income for social necessities mainly food and hence little is left for productive investment (Kasanga, 2005).

Furthermore, poor households tend to be more vulnerable to climate change impacts than rich households as they lack necessary resources for adaptation (Kurukulasuriya and Rosenthal, 2003). Results also indicated the majority of household with 1 - 4 members (88%) were vulnerable to climate change. Results might be explained by the fact that, usually small households in both Bagamoyo and Unguja tend to depend on contribution of one person, often the household head for livelihood. According to Kurukulasuriya and Rosenthal (2003) few income sources to household tend to increase household vulnerability to climate change impacts.

4.4.5 Household vulnerability to climate hazards

Results indicated the majority household in the study sites were vulnerable to drought, coastal level rise, beach erosion, salt water inundation and increase in pest and diseases.

4.4.5.1 Household vulnerability to drought

Results in Table 32 indicated drought to be the main climate related hazard the majority of respondents explained their household to experience in the study areas. About 55% of the respondents reported their households to experience drought. Vulnerability to drought had the highest mean score of 37.3 compared to other hazards. This indicates that the majority of households in the study area are vulnerable to drought and its effects are more remarkable than the effects of other hazards.

Chi-square test indicated households experience to drought to differ significantly between Bagamoyo and Unguja ($p<0.05$). The majority of respondents in Unguja (70%) admitted their household to experience drought. The results can be explained by the fact that the 30 years analysis of empirical data on rainfall show large amount of rainfall decline in Unguja than in Bagamoyo (refer to Fig. 4, annual rainfall trend of Bagamoyo and Unguja).

Table 32: Household experience to drought

	Location		
Response	**Bagamoyo**	**Unguja**	**Total**
Yes	53 (44.2)	61 (70.1)	114 (55.1)
No	67 (55.8)	26 (29.9)	93 (44.9)
Total	**120 (100.0)**	**87 (100.0**	**207 (100.0)**

Key: $\chi^2 = 13.725$, df = 1, n=207, p = 0.000, Vulnerability mean score=37.3

Figures in brackets are percentages

4.4.5.2 Household vulnerability to pests and diseases

Results in Table 33 showed that out of 207 interviewed respondents 33.3% admitted their household to experienced pest and diseases. Household vulnerability to pests and diseases had mean score of the 35.1 ranked the second after drought.

Table 33: Household experience to pests and diseases

	Location		
Response	**Bagamoyo**	**Unguja**	**Total**
Yes	22 (18.3)	48 (55.2)	70 (33.3)
No	98 (81.7)	39 (44.8)	137 (67.2)
Total	**120 (100.0)**	**87 (100.0)**	**207 (100.0)**

Key: $\chi^2 = 31.582$, df = 1, n=207, p = 0.000, Vulnerability mean score=35.1

Figures in brackets are percentages

High vulnerability mean score indicates pests and diseases to be among the major climate related hazards faced by households in the study areas. Informal discussion with respondents revealed mosquito prevalence to increase in the study sites. The findings are supported by Lema and Majule (2009) who found pests and diseases to be among the critical problems faced by farmers in Manyoni District, Singida. Among the most experienced diseases to human explained by respondents include malaria and water borne diseases i.e. typhoid, dysentery, diarrhoea and cholera (Fig. 6). URT (2007) noted that warming up of the country due to climate change has been responsible for more cases of malaria including in the highland areas.

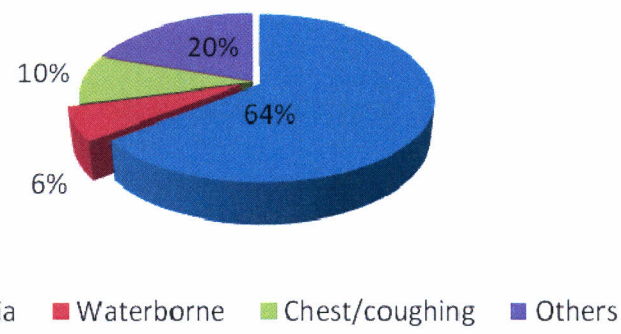

Figure 6: Common diseases in the study areas

Moreover, Chi-square analysis indicated significant difference in household experience to pests and diseases between Bagamoyo and Unguja ($p<0.05$). Results show 55% and 18% of respondents admitted their household to experience pests and diseases in Unguja and Bagamoyo respectively. However, this study could not come up with concrete reasons why large proportion of respondents claimed to experience pests and diseases in Unguja than in Bagamoyo.

4.4.5.3 Coastal/beach erosion

Results in Table 34 showed that out of 207 interviewed respondents, 41.5% admitted their households to have experienced coastal/beach erosion. Further, household vulnerability to coastal/beach erosion had a mean score of 30.8 which was categorized as a medium level and the third after drought and pests and diseases.

Table 34: Household experience to coastal/beach erosion

	Location		
Response	**Bagamoyo**	**Unguja**	**Total**
Yes	37 (30.8)	49 (56.3)	86 (41.5)
No	83 (69.2)	38 (43.7)	121 (58.5)
Total	**120 (100.)**	**87 (100.0)**	**207 (100.)**

Key: $\chi^2 = 13.492$, df = 1, n=207, p = 0.000, Vulnerability mean score=30.8

Figures in brackets are percentages

Chi-square analysis showed significant difference in household experience to coastal/beach erosion between Bagamoyo and Unguja ($p<0.05$). The majority of respondents (56.3%) in Unguja admitted their households to have experienced coastal/beach erosion. Coastal/beach erosion is usually associated with coastal level rise. Field observation also noted various trees including coconut and *Cassuarina spp.* along the coast in Unguja being up rooted by beach erosion (Plate 1).

Plate 1: Effects of coastal/beach erosion on coastal trees along Unguja Beach

4.4.5.4 Coastal level rise

Results showed that the majority of the interviewed respondents (43.5%) admitted their households to have experienced coastal level rise (Table 35). Vulnerability to coastal level rise was ranked the fourth with a mean score of 29.6. The respondents also explained the coastal level rise to be responsible for salt water intrusion in shallow water wells and in low lying farm plots resulting into drying up of coconut trees and reduced growth in food crops i.e. maize and cassava. The results are supported by Monirul and Mizra (2003) who found sea level rise to be responsible for tidal inundation, accelerated coastal erosion, rising water tables and increased saltwater intrusion along the coastal areas.

Table 35: Household experience to coastal level rise

Response	Location		Total (n=207)
	Bagamoyo (n=120)	Unguja (n=87)	
Yes	33 (27.5)	57 (65.5)	90 (43.5)
No	87 (72.5)	30 (34.5)	117 (56.5)
Total	**120 (100.0)**	**87 (100.0)**	**207 (100.0)**

Key: $\chi^2 = 29.662$, df = 1, n=207, p = 0.000, Mean score=30.8

Figures in brackets are percentages

Chi-square test indicated significant difference in household experience to coastal level rise between Bagamoyo and Unguja ($p<0.05$). Results show large proportion of respondents in Unguja (65.5%) to admit their households have experienced coastal level rise compared to Bagamoyo (27.5%). These results might be explained by the fact that Unguja being an island it is easier for the majority of residents to note changes in sea water than Bagamoyo which is only bordered by the sea on one side.

4.4.5.5 Vulnerability to salt water inundation

Results showed small proportion of respondents (40%) admitted their households have experienced saltwater inundation (Table 36). Household vulnerability to salt water inundation ranked the fifth with mean score of 29.3. Chi-square analysis showed a significant difference in household experience to saltwater inundation between Bagamoyo and Unguja ($p<0.05$). Higher proportion of respondents in Unguja (40%) who admitted their households to experience salt water inundation compared to Bagamoyo with only 26% admitted to experience salt water inundation might be attributed to coastal level rise which was claimed by majority of

respondents (65.5%) in Unguja (refer Table 35, household experience to coastal level rise). According to URT (2007) low-lying coastal regions and small islands are among the areas which are most likely to be affected by sea water inundation. For example, Maziwe Island in Pangani District is already submerged as a direct result of climate change (Kebede, 2010).

Table 36: Household experience to saltwater inundation

	Location		
Response	**Bagamoyo (n=120)**	**Ungula (n=87)**	**Total (n=207)**
Yes	31.0(25.8)	35.0(40.2)	66.0(31.9)
No	89.0(74.2)	52.0(59.8)	141.0(68.1)
Total	**120.0(100.0)**	**87.0(100.0)**	**207.0(100.0)**

Key: $\chi^2 = 4.813$, df = 1, n=207, p = 0.028, Mean score=29.3

Figures in brackets are percentages

4.4.6 Socio-economic, demographic and physical factors influencing vulnerability

Results in Tab le 37 sh-owed the association between household vulnerability to climate change impacts and demographic factors, farm factors and socio-economic factors. The factors which were considered to influence household vulnerability to climate change impacts include; age, sex and occupation of the household head, household size, assets, farmland size and ownership. Others factors which were considered include; household labour force, annual income, number of remittance sources and distrust to weather information. The model was regarded to be significant since 53% of independent variables explained the dependent variable ($R^2 = 0.529$). In this study beta weights were used to determine the influence of each independent variable to household vulnerability to climate change.

Table 37: Multiple linear regression showing factors influencing household vulnerability

Variable	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	T	Sig.
(Constant)	64.043	10.398		6.159	.000 **
Age of HH head	-.685	3.580	-.013	-.191	.849 ns
Sex of HH head	-1.973	1.518	-.095	-1.300	.196 ns
Size of HH	3.432	2.885	.092	1.190	.236 ns
Occupation of HH head	1.202	1.334	.063	.901	.369 ns
HH assets	-12.827	2.534	-.376	-5.062	.000 **
Size of farmland	-1.407	1.654	-.057	-.851	.397 ns
Farmland ownership	-1.669	1.217	-.088	-1.371	.173 ns
HH annual income	-.597	1.235	-.036	-.483	.630 ns
HH labour	-8.485	3.649	-.185	-2.325	.022 *
Remittance	-3.866	1.025	-.250	-3.773	.000 **
Distrust of weather information	9.930	1.315	.533	7.552	.000 **

R square 0.529
F value 0.000
* Statistically significant at 0.05 level of significance
** Statistically significant at 0.01 level of significance
Ns Not statistically significant at 0.05 level of significance
Sig Significance level

Results indicated that age and sex of the household head, household assets, farm size, farm ownership, annual income, household labour and household sources of remittance to have negative correlation with household vulnerability. The negative correlation implies that the variables are inversely related to household vulnerability to climate change. However, only household assets, labour force, and number of remittances sources had significant contribution to household vulnerability ($p<0.05$).

Household assets had a negative correlation with vulnerability. This implies that household assets tend to reduce household vulnerability to climate change hazards. The study found household assets to contribute in reduction of household

vulnerability to climate change impacts by a factor of 0.376 at ($p<0.01$). This can be explained by fact that households which posses larger number of assets tend to be more secured and capable to cope with the effects of climate change as compared to households with few or inadequate assets. Gbetibouo, (2009) found households with large number of assets to be more adaptable to climate change impacts in Limpopo Basin in South Africa.

Results also indicated a negative correlation between household labour and vulnerability. The negative correlation implies that household labour has a tendency of reducing household vulnerability. The study found household labour to reduce vulnerability to climate change impacts by a factor of 0.185 at ($p<0.05$). Households with large labour force tend to be less vulnerable to climate change impacts since household members participate in production activities such as farming and fishing which increase food and income.

Number of remittance sources had a negative correlation with vulnerability, indicating that an increase in the number of family members or friends providing remittances to the household reduce household vulnerability. The study found number of remittance source to reduce household vulnerability to climate change by a factor of 0.25 at ($p<0.01$). This can be explained by the fact that households which are able to access remittance from various stable sources away from the study areas have an ability to diversify their income sources and hence more adapted and less vulnerable to the impacts of climate change.

The study further found household size, occupation of household head and distrust of weather information had a positive correlation with household vulnerability. This means the variables tend to increase household vulnerability to climate change. However, only one variable (distrust of weather information) had a significant contribution to household vulnerability ($p<0.05$). The variable had a positive correlation, implying that it has a tendency of increasing vulnerability. Distrust of weather information was found to contribute to household vulnerability by a factor of 0.533 at ($p<0.01$). The results might be explained by the fact that adaptation to climate change impacts depend on the availability of weather information and the extent an individual or a community in question trust in the source of information. Usually households which have access to weather information but do not trust the source tend to lack advance measures against climate hazards such as early preparation of farmlands, crops diversification or not going to the sea during bad weather and hence more vulnerable to climate change hazards.

4.5 Coping Strategies Against Climate Change Hazards

4.5.1 Drought

Results showed drought was the main climate hazard which affected the livelihood of the majority of population in the study areas. The majority of respondents who admitted to experience drought, 45.7% explained to do nothing than waiting for the god's kindness in order to cope with drought. About 17.1% of the respondents explained to change crops which previously used to be cultivated in their farms in order to cope with drought. For example respondents in Mlingotini village, Bagamoyo claimed to cultivate cassava in areas which were used to grow maize

while areas previously used for paddy are now replaced by maize in order to cope with drought. About 13% of respondents explained to opt for non-farming jobs such as driving motorcycles, food vending or doing causal jobs. Similar findings were reported by Mongi *et al.* (2010) where farmers in Tabora shift to non-farm activities such as causal labour, charcoal making and carpentry in order to cope with the effects of drought. About 8.6% of respondents explained to plant trees as a coping and adaptation method against drought (Fig.7).

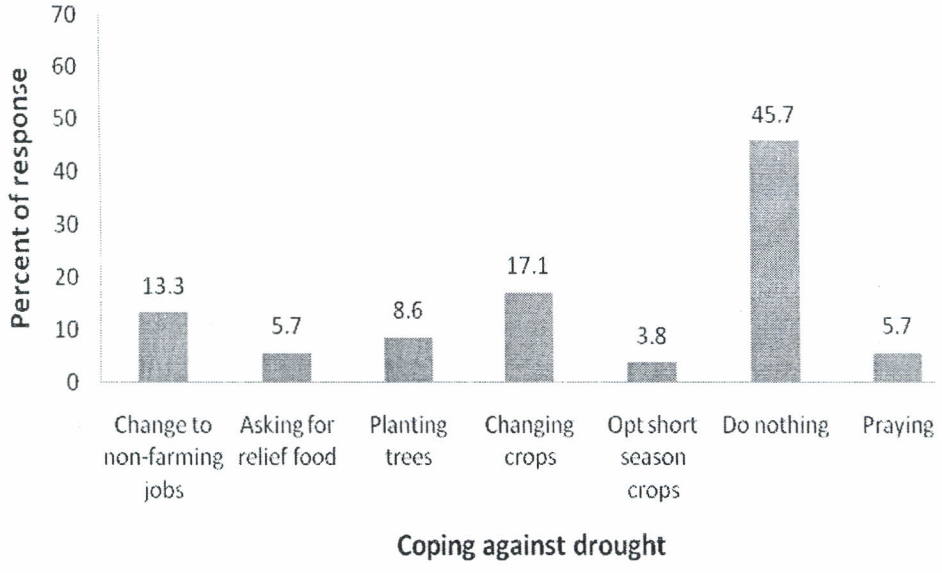

Figure 7: Coping strategies against drought

4.5.2 Pest and Diseases

Results in Figure 8 indicated 39.7% of the respondents to do nothing in order to cope with pests and diseases. The large proportion of respondents who indicated to do nothing in order to cope with pests and diseases might be attributed to low awareness of the local communities on how to deal with pest and diseases.

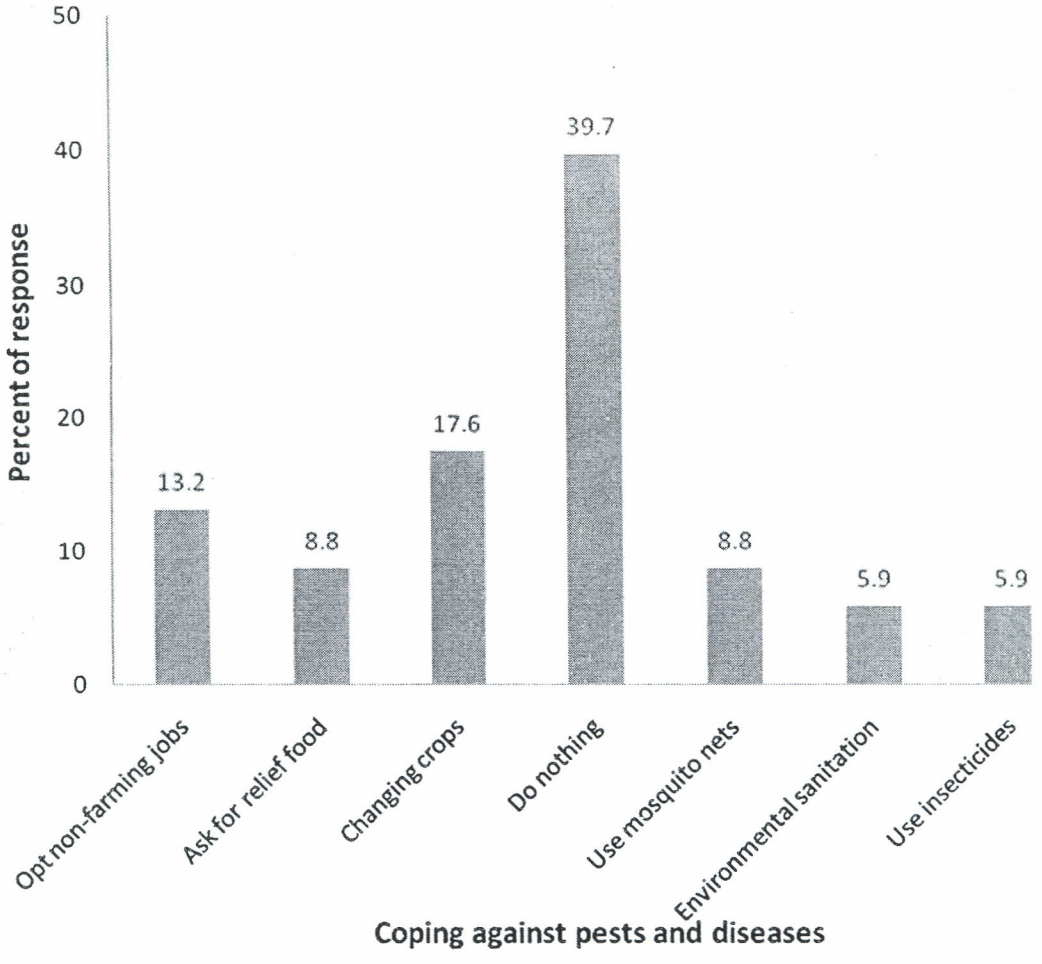

Figure 8: Coping strategies against pests and diseases

About 18% of respondents explained to change crops they used to cultivate in their farm plots due to diseases. Respondents explained to change from cultivating cassava and rice to cowpeas and beans due to the effects of diseases. However, the respondents were unable to explain the type of diseases which infected their crops. Further, the study showed 13% of the respondents have opted for non-farming jobs in order to cope with pests and diseases. Informal discussion with respondents revealed some farmers have abandoned farming and opted for non-farming activities i.e. motorcycle driving, cooked food vending and casual works in order to cope with diseases which have infected their crops. One of the respondents in Bagamoyo

explained to stop farming and engaged in food catering after his cassava being infected with unknown disease.

4.5.3 Coastal/beach erosion

Results in Fig. 9 indicated more than 83% of respondents do nothing to cope against coastal/beach erosion. The results might be attributed to economic status of the community which make them unable to construct structures such as walls and dykes along the beach so that to cope with the effects of beach erosion.

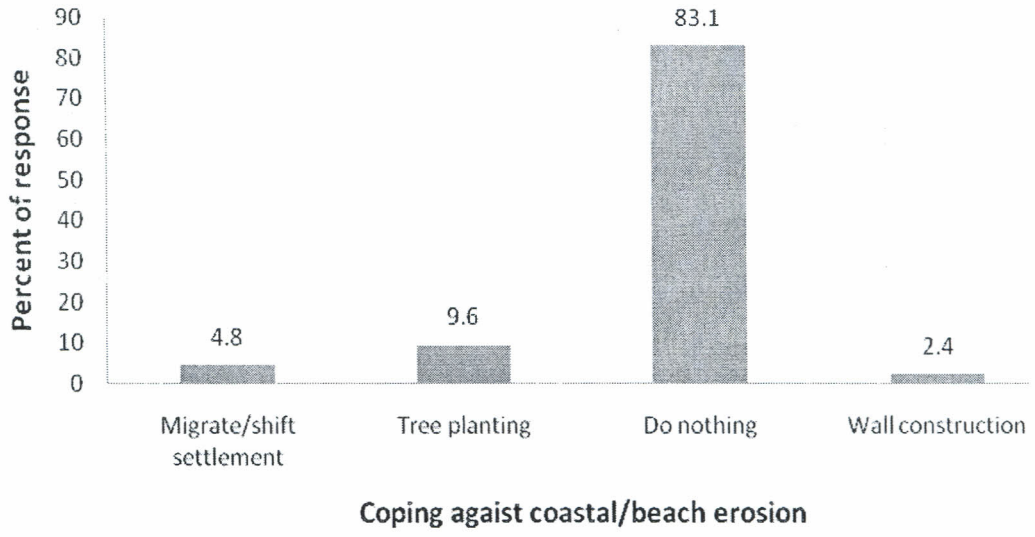

Figure 9: Coping strategies against coastal/beach erosion

About 9.6% of respondents indicated to plant trees and 6% explained to migrate/ shift the settlement away from the sea in order to cope with the effects of beach erosion. Only 1% of respondents indicated to construct wall along the beach in order to cope with the effects of beach erosion. The local community needs to be more sensitized on the importance of planting trees along the beach so that to prevent further effects of beach erosion.

4.5.4 Coastal level rise

The study found more than 88% of respondents to do nothing in order cope against sea level rise. Respondents explained coastal level rise to be beyond their ability to cope with and hence they leave it to God to control the problem. About 7% explained to migrate or shift their houses and farms away from the sea to avoid the effects of coastal level rise. About 4% explained to plant trees so that to cope and adapt with further effects of coastal level rise such beach erosion. One percent of the respondents explained to resort to prayer/other spiritual exercises to cope against coastal level rise (Fig. 10).

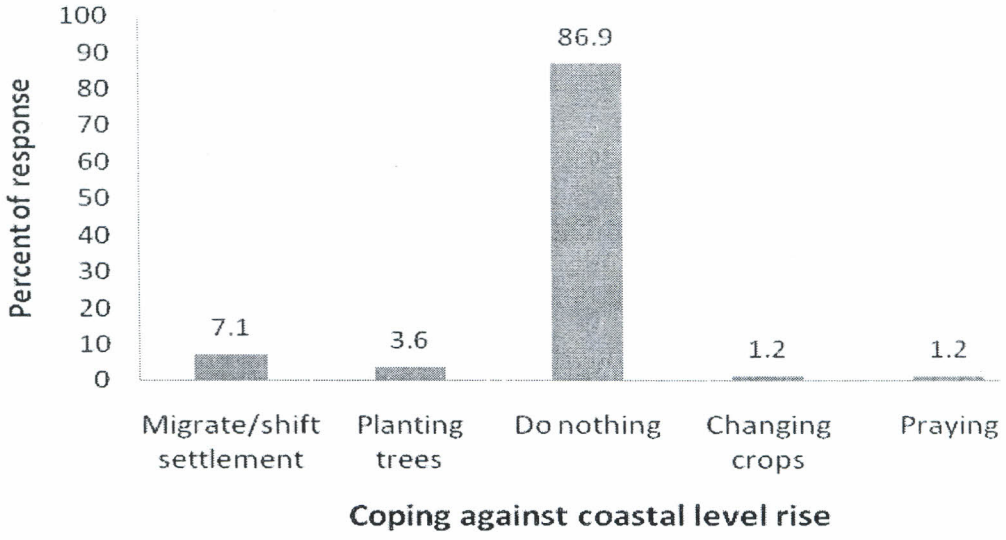

Figure 10: Coping strategies against coastal level rise

4.5.5 Salt water inundation

Results in Fig. 11 showed that more than 30% of respondents explained to buy water from vendors for domestic use in order to cope with the effects of salt water inundation in fresh water wells.

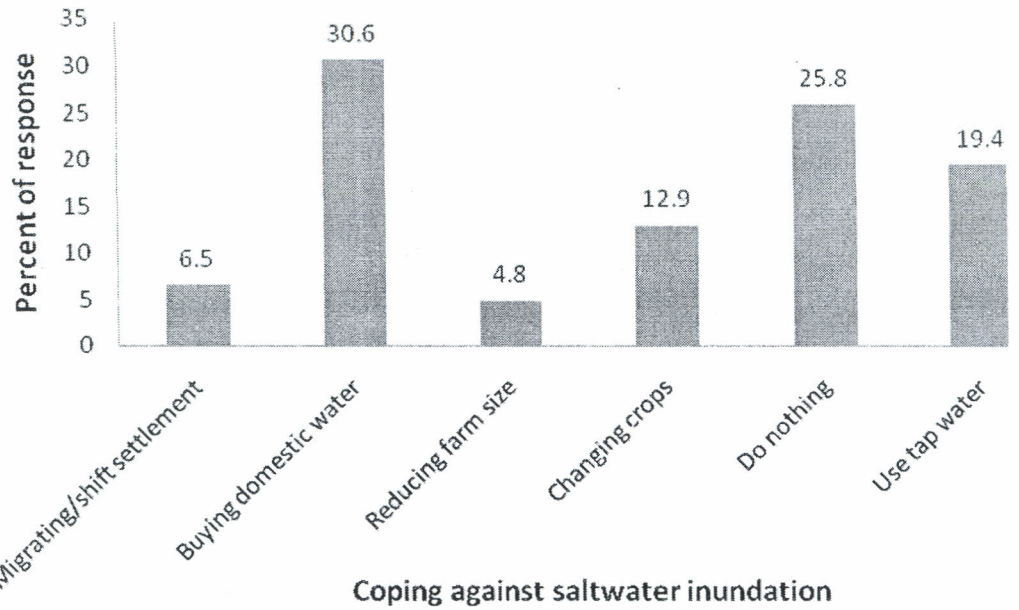

Figure 11: Coping strategies against salt water inundation

About 25.8% of respondents explained to do nothing, 19.4% explained to use tap water and 12.9% explained to change crop type they used to cultivate nearby the coast in order to cope with the effects of saltwater inundation. Further, 6.5% of the respondents explained to migrate /shift the location of settlement and farms away from the sea in order to cope with salt water inundation. Respondents in Bagamoyo claimed to abandon some fresh water wells used for domestic purpose as results of excessive salinity which has been caused by salt water inundation.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

It was found from the study that more than a half of respondents strongly agree that rainfall distribution and intensity has declined over the last two decades. Respondents also noted that the rainfall seasons have become more unpredictable with often delayed onset and early cessation. Respondents perceived air temperature has increased over the past 10 – 20 years in both Bagamoyo and Unguja. The study also found 89% of the households to be vulnerable to climate change impacts in the study areas, Bagamoyo District showed higher level of vulnerability than Unguja.

Households headed by low income earners, farmers, fishermen and people engaging in informal jobs were more vulnerable to climate change impacts as compared to households headed by civil servants. It was further found that more than three quarters of the households located very near to the sea were vulnerable to climate hazards including sea level rise and coastal erosion. Households with (1 - 4) and (9 - 12) members were found to be more vulnerable to climate change impacts as compared to households with (5 - 8) members. Among the climate change hazards, drought, pests and diseases were most reported by the respondents in both Bagamoyo and Unguja to be experienced by their households. Among the socio-economic, demographic and physical factors which were supposed to influence household vulnerability to climate change impacts; household assets were found to significantly reduce household vulnerability while distrust of weather information was found to significantly increase household vulnerability.

The study found about one third of respondents to do nothing in order to cope with the most prevalent climate change hazards in the study areas i.e. drought, pests and diseases, coastal/beach erosion, coastal level rise and salt water inundation. However, it was found that local coastal communities coped and adapted with most prevalent climate change hazards in various ways. For example, local communities opted for non-farming jobs (i.e. food vending, carpentry and driving motorcycles), planting trees and changing the crop type which they used to cultivate in their farm plots in order to cope with the effects of drought.

Respondents further explained to opt for non-farming jobs, change the crops being cultivated from cereals to legumes in order to cope with the effects of pests and diseases to crops and use of mosquito nets and insecticides in order to cope with the effects of pests and diseases to both human and crops. Buying water from vendors and opting for tap water was explained by respondents as the mechanisms developed to cope with the effects of salt water inundation into fresh water wells. Very small proportion of respondents explained to plant trees, migrate/shift the location of the farms and settlement, construct walls along the beach and opt for prayers so that to cope with the effects of coastal level rise and beach erosion.

5.2 Recommendations

The study therefore, recommends more documentation of the current coping and adaptation strategies practiced by the local communities against climate change hazards. The current coping strategies practiced by the local communities against climate change should also be strengthened. The study also recommends

combination of local communities' coping and adaptation methods with new innovations to enhance adaptations to climate change hazards. Education should be given to local communities in order to increase their awareness to climate change and its impacts. There is a need to use agriculture extension officers to provide the local communities with knowledge on modern farming practices in order to effectively cope with the effects of climate change hazards.

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APPENDICES

Appendix 1: Household survey interview guide

[Climate change Perceptions, Vulnerability and Coping strategies]

Questionnaire No. ☐

Date of interview: .....Name of enumerator.....

Name of person doing quality check: .....

Sub-village Name ..... Village.....

Ward ..... Division.....

District ....Region: ..... .

Distance of the household from the sea (established through field observation):

Code: 1 = Very near to sea; 2 = Near to sea; 3 = Far from sea [circle off what is appropriate]

Household wealth status (established through wealth ranking exercise at village level):

Code: 1 = Rich; 2 = Normal/Average; 3 = Poor; 4 = Very poor [circle off what is appropriate]

SECTION 1: HOUSEHOLD BASIC INFORMATION

1.1Name of household head: .....

1.2Name of respondent: .....

1.3 Age of respondent: ..... years

1.5 Sex of respondent (1) Male ..... (2) Female .....

1.6 Education: Years of formal education of respondent .....

1.7 Marital status: (1) Single ..... (2) Married..... (3) Widow.....

(4) Widower (5) Divorced .....

1.8 Household size and structure

SN	HH members (list by role start with the head of HH)	Age (years)	Sex 1= M 2= F	Educ.*	Occ.**	Health needs/disabilities 1=Yes, 2=No
1.						
2.						
3.						
4.						
5.						

*(1) No formal education; (2) Primary; (3) Ordinary level Secondary; (4) High level Secondary; (5) Tertiary; (6) Others (Specify)

** (1) Retired; (2) Fishermen; (3) Canoe maker (4) Farmer (5) Others (specify) .....

SECTION 2: HOUSEHOLD ASSETS

2.1 Assets

	Asset type	**Number**
1.	Motor vehicle	
2.	Motorcycle	
3.	Bicycle	
4.	Canoe	
5.	Yatch	
6.	Outboard engine boat	
7.	Dhow	
8.	Mkokoteni	
9.	Tractor	
10.	Power tiller	
11.	Radio	
12.	Mobile phone	
13.	Sewing machine	
14.	TV	
15.	Others (specify)	

SECTION 3: HOUSEHOLD ACCESS TO HEALTH CARE

3.1 Health care

		1= Yes 2 = No	Distance from HH Appr. Km	Frequency of attending per month
1.	Dispensary			
2.	Health centre			
3.	Hospitals			

3.2 Common household ailments.....

Code: 1 = Malaria, 2 = Waterborne diseases, 3 = Elephantiasis, 4 = TB, 5 = others (Specify)_____

SECTION 4: HOUSING, DOMESTIC WATER, LATRINES AND COMMUNICATION

4.1 Main house information

4.1.1) Wall _____ 4.1.2) Roof _____ 4.1.3) Floor _____

Code for housing materials: 1 = Brick, 2 = Block 3 = Mud only, 4 = Mud and poles, 5 = Roofing tiles, 6 = Iron sheet, 7= Grass/straw, 8= Cement floor, 9= Non-cemented floor, 10= others/specify _____

4.2 Type of latrine/toilet _____

Code: 1 = Pit .....2 = Water flushing .....= Open defecation .....
4 = Hanging, 5 = Others (specify).....

4.3 Domestic water sources

	Source for domestic	**Distance from HH (km)**	Rank*
1.	Tap water		
3.	Protected well/bore hole		
4.	Unprotected well/bore hole		
5.	River		
6.	Spring		
7.	Water vendors		
8.	Others		

*Order of accessibility: i.e. 1 = Most accessible, 2 = Second accessible etc.

4.4 How many years have you lived in this area? .....

4.5 Have water sources for domestic use changed for the past 10 years? .....

Code: 1 = Yes, 2 = No

4.6 If yes, explain .....

4.7 What type of road is mainly used to access this village? .....

Code: 1 = Tarmac road, 2 = All weather road, 3 = Seasonal road

4.8 Is this village supplied with National grid electricity? .....

Code: 1 = Yes, 2 = No

4.9 Do you have reliable telecommunication system (mobile coverage) in this village? .....

Code: 1 = Yes, 2 = No

SECTION 5: FOOD SECURITY

5.1 Number of meals household can afford per day .....

5.2 Does this household receive relief food? .....

Code: 1 = Yes , 2 = No

5.3 What is the source? .....

Code: 1 Government, 2 = Religion, 3 = Relatives, 4 = others (specify) .....

5.4 Does this household reserve food? .....

Code: 1 = Yes, 2 = No

5.5 What are the food shortages months?

.....

5.6 Changes in household food stock during the past 10 years ago .....

Code: 1 = Diminishing, 2 = Unchanged, 3 = Increasing

5.7 What is the reason for such changes?

.....

5.8 What are your coping strategies during the time of food shortage? .....

Code: 1= Consuming less/expensive food, 2 = Reduce number of meals/portion size 3 = Borrow food from neighbors, 4 = Consume seed stock, 5 = Sale of animals, land and assets,6= other (specify).....

5.9 Impact of the situation on the population overall existence and how you lived it?

.....

SECTION 6: CROP PRODUCTION

6.1 Has your household involved in farming during the last six months.....

Code: 1 = Yes, 2 = No

6.2 Crops information

	Cereals	**Acres**	**Bags/Kg**
1.	Maize		
2.	Cassava		
3.	Rice		
4.	Sweet potatoes		
5.	Others		
	Legumes		
1.	Beans		
2.	Pigeon peas		
3.	Others (specify)		

6.3 Type of the farmland .....

Code: 1 = family, 2 = communal, 3 = rental, 4 = other (specify)

6.4 Agriculture inputs and technology on farm produce?

	Input type	1 = Yes, 2 = No
1.	Hybrid seed	
2.	Organic fertilizers	
3.	Inorganic fertilizers	
4.	Insecticide/pesticides	
5.	Irrigation	
6.	Crop rotation	
7.	Intercropping	
8.	Fallowing	
9.	Others specify	

6.5 Do you have constraints in your crop production? .....

Code: 1 = Yes, 2 = No

6.6 If yes mention them

.....

6.7 Have you changed the crops produced in your farm? .....

Code: 1= Yes , 2 = No

6.8 If yes, why?

.....

6.9 Have you noticed any changes in the planting seasons? .....

Code: 1= Yes , 2 = No

6.10 If yes, what kind of change? .....

Code: 1 = Delayed planting season, 2 = Others (mention)

6.11 How long have you noticed this? .....

Code: 1 = 2 years, 2 = 5 years, 3 = 10 years, 4 = More than 10 years

6.12 Impact of the situation on the population overall existence

.....

6.13 What do you think are the causes of the change?

.....

6.14 Do you produce more crops than you consume? .....

Code: 1 = Yes, 2 = No

6.15 If yes, what do you do with surplus? .....

Code: 1 = Store, 2 = Sale, 3 = Others (specify).....

6.16 Is the stored food sufficient to cover household requirements during shortage period? .....

Code: 1 = Yes, 2 = No

6.17 Do you intend to sell any agriculture produce following your most recent harvest? .....

Code: 1 = Yes, 2 = No

6.18 What is your main market outlet for your agriculture produce? .....

1= In the village market, 2 = In market outside the village, 3= State marketing board, 4 = NGO or donor project, 5 = Farmers' groups or organization, 6 = Other (specify) .....

6.19 Do you grow crops on the basis of a pre-arranged contract with the private trader? .....

Code: 1 = Yes, 2 = No

6.20 Are you able to save money every year for future needs? .....

Code: 1 = Yes, 2 = No

SECTION 7: FISHERIES

7.1 Do you engage in fishery? .....

7.2 Role of fishery in the household? .....

Code: 1 = Cash income, 2 = Food, 3 = income and food, 4 = Other interest(Specify)

7.2 How long have you been fishing? .....

Code: 1 = 5 years and below, 2 = 5 - 10 years, 3 = 10 - 20 years, 4 = 20 - 30 years, 5 = more than 30 years

7.3 Which division of the fishery? _____

Code: 1 = Deep sea, 2 = Shallow waters, 3= Mangrove creek, 4 = Inland, 5 = Aquaculture, 6 = others (specify) .....

7.4 Have you noticed any change in the fishery since you started? .....

Code: 1 = Yes, 2 = No

7.5 What component of the fishery have you observed to be changing?

	Component	**Tick**	**Status***	**Reason for change****
	Total catch			
	Catch composition			
	Fish aggregation			
	Migration			
	Spawning pattern			

*Code: 1=Increase, 2 = Decrease, 3 = No change **Code: 1 = Fishing by poison, 2 = Dynamite fishing, 3 = Increase in fishing effort, 4 = Natural variability, 5 = Seasonality 6 = Fishing by trawling, 7 = Law enforcement, 8 = Others (specify)

7.6 Change in catch composition with respect to the following common fish species?

	Fish species	**Kiswahili**	**status***	**reason****
1.	Sharks	Papa		
2.	Rays	Taa		
3.	Octopus	Pweza		
4.	Prawns	Kamba miti		
5.	Psattodes spp./Flat fishes	Gayogayo		
6.	Sardines/Anchovy	Dagaa		
7.	Nemipterus spp./Threadfins	Koana		
8.	Half beaks	Chuchunge		
9.	Parrot fish	Pono		
10.	Rabbit Fish	Tasi		
11.	Lethrinus	Changu		
12.	Kingfish	Nguru		
13.	Tuna	Jodari		
14.	Jacks	Kolekole		
15.	Rockods	Chewa		
16.	Silver biddy	Chaa		
17.	Mullet	Mkizi		
18.	Chanos chanos/Milk fish	Mwatiko		
19.	Rachycentron/Cobia	Songoro		
20.	Sword fish	Samsuli/Duaro		
21.	Lobsters	Kamba koche		
22.	Barracuda	Mzia		
23.	Wolf herring	Mkonge		
24.	Queen fishes	Pandu		
25.	Others (specify)			

*Code: 1 = Increase, 2 = Decrease, 3 = No change, 4 = Disappeared

**Code: 1 = Fishing by poison, 2 = Dynamite fishing, 3 = Increase in fishing effort, 4 = Natural variability, 5 = Fishing by trawling, 6 = Climate change, 7 = Others (specify)

7.7 In case there is change, how long have you noticed this? .....

Code: 1 = 2 years, 2 = 5 years, 3 = 10 years, 4 = More than 10 years

7.8 Do you think others, apart from you, have noticed the changing conditions? ...

Code: 1 = Yes, 2 = No

7.9 If yes explain

.....

7.10 How has this impacted the industry? .....

Code: 1 = Change in price, 2 = Unemployment, 3 = Others (specify) .....

7.11 What adaptation or mitigation options are you and others do to survive with the named changes?

.....

7 12 Do you have economic capital for your activity? .....

Code: 1 = Yes, 2 = No

7.13 What are your fishing gears?

	Type	Number	Condition: 1= New, 2 = Good, 3 = Poor	Ownership 1=Private, 2 = Hired, 3 = Group (share),4 = Others

7.14 Do your fishing gears provide you mobility and ability to fish in different waters and adverse weather conditions? .....

Code: 1 = yes , 2 = no

7.15 How many days in a month do you miss to fish due to bad weather e.g. storms and heavy rains? .....

7.16 Are there fishermen death cases due to bad weather? ……..

Code: 1 = yes , 2 = no

7.17 What is the death frequency as compared to the past 10 years? ……..

Code: 1 = Increasing, 2 = decreasing, 3 = No change

7.18 What might be possible reasons for the above answer? ……

7.19 Do you have any constrain in your fishing? ……..

Code: 1 = Yes, 2 = No

7.20 If yes mentioned them

……

SECTION 9: MANGROVES AND OTHER MARINE RESOURCES

9.1 What are the common mangroves species in this area?

	Species name	Abundance*	Status**	Reason***
1.	*Rhizophora mucronata* (**mkoko**)			
2.	*Avicennia marina* (**mchu**)			
3.	*Ceriops tagal* (**mkandaa**)			
4.	*Bruguiera gymnorrhiza* (**mshinzi**)			
5.	*Sonneratia alba* (**mpira**)			
6.	*Heritiera littoralis* (**mkungu** or **msikundazi**),			
7.	*Xylocarpus granatum* (**mkomafi**)			
8.	*Lumnitzera racemosa* (**mkandaa dume**).			

*Order of abundance within the area: i.e. 1 = Most abundant, 2 = Second abundant etc

**Code: 1 = Increased, 2 = Decrease, 3= No change, 4 = Disappeared

***Code: 1 = Deforestation by human, 2 = Climate change, 3 = Natural phenomenon

9.2 Which products/ services do you normally derive from the mangroves? .....

Code: 1 = Building poles, 2 = Timber, 3 = Logs for canoe making, 4 = Honey, 5 = Firewood, 6 = Charcoal, 7 = Other (Specify)

9.3 In your opinion how do you think people access mangroves products in this area? .....

Code: 1 = open access, 2 = by permit, 3 = Others

9.4 Are you able to access products from mangroves species mentioned above? .....

Code: 1 = Yes, 2 = No

9.5 If yes how? .....

Code: 1 = open access, 2 = by permit, 3 = Others?

9.6 For the last 10 years have you experienced change in stocking of tree species? .....

Code: 1 = Yes, 2 = No

9.7 How do you cope with the above changes?

.....

SECTION 10: SOURCE OF LIVELIHOOD, INCOME AND SOCIAL CAPITAL

10.1 What are your household's main livelihood activities?

SN	Livelihood activity	Rank[1]	Role[2]	Annual income (TAS)
1.	Farming			
2.	Fishing			
3.	Petty trading			
5.	Formal employment			
6.	Others			

[1]Order of importance: i.e. 1 = Most important, 2 = Second important etc.
[2] Code: 1 = Cash, 2 = Food, 3 = Both

10.2 Household membership to social association.

	Affiliation type	Code: 1=Yes 2 = No	**Name**	**Position 1=member 2=leader**	**Major activity**	**Major Benefit**
1.	Religion					
2.	Civil					
3.	NGO/CBO					
4.	Farmers					
5.	Fishermen					
6.	Others (specify)					

10.3 Have you ever obtained any credit facilities in the last six months? .....

Code: 1 = Yes, 2 = No

10.4 Explain the source of credit .....

Code: 1 = Government, 2 = Relatives and friends, 3 = Non-governmental organizations, 4 = Others (specify)

10.5 What form was the credit .....

Code: 1 = Asset Value, TAS ..... 2 = Cash, TAS .....

10.6 If you face problems (sickness, food shortage, floods etc.) and require support in terms of limited cash and/or kind, are you likely to get it from family and friends/neighbours? .....

Code: 1 = Never, 2 = Not often, 3= Sometimes, 4 = Often, 5 = Yes, always

10.7 What support did you receive from others? (Government, NGOs, etc.) .....

Code: 1 = Cash, 2 = Kind (food, firewood, clothes, etc), 3 = Labour, 4 = Others (specify).....

10.8 Do you have any friends or family members who live other than in this village? .....

Code: 1 = Yes, 2 = No

10.9 Have you ever obtained remittance from them? .....

Code: 1 = Yes, 2 = No

10.10 What are their income earning activities?

.....

SECTION 11: AWARENESS AND PERCEPTION TO CLIMATE CHANGE

11.1 From what source do you get weather related information? .....

Code: 1 = Radio, 2 = Newspapers, 3 = Television, 4 = Village leaders, 5 = Family members/friends, 6 = Internet, 7 = School curricula, 8 = None

11.2 Do you trust the source of information in predicting the future weather? .....

Code: 1 = Yes, 2 = No

11.3 Have you heard about climate change? .....

Code: 1 = Yes, 2 = No

11.4 If yes, how did you get to know climate related matters? .....

Code: 1 = Radio, 2 = Newspapers, 3 = Television, 4 = Village leaders, 5 = Family members/friends, 6 = Internet, 7 = School curricula

11.5 What do you think about the level of awareness of climate change in this neighborhood? .....

Code: 1 = None, 2 = High, 3 = Average, 4 = Low

11.6 What suggestion do you have to rectify this situation? .....

Code: 1 = Public education/seminar, 2 = Posters/handouts, 3 = Training program, 5 = village meeting, 6 = Other (specify)

11.7 Indications that weather has been changing over time.

(1) ..... rainfall has decreased

(2) ..... sea level has increased

(3) ..... fish landings has decreased

(4) ..... water and air temperatures has increased

(5) ..... upwelling patters has changed

(6) ..... river runoff has decreased

(7) ..... storms intensity has increased

(8) ..... frequency of floods has increased

(9) ..... salt water intrusion in shallow wells has increased

(10) ..... frequency of drought has increased

Codes: 1 = Strongly disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5 = Strongly agree

11.8 Awareness and household vulnerability to climate hazards in the area in the last 20 years

S/N	Climate hazards	If experienced by the HH (√)	A. Frequency of occurrence 12 = High 8 = Medium 4 = Low	B. Severity of the hazard 12 = High 8 = Medium 4 = Low	C. Degree of negative impact of the hazard to your HH 12 = High 8 = Medium 4 = Low	D. Difficulty in coping with this hazard 12 = High 8 = Medium 4 = Low	Total vulnerability [A+B+C+D]	*Coping strategy
1.	Storm surge							
2.	Coastal /beach erosion							
3.	Salt-water inundation							
4.	Flood							
5.	Climate-related land or mud slide							
6.	Bush fire caused by heat/dryness							
7.	Coastal level rise							
8.	Drought							
9.	Increased water surface temperature							
10.	Coral bleaching							
11.	Hotter weather							
12.	Cooler weather							
13.	Pest and diseases							

Coping strategies against the climate hazards

	Coping strategy against the climate hazards
1.	Migrating to other places
2.	Buying domestic water
3.	Reducing the size of farmland
4.	Occupation change
5.	Selling the assets
6.	Asking for relief food
7.	Trees replanting
8.	Changing the crops
9.	Planting short season crops/seeds
10.	Do nothing
11.	Others (specify) .....

11.9 With regard to governance and leadership at village level, kindly rate the following statements according to your level of agreement

(1) ..... Our community leaders have knowledge and skills to effectively lead us through climate change adaptation

(2) ..... Our community leaders inform us of national or regional climate change policy and initiatives

(3) ..... Our leader inform us where we can get climate related information

(4) ..... Our leaders can provide us with resources we need for climate change adaptation

(5) ..... My voice is heard in community planning for climate change adaptation

Codes: 1 = Strongly disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5 = Strongly agree

11.10 Vulnerability index for household level

		Score	Final score
	Material Vulnerability		
1	**Income source:** If dependent on a local level productive asset, e.g. fish, land and shop etc • Lower vulnerability score by 1 for every 10% of non-local income reported. • Subtract 2 if the income source is stable and insensitive to local hazard.	10	
2	**Education attainment:** If no member of the household is literate • Lower vulnerability score by 1 for every 5 years of schooling of most educated male member of the household. • Lower vulnerability score by 2 for every 5 years of schooling of most educated female member of the household.	5	
3	**Assets:** If none of the assets are immediately fungible, e.g. farm implements, household items. • Lower the score by 1 for every THS. of fungible assets e.g. tractor, animals, savings, jewelry.	10	
4	**Exposure:** Distance of the main house from the source of prime hazard, e.g. river, coastline, landslide zone. If it is 10 m from the source of hazard • Lower the score by 1 if the house is more than 10 m from the source. • Lower the score by 1 if the house has elements of hazard proofing, e.g. light construction or elevated foundation.	10	
	Institution Vulnerability		
5	**Social Networks:** If not membership of an association. E.g. professional, religious organization or civil association. • Lower vulnerability score by 2 for every instance of past assistance by a group /organization in adversity. • Lower by same number as per number of association providing assistance	10	

6	**Extra – local kinship ties:** If no extra local kinship or other ties, which could be source of shelter and assistance during adversity • Lower the score by 2 for every family member who live away from the village, with stable income and provide remittance • Lower the score by 1 for every family friend who live away from the village, with stable income and provide remittance	10	
	Infrastructure and healthcare		
7	Lack of an all weather road. Lack of electricity. Lack of clean drinking water and sanitation. Lack of robust telecommunications (mobile coverage). Lack of local medical facility (family health and nutrition).	5 3 6 5 6	
8	**Proportion of dependents in a household:** If a single parent headed household. • Lower the number by 1 for every family member who is able to work.	10	
9	**Information media** Lack of weather information media or information media system exists but people are not aware of it or don't trust.	10	
	Total Possible Vulnerability Score	**100**	

THANK YOU VERY MUCH FOR ANSWERING OUR QUESTIONS!

Do you have any question or additional statements that you would like to make?

Appendix 2: Checklist for Focus Group Discussion

Name of Informants: _____
Recorder: _____

Date: _____

1 Administrative information

1.1 a) Village Name: _____(b) Ward _____

1.2 c) Division _____ (d) District_____

2 Socio-economic information

2.1 What are the main activities for the residents' livelihood in this village?

2.2 Do the central and local governments provide subsidies to livestock keepers, farmers and fishermen?

2.3 What are these subsides if any?

2.4 What are the main sources of market for agricultural and fishery products?

2.5 What are the main production constraints do the farmers and fishermen face in this village?

2.6 Are there activities which are gender specific in this village? What are these activities and how practice them?

2.7 Do you have migration of people in this area? What is type of migration and what are possible reasons?

2.8 What are the ecological and socio-economic effects this migration?

3 Access and use of natural resources

3.1 Do you have land use plan in this village?

3.2 Has there been any change in land use and occupation in this village?

3.3 Have you experienced changes in natural resources stocks in this village? How do you compare the changes with the past 10 years? What might be possible reasons?

3.4 What kind of natural resources are accessible to the community of this village? Which resources are accessed freely by the locals in this village?

3.5 Do you derive products from mangroves? What are these products?

3.6 Do you have laws, bi laws or regulations which control or prevent the access to natural resources in this village? If yes explain?

3.7 Are women allowed to acquire land in this village? If Yes why, and if No why?

4 Weather/climate information

4.1 Where do you get weather/climate related information in this village?

4.2 Do you keep records of occurrence of climate related extreme events such as drought, floods, sea storms, pest and diseases eruption in this village?

4.3 Do you have death records of human and animals due to climate related extreme events?

4.4 How do you compare the intensity and frequency of the events with the past 10 years?