

## Climate Change Adaptation Series: Document 6

# LIVELIHOODS, CLIMATE AND NON-CLIMATE THREATS AND ADAPTATION: PANGANI DISTRICT COASTAL VILLAGES

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Prepared by the Pwani Project

In partnership with the Pangani District Council



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

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## **Foreword**

Climate change is a global issue posing challenges to the very survival of mankind and preventing sustainable development. The adverse potential impacts of climate change are now evident in Pangani District. Pangani District villages are exposed to climate change and non-climate related stresses. The impacts pose danger to livelihoods, social assets and the natural environment.

One of the visible impacts is on the economically important water sector. The Pangani river basin is already subject to competing uses of water for agriculture, power production and fresh water supply, depriving the lower river and estuary of necessary fresh water inflows. Drought and shifting rainfall patterns resulting from climate change and climate variability would affect the estuary and hydropower even further, while floods from more intense rainfall due to climate change would cause damage to hydropower stations and human settlements along the river basin.

This report seeks to understand the vulnerabilities specific to six coastal communities in the District with the view of providing guidance for planning directed at improving livelihood resilience and reducing vulnerability in communities to climate and non-climate stressors.

Pangani District appreciates the assistance of the University of Rhode Island's Pwani Project in carrying out this effort and invites village leaders in all Pangani villages to learn from the findings in this report.

Neneka Rashid

DISTRICT EXECUTIVE DIRECTOR

PANGANI DISTRICT COUNCIL.

## 1. INTRODUCTION

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

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

These climate and chemical threats and the problems they create are in addition to existing local stresses such as deforestation, over fishing, deterioration in water supply and quality, and development pressures.

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

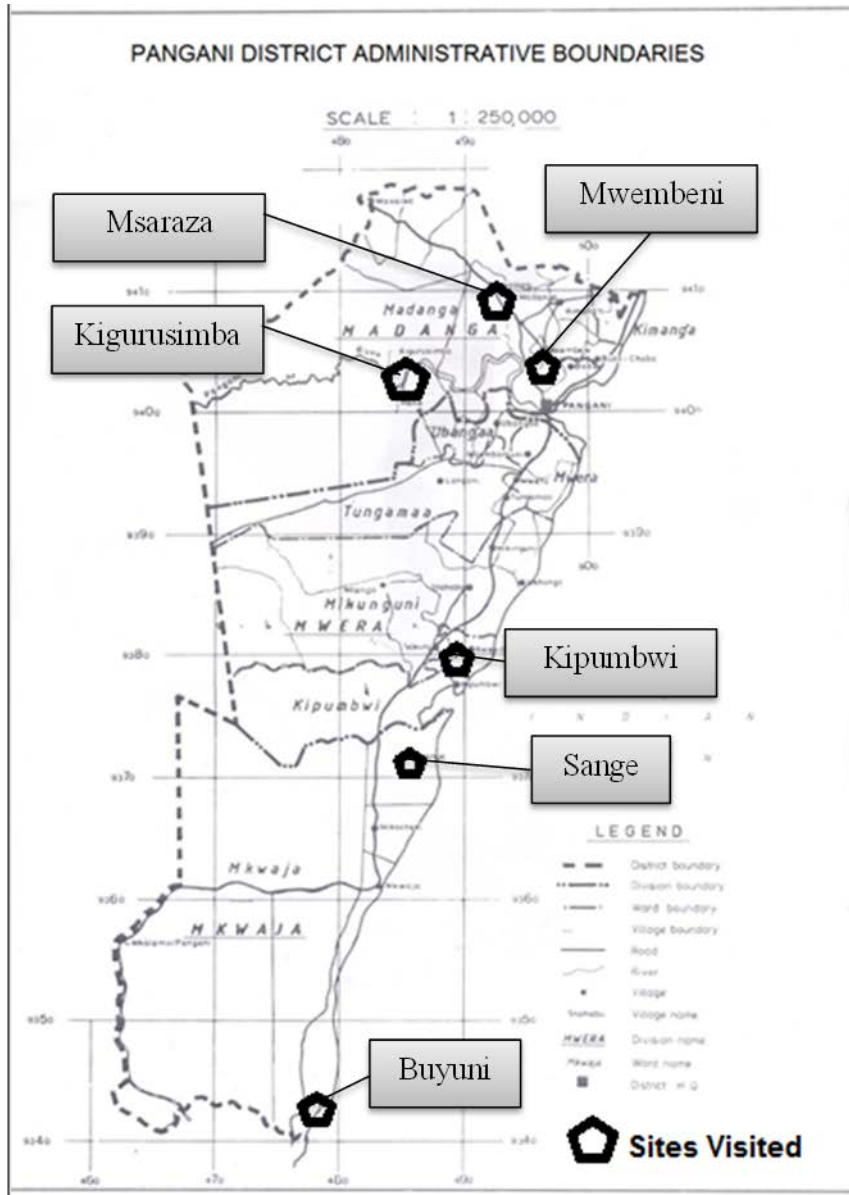
This report is an overview of climate and non-climate threats to livelihoods in 6 coastal communities in Pangani District (see Figure 2). Pangani is the smallest of the seven districts in Tanga Region. It is administratively divided into 4 divisions and 13 wards. It has a total of 33 villages, coastal and terrestrial combined, which all together have 95 sub villages (Appendix 1). Pangani District is one of the oldest districts on the coast of Tanzania. According to the 2002 census, the district has a population of 43,920.

The District headquarters are located in Pangani Town, the largest urban center. It has been an important port, commercial and administrative center at the mouth of the Pangani River since the arrival of Arab and Persian traders and during German colonial development in the 19<sup>th</sup> and early 20<sup>th</sup> century (Figure 1).



**Figure 1.** A Photo of Pangani Town in 1890. The town has now extended far back in the background forest. Was Pangani more climate resilient 100 years ago than it is today?

**Figure 2.** Map of Pangani District showing Divisions and Wards and Study Sites





## 2. VULNERABILITY ASSESSMENT METHODOLOGY

### Definitions

Climate Change	A shift in the pattern of weather averaged over time due to natural variability or because of human activity
Vulnerability	The degree to which a human or natural system is susceptible to, or unable to cope with, adverse effects of climate change. Vulnerability is a function of the types and amount of assets at risk (exposure), the degree to which those assets and people are impacted (sensitivity), and the ability to cope with actual or expected changes (adaptive capacity).
(Planned) Adaptation	Is a process of deliberate decision making to take societal actions in response to actual or expected climatic changes or their impacts, so as to reduce harm or exploit beneficial opportunities
Exposure	Refers to assets (land, infrastructure, human society) at risk to the impact of climate change
Sensitivity	The degree to which assets are sensitive to incurring negative impacts from climate change and climate variability
Adaptive capacity	The ability of society to change in a way that makes it better equipped to manage its exposure and/or sensitivity to climate influences. A community with the capacities to adapt is likely to be more resilient or able to recover from stressful events and conditions.

A Climate Change Task Force of nine members was formed from members of the Pangani District ICM Working Group and Pwani Project (Appendix 2). Prior to the field work, the Task Force collected information related to Pangani District from published sources (scientific literature, reports, articles, and papers) and from documents collected from different offices within the Pangani District Council (see Appendix 3). Detailed review of this information was carried out by the Task Force to explore climate change trends and impacts in Pangani District (Figure 3). The team also conducted a focus group interview with other District staff and stakeholders from different institutions and organizations in Pangani District.





**Figure 3.** Climate Change Task Force team at Pangani District Council during the process of literature review and discussion

Visits, observations, and discussions with key informants were made by the Task Force to 6 representative coastal villages (three riverine coastal villages and three villages with shoreline on the Indian Ocean) (Figure 4). Representative villages in riverine ecosystems:

- Kigurusimba
- Mzaraza
- Mwembeni

Representative villages in shoreline, coastal ecosystems:

- Sange
- Kipumbwi
- Buyuni



**Figure 4.** Members of the Climate Change Task Force team getting information from key informants from Mwembeni (A) and Sange (B) villages, respectively

### **3. CLIMATE CHANGE TRENDS AND PROJECTIONS**

The overall projections from climate models for coastal Tanzania are that surface water temperature and ambient air temperature will rise, sea level will rise (from the thermal expansion of the sea), the sea will become more acidic from carbon sequestered in the sea which then forms carbonic acid, and areas with bimodal rainfall patterns (e.g. Pangani) will experience increased rainfall and less predictable seasonality and temporal distribution of precipitation. The effects of these precipitation and seasonality changes are both flooding and droughts.

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

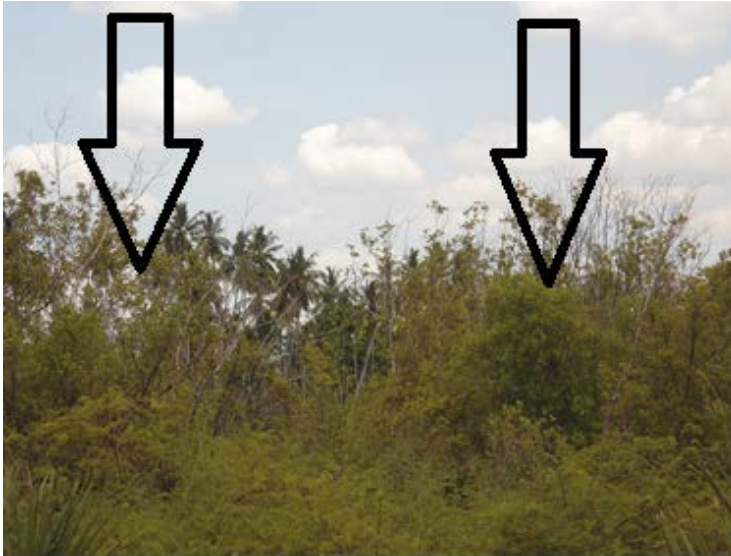
### **4. LIVELIHOODS, CLIMATE AND NON-CLIMATE THREATS, AND ADAPTATION: RIVERINE ECOSYSTEMS**

Riverine ecosystems in the Pangani area are observed to be exposed to climate and non-climate changes, affecting the natural ecosystem upon which most livelihoods in rural areas depend. Adaptive capacity is low in all of the communities due to poverty and the degradation or depletion of ecological services and natural resources.

The three riverine villages have very similar climate and non-climate threats and consequences to livelihoods. These include reduced fresh water fish catch, less productive pasture and livestock productivity, reduced abundance of the palm leaves used to produce mats, and less productive crop agriculture, and die-out of coconut trees due to disease.

The fresh water stream at Kigurusimba village which is the main source of water to rice farms has been affected by sea water intrusion, permitting mangrove (*Avicenia marina*) to grow (Figure 5) where rice was once cultivated. The inland intrusion of salt water may be the result of reduced freshwater flows in the Pangani River partly due to climate change induced reductions in precipitation. The same area has been invaded by pastoralists with their cattle, leading to serious environmental degradation (Figure 6).

The communities within the riverine ecosystem depend mostly on agricultural activities where the main cash crop is coconut. This crop is now facing a very serious problem from a viral disease which infects the upper growing shoot of the plant, drying out and killing the tree, as seen in Mwembeni village (Figure 7).



**Figure 5.** Mangrove trees (*Avicenia marina*) growing in a formerly freshwater stream connected to the Pangani River at Kigurusimba village, approximately 21 km upstream from the Indian Ocean. Reduced freshwater flows, due in part to reduced precipitation in the water basin from climate change, are thought to be the cause of salt water intrusion.



**Figure 6.** A freshwater stream at Kigurusimba village with serious erosion as a result of cattle trampling





**Figure 7.** A coconut farm at Mwembeni village showing diseased and dead upper shoots as a result of a new viral disease. Drought, heat, saline soil may stress vegetation and contribute to this disease

**Table 1.** Livelihoods, climate and non-climate threats, and coping actions - Kigurusimba

Village	Existing livelihood activities	Perceived climate and non-climate Impacts	Potential climate related threats	Non-climate threats	Existing adaptation actions and adaptive capacities to cope with threats	Additional potential small, do-able adaptation actions
Kigurusimba	Fishing and fish processing (frying)	Significant decline in fresh water fish catch and change in species composition (more marine species)	By the river, <i>Avicennia marina</i> mangroves are now found. This is a sign of inland saline water intrusion that may be the result of reduced freshwater flows in the Pangani partly due to climate change	Increased fishing effort, and illegal and destructive fishing	Protein source from milk and meat  Strong local government  conflict reduction  Water supply is from the Pangani river  Land use plan  The village has a dispensary and primary school	Possible aquaculture opportunity using brackish water species
	Small business (shops)	Increased number of food vendors (“Mama Lishe”)	None	Growing number of pastoralist immigrants		Build a livestock auction center in order to increase local government revenue
	Small scale livestock keeping (chickens, ducks, goats, cows, and sheep) and pastoralism	Reduced grazing grass quality and productivity due to drought	Changing rainfall patterns, drought and increased temperatures	Large number of livestock due to migrating pastoralists		Construct a slaughter house  Research on why cattle and goats are becoming smaller
		Reduced livestock feeding appetite and decreased size of cattle and goats	Changing rainfall patterns, drought and increased temperatures	Large number of livestock due to migrating pastoralists		
		Decreased value and quality of pasture due to overgrazing, drought and serious soil erosion	Changing rainfall patterns, drought and increased temperatures	Large number of livestock due to migrating pastoralists		
Mat making from Ukindu (a species of palm found in lowland areas)	Decline in abundance of mat making raw material (“ukindu”)	Saline water intrusion kills the palm tree	Livestock from migrating ppastoralists forage the material			

Village	Existing livelihood activities	Perceived climate and non-climate Impacts	Potential climate related threats	Non-climate threats	Existing adaptation actions and adaptive capacities to cope with threats	Additional potential small, do-able adaptation actions
	Agriculture (coconut collection, rice, sesame (sim sim), cassava, sweet potatoes, cow peas, areca nuts (Popoo))	Viral disease that affects the upper shoot of old coconut trees	The disease may be related to climate change and climate variability	None		
		Salt water intrusion in rice paddies	Reduced fresh water flow of the Pangani river	None		
		Reduced overall agricultural harvest	Unpredictable rainfall patterns and more droughts and flooding events	None		
		Washing away of crops	Rainfall events causing flooding	None		

**Table 2.** Livelihoods, climate and non-climate threats, and coping actions – Mwembeni

Village	Existing livelihood activities	Perceived climate and non-climate Impacts	Potential climate related threats	Non-climate threats	Existing adaptation actions and adaptive capacities to cope with threats	Additional potential small, do-able adaptation actions
Mwembeni	Fishing	Significant decline in fresh water fish catch and change in species composition (more marine species)	River's inland saline water intrusion may be the result of reduced freshwater flows due to climate change	Increased fishing effort, and illegal and destructive fishing	Protein source from milk and meat, ensures food security	Use of early maturing, drought resistant crop and tree varieties  Improved grafting and budding technologies for oranges and mangoes
	Small business (shops and milling machine)	None	None	None	Local leadership is environmentally aware	
	Subsistence livestock keeping (chicken, duck, goats, cattle and sheep)	Reduced grazing grass quality and productivity due to drought  Decreased size of cattle and goats  Decreased value and quality of pasture due to drought	Changing rainfall patterns, drought and increased temperatures	None	Water supply from piped water and river  Village has a dispensary and primary school	



Village	Existing livelihood activities	Perceived climate and non-climate Impacts	Potential climate related threats	Non-climate threats	Existing adaptation actions and adaptive capacities to cope with threats	Additional potential small, do-able adaptation actions
		Reduced animal appetite due to higher ambient air temperatures			Growing of cowpeas, cassava, self-budding orange and grafted mango trees	
	Mat making from Ukindu (a species of palm found in lowland areas)	Decline in abundance of the mat making material	Saline water intrusion kills the palm tree	Large number of cattle from migrating pastoralists		
	Agriculture (coconut, rice, cassava, sweet potatoes, cow peas, oranges) and beekeeping	Viral disease affects the upper shoots of old coconut trees	The disease may be related to climate change	None		
Unreliable rainfall for overall agriculture		Unreliable and reduced annual rainfall	None			
		Saline water intrusion in rice paddies				
		Washing away of riparian vegetables and crops during fresh				

Village	Existing livelihood activities	Perceived climate and non-climate Impacts	Potential climate related threats	Non-climate threats	Existing adaptation actions and adaptive capacities to cope with threats	Additional potential small, do-able adaptation actions
		<p>water floods</p> <p>Reduced rain fed agricultural output</p>				

**Table 3.** Livelihoods, climate and non-climate threats, and coping actions – Mzaraza

Village	Existing livelihood activities	Perceived climate and non-climate Impacts	Potential climate related threats	Non-climate threats	Existing adaptation actions and adaptive capacities to cope with threats	Additional potential small, do-able adaptation actions
Msaraza	Fishing	Significant decline in fresh water fish catch and change in species composition (more marine species)	River's inland saline water intrusion may be the result of reduced freshwater flows due to climate change	Growing level of fishing effort due to population increase, and illegal and destructive fishing	Protein source from milk and meat  Water supply from piped water and river	Possible aquaculture opportunity using brackish water species
	Small business (shops and milling machine)	None	None	None	Land use plan	
	Small scale livestock keeping (chicken, duck, goats, cows and sheep) and pastoralism	Reduced grazing grass quality due to drought	Shift of rainfall patterns and increased temperature regime affecting productivity and quality of grass	Large number of cattle from migrating pastoralists	The village has a dispensary, and primary and secondary schools  Growing of cowpeas, cassava, orange trees	
	Mat making from Ukindu (a species of	Decline in Ukindu due to saline water	Saline water intrusion kills the	Overstocking from migrating		

Village	Existing livelihood activities	Perceived climate and non-climate Impacts	Potential climate related threats	Non-climate threats	Existing adaptation actions and adaptive capacities to cope with threats	Additional potential small, do-able adaptation actions
	palm found in lowland areas)	intrusion	palm tree	Pastoralists	Shifting of some fishers partly or wholly to agriculture activities  Introduction of upland irrigation schemes	
	Agriculture (coconut, rice, cassava, sweet potatoes, cow peace, oranges and beekeeping)	Viral disease that kills the upper shoots of coconut trees	The disease may be related to climate change and climate variability	None		
		Reduced rain fed agricultural output (rice)	Unreliable and reduced annual rainfall	None		
		Washing away of riparian vegetables and crops during fresh water floods	More severe rainfall events and flooding	None		

## 5. LIVELIHOODS, CLIMATE AND NON-CLIMATE THREATS, AND COPING: COASTLINE ECOSYSTEMS

Climate and non-climate threats in shoreline coastal villages are similar to those of coastal, riverine villages, but the decline in marine fisheries and reduced abundance, and shoreline erosion are more vivid. There are many causes of erosion and accretion, and sea level rise and higher wind/more severe rain storms due to climate change, are not the only culprits. Natural processes, nearshore development and habitat change, coral reef destruction, mangrove and seagrass destruction are the primary causes of erosion, but climate change exacerbates these other causes.

Whatever is the main culprit, the impacts of erosion can be very costly. The photo below shows a section of sea wall that eroded in historic Pangani town at the mouth of the Pangani River, which resulted in the collapse of nearby homes (Figure 8).



**Figure 8.** Photo of Pangani river wall near UZIKWASA Office, March 2012

The location of the eroded sea wall would be located in the historic photo in Figure 1 above. What was once a white beach riverfront is now experiencing high tide waves so high and strong that the water flows into the streets.

The entire shoreline of Pangani district has severe beach erosion, which in a village like Buyuni has put the sea now very close to residential houses (Figure 9).



**Figure 9.** Beach erosion in Buyuni Village

Strong winds, waves, and sea level rise have wiped out some residential houses in Buyuni, and changed beach landscape vegetation cover (Figure 10). In Sange village, coconut farms not long ago far from the shore are not on the tidal zone (Figure 11).





**Figure 10.** This tidal pool at Buyuni was once covered with vegetation. Natural processes, climate and non-climate stressors are probably all at play



**Figure 11.** A coconut farm at Sange village believed to have been more than 50 meters away from the sea in the 1970s, is now at the edge of the tidal zone. Likely a consequence of mainly non-climate stressors, but sea level rise makes such erosion worse.



**Table 4.** Livelihoods, climate and non-climate threats, and coping actions - Buyuni

Village	Existing livelihood activities	Perceived climate and non-climate Impacts	Potential climate related threats	Non-climate threats	Existing adaptation actions and adaptive capacities to cope with threats	Additional potential small, do-able adaptation actions
Buyuni	Fishing and fish processing (salt and sun drying)	Significant decline in fish catch and serious beach erosion at landing site	Sea surface temperature rise may change fish distribution, seasonality, reproduction patterns and health	Overfishing and destructive fishing (e.g. beach seine and dynamite fishing)	A land use plan to a new village site will reduce sensitivity to climate change impacts	Vegetable pot gardening
	Small business (kiosk)	None	None	None		Replanting “myaa” to stabilize the beach
	Subsistence livestock keeping (chicken and goats)	None	None	None		Mangrove replanting
	Mat making from the leaves of the palm tree <i>Hyphaena spp.</i> “myaa”	Reduced abundance of raw material	Saline water intrusion affects its growth	Wild animals forage the material and increased village population increases resource users		

Village	Existing livelihood activities	Perceived climate and non-climate Impacts	Potential climate related threats	Non-climate threats	Existing adaptation actions and adaptive capacities to cope with threats	Additional potential small, do-able adaptation actions
	Salt making	Unpredictable weather patterns for solar drying	Changing seasonality of rainy seasons	None		
	Agriculture (coconut)	Viral disease that kills the upper shoots of coconut trees	The disease may be related to climate change and variability	None		
		Elephants attack crops during the dry season.	Decreased amount of fodder during dry season due to climate change related droughts	Possible increased elephant population in SANAPA or migration		
		Serious beach erosion, washing out coconut trees	Sea level rise and/or increased wind speed driving erosion	Development and habitat change close to shoreline		

**Table 5.** Livelihoods, climate and non-climate threats, and coping actions - Sange

Village	Existing livelihood activities	Perceived climate and non-climate Impacts	Potential climate related threats	Non-climate threats	Existing adaptation actions and adaptive capacities to cope with threats	Additional potential small, do-able adaptation actions
Sange	Fishing and fish processing (frying)	Significant decline in fish catch	Sea surface temperature rise may change fish distribution, seasonality, reproduction patterns and health	Overfishing and destructive fishing (e.g. beach seine and dynamite fishing)	Water source is shallow wells Village has a land use management plan Village has a dispensary and primary school	Mangrove replanting
	Small business (shops)	None	None	None	The community has knowledge about sea turtle conservation (potential for ecotourism)	
	Subsistence livestock keeping (goats, cattle, sheep, and chickens)	Reduced grazing grass quality	Changed rainfall patterns have affected grass productivity and quality	Too many cattle due to herds of migrating pastoralists	The village grows drought resistant crops( e.g. sesame, cassava and sweet potatoes)	
	Local mat making from Hyphaena	Reduced abundance of raw material	Saline water intrusion affects its growth	Expanding agriculture and pastoralists migrating to this area		

Village	Existing livelihood activities	Perceived climate and non-climate Impacts	Potential climate related threats	Non-climate threats	Existing adaptation actions and adaptive capacities to cope with threats	Additional potential small, do-able adaptation actions
	<i>spp.</i> “miyaa”					
	Bee keeping in mangrove areas	Decreased honey production because bees spend more time in fanning juvenile bees than foraging and good forage from flowering plants is now more unpredictable	Warming and changes in precipitation patterns may reduce the productivity of bee foraging areas	Salt making is by boiling which encourages mangrove deforestation affecting flowering pattern. Flowering pattern affects honey production		
	Salt making	None	None	None		
	Agriculture (coconut, rice, sesame (simsim), cassava, cashew nuts, and sweet potatoes)	Viral disease that kills the upper shoots of coconut trees	The disease may be related to climate change and climate variability	None		
		Unreliable rainfall affecting rice production	reduced and shifting rainfall patterns			
		Destruction of land suitable for agriculture in search for food and water	Saline water intrusion, creating saline soils	Migrating pastoralists in search for food and water		
Elephants attack during dry season		None	Possible increased elephant population in the park or migration			

**Table 6.** Livelihoods, climate and non-climate threats, and coping actions – Kipumbwi

Village	Existing livelihood activities	Perceived climate and non-climate Impacts	Potential climate related threats	Non-climate threats	Existing adaptation actions and adaptive capacities to cope with threats	Additional potential small, do-able adaptation actions
Kipumbwi	Fishing, processing and storage (freezing, frying)	Fish catch	Sea surface temperature rise may change fish distribution, seasonality, health and reproduction patterns	Dynamite fishing from neighboring villages	Water supply from water taps (faucets) and wells	<p>Mangrove replanting-Environment committee and school children to ensure sustainability</p> <p>Promote sea turtle ecotourism</p> <p>Promote possible drought resistant crops</p> <p>Monitor illegal cutting and exportation of mangroves</p>
	Crab fattening	Weather and tidal variability at the Mafreta river	Fluctuating and unpredictable rainfall, wind and seasonality	None	The village has a dispensary and primary school	
	Small business (shops and small scale hotels: “Mama Lishe”)	None	None	None	The community has knowledge about sea turtle conservation (potential for ecotourism)	
	Boat making	None	None	None		
	Marine transportation	Increased wind speed and wave strength	Increased wind speed may be associated with climate change	None	MACEMP project provided boats and engines for fishing further off shore	
	Subsistence livestock keeping (chicken, dairy, and goats)	Food and forage				
	Local mat making from Hyphaena	Reduced abundance of	Saline water intrusion affects its growth	Population increase and expanding	Corals and mangroves in good condition, increasing fishing	

Village	Existing livelihood activities	Perceived climate and non-climate Impacts	Potential climate related threats	Non-climate threats	Existing adaptation actions and adaptive capacities to cope with threats	Additional potential small, do-able adaptation actions
	<i>spp.</i> “miyaa”	raw material		agriculture	livelihood resilience	
	Seaweed farming	Unpredictable weather patterns Failed farms when beach seiners trample on seaweed lines	More intense rainfall events, drought and more unpredictable seasonality may be caused by climate change	Beach seining conflicts with seaweed farm space	The District initiated an irrigation scheme for vegetables and rice	
	Beekeeping	Bee forage from flowering plant is more unpredictable	Warming and changes in precipitation patterns may reduce the productivity of bee foraging areas	None	Business opportunities due of the existing local port to Zanzibar and other places along the coast	
	Agriculture	Viral disease that kills the upper shoots of coconut trees	The disease may be related to climate change and variability	None		
		Elephants attack and unreliable rainfall for rice production	None	Possible increased elephant population in the park or migration		

## **6. CONCLUDING COMMENTS**

Livelihoods are limited, vulnerable and almost entirely based on natural resources that are being degraded by climate and non-climate threats. The types of livelihoods and threats are very similar across the riverine coastal sites, and the beach front coastal sites. Some differences are that the non-climate stress of pastoralists is degrading pasture, eroding river banks, and other natural resource degradation. On the coastal strip, the effects of erosion are significantly being felt. Some adaptations have been made (e.g. planting more drought and heat resistant crops) but there was little evidence of district wide or village based long term adaptation planning. There are many actions that can be taken, even on a small budget. The similarity of the issues in the villages also suggests that cross-village exchanges on adaptation actions, results and lessons learned would be helpful.



## REFERENCES

- Adaptive Learning Mechanism. (2009) Mainstreaming Climate Change in Integrated Water Resources Management in Pangani River Basin – Tanzania.  
[http://www.adaptationlearning.net/projects/tanzania\\_pangani](http://www.adaptationlearning.net/projects/tanzania_pangani)
- Agrawala, S., Moehner, A., Hemp, A., van Aalst, M., Hitz, S., Smith, J., Meena, H., Mwakifwamba, S., Hyera T., and Mwaipopo, O. (2003). “Development and climate change in Tanzania: focus on Mount Kilimanjaro.” Environment Directorate and Development Co-operation Directorate, Working Group on Global and Structural Policies, Working Group on Development Co-operation and Environment, Organization for Economic Cooperation and Development, COM/ENV/EPOC/DCD/DAC (2003) 5/FINAL, 72 pp.
- Batchelor, C., A. Singh, M.S. Rama Rao and J. Butterworth. (2005). Mitigating the potential unintended impacts of water harvesting.  
<http://www.nri.org/projects/WSSIWRM/Reports/water%20harvesting%20impacts.pdf>
- Gideon, M. (2012) Mabadiliko ya Tabia Nchi Ni Tishio Kwa Usalama wa Chakula. Na Marko Gideon, Thursday, March 01, 2012, Inter Press Service News Agency, Tanzania
- Makoye, K. (2012) Tanzania: Rising Tides Threaten Coastal Towns, by Kizito Makoye, 23 March 2012, Alert Thomson Reuters Foundation - Fri, 23 Mar 2012 10:53 AM  
<http://www.trust.org/item/20120323105300-ri0p6/?source=search>
- Mfugale, D. (2011) “Rising sea levels threaten safety of Pangani residents.” By Correspondent Deodatus Mfugale, 14th February 2011. Daily News, Online Edition.
- National Bureau of Statistics and Tanga Regional Commissioner’s Office. (2008) Tanga Regional Socio-Economic Profile. Ministry of Planning, Economy and Empowerment, Dar es Salaam, Second Edition, 140 pp.
- Pangani Water Basin Office (PWBO) and International Union for the Conservation of Nature (IUCN). (2010). Climate change modelling for the Pangani Basin to support the IWRM planning process. Pangani River Basin Flow Assessment. Pangani Basin Water Board, Moshi and IUCN Eastern and Southern Africa Regional Programme. V+36 pp.
- Turall, H., Burke, J. and Faurès, J. (2001). Climate change, water and food security. United Nations Food and Agriculture Organization (FAO) Land and Water Division.  
<http://www.fao.org/docrep/014/i2096e/i2096e.pdf>
- United Republic of Tanzania (2009). Preparing for the REDD initiative in Tanzania: A synthesized consultative report for REDD task force in Tanzania. <http://www.reddtz.org/> .
- United Republic of Tanzania (2007). National Adaptation Programme of Action (NAPA), Vice President’s Office, Division of Environment, 52 pp.

## APPENDICES

### Appendix 1: Villages in Pangani District with associated Divisions, Wards and sub-villages

DIVISION	WARD	VILLAGE	SUB-VILLAGE
Mkwaja	1 Mkwaja	1 Mkwaja	1 Mkwaja Kijijini 2 Mkwaja Juu
		2 Sange	3 Sange Kijijini 4 Sange Kuu 5 Makorora
		3 Mikocheni	6 Mikocheni Kijijini 7 Mbugani 8 Shirikishoni, 9 Mkwaja Ranchi
		4 Buyuni	10 Buyuni Kuu 11 Kitopeni
	2 Mkalamo	5 Mkalamo	12 Mtakuja 13 Chamwino 14 Boza 15 Mhungura 16 Sokoni
		6 Mbulizaga	17 Mbulizaga
Mwera	3 Kipumbwi	7 Kwakibuyu	18 Kwakibuyu 19 Mkoko 20 Sakura Estate
		8 Kipumbwi	21 Kipumbwi Mji Mpya 22 Serewani 23 Kipumbwi Mtoni 24 Kipumbwi Mji Mkuu
	4 Mwera	9 Mwera	25 Mwera Estate 26 Mwera Kijijini 27 Mwera Kombania
		10 Mzambarauni	28 Mzambarauni 29 Bojo 30 Putini
		11 Ushongo	31 Ushongo Mtoni 32 Ushono Mabaoni

	5 Tungamaa	12 Langoni	33 Langoni 34 Makarawe 35 Kirupu 36 Mahazara
		13 Tungamaa	37 Tungamaa 38 Kasanga
	6 Ubangaa	14 Ubangaa	39 Ubangaa 40 Kibinda
		15 Meka	41 Meka 42 Mafisi
		16 Mkwajuni	43 Mkwajuni 44 Mshine ya Maji
		17 Mseko	45 Mseko 46 Mahazara
	7 Mikinguni	18 Mikinguni	47 Kwa Fakii 48 Kwa Mkwaju
		19 Mtango	49 Mtango 'A', 50 Mtango 'B' 51 Mtango 'C'
		20 Stahabu	52 Stahabu Pwani 53 Jasini 54 Stah, Azimio 55 Mkiziga
		21 Mtonga	56 Mtonga
Pangani	8 Pangani East	22 Pangani East	57 Funguni 58 Malindi 59 Mkoma 60 Gombero
	9 Pangani West	23 Pangani West	61 Sokoni 62 Kumba 63 Kinarani
	10 Bweni	24 Bweni	64 Bweni 65 Kikokwe 66 Mashado
Madanga	11 Madanga	25 Madanga	67 Barabarani 68 Ng'ambo 69 Barabara ya Pangani

		26 Jaira	70 Jaira, 71 Kidutani
		27 Mwembeni	72 Miti Ulaya 73 Makuyuni 74 Mwembeni
	12 Bushiri	28 Masaika	75 Masaika 76 Kilimani 77 Masaika Bondeni 78 Masaika Godown
		29 Kigurusimba	79 Pombwe 80 Misufini 81 Kijiweni 82 Mrozo
		30 Mivumoni	83 Mivumoni 84 Kovukovu
		31 Msaraza	85 Bushiri Estate 86 Matakani/Jasini 87 Sahanini 88 Msaraza
	13 Kimang'a	32 Kimang'a	89 Kimang'a 'A' 90 Kimang'a 'B' 91 Mbuyuni
		33 Boza	92 Boza 93 Choba 94 Kibaazi 95 Mnazi mmoja

## Appendix 2: Pangani Assessment Team Members

Name	Title
Mr. Jairos Mahenge	TCMP-Pwani Project Deputy Director
Mr. Wilbard Mkama	TCMP-Pwani Project Officer
Ms. Joyce G. Bwindiki	District Beekeeping Officer and Climate Change Task Force Secretary
Mr. Hassan A. Mzungu	Livestock Field Offer, Range Management
Mr. Archie John Mntambo	Livestock Officer MACEMP Coordinator
Mr. Martin M. Nekwa	Community Development Officer, Integrity Coordinator, and Climate Change Task Force Chair
Dr. Ole Sepere	Medical Doctor
Mr. Daudi Mlahagwa	Community Development Officer, TASAF Coordinator
Ms. Frida Urio	District Agricultural Officer and Pangani District ICM facilitator