Climate Change Impacts on Coastal Resources Used as Tourist Attractions and Vulnerability of Coastal Tourism: A Case of Bagamoyo District, Tanzania

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ABSTRACT

Tourism is one of the fastest growing sectors of the economy in Tanzania. This study was conducted to assess the climate change impacts on coastal tourism along the coast of Tanzania focusing on Bagamoyo District. Specifically, the study aimed at identifying climate change impacts on coastal resources that are used as tourist attractions, the vulnerability of coastal tourism and it is adapted to impacts. Data collection methods include Geographical Information System and remote sensing, key informants and household interviews, participant observation as well as review of secondary data sources. The results from the analysis of rainfall data from 1950-2007 showed that the rainfall availability trend declined by about 23 percent *from about 1100 mm in the 1950s to 850 mm in 2007. This was mainly associated with variations and changing patterns. The mean maximum and minimum temperature increased by approximately 0.5°C and 2°C respectively, whereas the average annual temperature increased by 1°C from 1978 to 2008, causing discomfort to tourists as well as local communities. The impacts such as sea level rise and coastal erosion are evident, causing destruction of infrastructures such as hotels, cultural, historical, and archaeological sites, and sea walls and seawater intrusion into hotels compounds. The occurrences of climate-related diseases such as malaria, dysentery, and skin rashes were common, posing a threat to coastal tourism activities. Generally, incidences related to climate change are increasing and have impacts on coastal tourism. Thus, emphasis should be on adaptation measures, enforcement of institutional capacity building and policy, including proactive forward planning on coastal management, enhancing public awareness on climate change impacts among the coastal communities, tourism stakeholders, private sectors, and government officials in the affected areas.*

Key words: *Climate change, Coastal tourism, Adaptation, Tanzania*

1. INTRODUCTION

Climate change is one of the main global issues of the 21st century, and which will severely affect the world at various levels. The average global surface temperature is reported to have warmed by 0.8°C in the past century and 0.6°C in the past four decades (Hansen et al., 2006). Globally, climate change and the rise of sea level together will expose many coasts to increasing risks, including coastal erosion and inundation (IPCC, 2007). Climate change places tourism at risk, particularly in the coastal zones and mountain regions. The economic benefits of tourism in Africa, which accounts for about 3 percent of the worldwide tourism, may change with the change of climate. Although scientific evidence is still limited, it is probable that destruction of tourist infrastructures such as hotels, recreational facilities, beaches erosion, flood risks, and water-pollution-related diseases in low-lying coastal regions, as well as coral reef bleaching would have a negative impact on tourism.

Tanzania has an area of 945,000 km^2, which includes the three coastal islands of Mafia, Pemba, and Zanzibar, and a coastline that is about 800 km long (Agrawala *et al.,* 2003). The coastal area covers about 15 percent of the total land area and supports approximately 25 percent of the population of Tanzania. The coast is characterized by a wide diversity of habitats including coral reefs, sea-grass beds, and mangrove forests, which support a wide variety of living organisms and various economic activities such as tourism, fisheries and agriculture (Kairu and Nyandwi, 2000).

Tourism is one of the fastest growing sectors of the economy in Tanzania. For the past few decades, the sector has grown steadily and has contributed significantly to nature conservation, economic development, and poverty reduction in rural and remote areas where it is carried out (URT, 2004). Apparently, the coastal areas of Bagamoyo District have also become an important area for tourist activities. The main attractions in Bagamoyo coastal areas include cultural and natural attractions ranging from wildlife, white sandy beaches, mangrove forests, geological formations, or other natural resources that could be of interest to tourists. Bagamoyo District is blessed with an amazing historical and cultural heritage and was recently designated a United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Heritage Site (UN, 2009; Mkama et al., 2013). Bagamoyo has developed beach hotels that attract many visitors and tourists from Dar es Salaam and beyond.

However, the fact that most of the facilities are within 60 meters of the highest tidal mark, makes them vulnerable to the impacts of climate change such coastal erosion and storm surges associated with the rise of sea level. Cultural attractions include historical and archaeological sites such as Kaole ruins, which were built in the 13th century, the ancient German architecture (German BOMA built in 1897), and Old harbour and Customs House (1895). Others include, the first church in East Africa (1868), the first multi-racial school in Tanganyika (1898) and the Arab Fort, performing arts, traditional lifestyles and other cultural or human resource that could be of interest to tourism (TCMP, 2001). Other attractions include man made features such as magnificent beach hotels and other structures established for tourism purposes that contribute significantly to the national economy (Toroka, 2003).

Despite the diversity of the tourist resources that can be used for coastal tourism, more understanding is needed on how these resources have been impacted by climate change, how vulnerable such resources are, and how coastal tourism is likely to perform in the midst of the changing climate. This study is particularly necessary now given the growing importance of coastal tourism in general and the fact that Bagamoyo District has become an important tourist destination along the western coastline of the Indian Ocean (Mkama et al., 2013). This study was conducted to assess the impacts of climate change on coastal tourism along the coast of Tanzania focusing on Bagamoyo District. Specifically, the study aimed at identifying climate change impacts on coastal resources that are used as tourist attractions, the vulnerability of coastal tourism and adaptation associated with climate change impacts.

2. METHODOLOGY

This study was conducted in two villages in Bagamoyo District namely, Dunda and Kaole (Figure 1) in Dunda Ward. Bagamoyo is located at 6°26′S 38°54′E. It lies 65 km north of Dar es Salaam on the western coast of the Indian Ocean. The District covers an area of 9,842 km^2. About 855 km^2 are covered by water (Ocean and Rivers) while the remaining part is occupied by dry lands. Bagamoyo District was selected for the study due to its cultural and historical background, as well as its large coastal tourism activities taking place in the district.

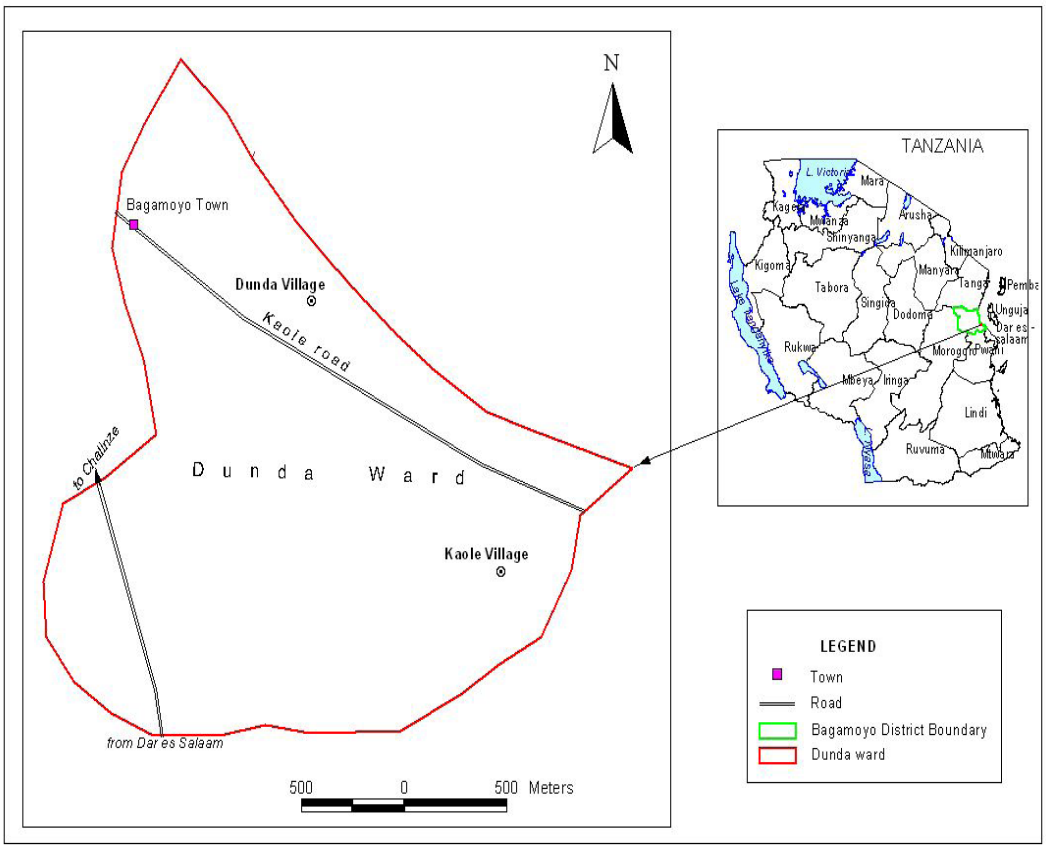

Figure 1*: Map of Dunda Ward showing location of study areas. The Insert shows the location of Bagamoyo district within Tanzania.*

Source: *IRA GIS Lab*

Climatically, Bagamoyo is more or less the same as the rest of the coastal areas of Tanzania mainland, which are hot, humid, and tropical in general (URT, 2006). Bagamoyo District experiences moderately high temperature 32°C and humidity of as high as 98 percent. The district has two main rainy seasons with the average annual rainfall ranging from 800 to 1200mm. The first season, which is the main rainy season, is characterized by long rains (*masika*) which lasts for three months beginning from March to May. The second season is called short rainy season (*vuli*) and lasts for four months beginning from October to January each year. Sea surface temperatures exhibit seasonality that is influenced by changes in the water masses of the Indian Ocean and climate factors (URT, 2006). The seasonality experienced in the area is among the factors influencing tourism-related activities in the area,

such as beach erosion and inundation of tourist facilities. Among the examples of tourism-related activities is the rain-fed crop production where most crops are grown during the more dependable long rainy season (masika). This is because the short (vuli) rains have increasingly become irregular and although farmers make use of the rains opportunistically to grow second season crops such as maize or cowpeas. However, the outcome is not reliable (URT, 2015). Thus, any variation in climatic patterns may have significant impacts on food production causing subsequent decline in supply of such products.

Data collection for the study used GIS and remote sensing, key informants and household interviews and participant observation. Both secondary and primary data were collected in order to complement each other and to enhance accuracy of information collected as a way of triangulation. Secondary sources included rainfall and temperature data obtained from Tanzania Meteorological Agency (TMA), and other relevant sources. Primary data were collected using key informant interviews, focus group discussions with a total of 8-15 participants per village, household interviews to 5 percent (133 households) of the total number of households per village, and direct field observations. The diversity of methods was intended not only as a triangulation technique but also as a mechanism of soliciting information from various groups of stakeholders involved in and/or influenced by coastal tourism. Data from household interviews were analysed using the Statistical Package for Social Science (SPSS), where cross-tabulation allowed a comparison of different study parameters in the two villages. Qualitative data from focus group discussions, key informants interviews, and participant observation were analysed using content analysis. Temperature and rainfall data from meteorological stations were analysed using Microsoft Office Excel 2003 to establish temporal patterns and trends of rainfall and temperature.

3. RESULTS AND DISCUSSION

Local perceptions of climate change and its impacts

An inquiry was made on how the local communities perceived climate change in their contexts. The coastal people of Bagamoyo District appeared to be much aware of the climate change and they could associate it with years dominated by extreme climatic conditions and other significant events leading to destructions, disturbances, and even loss of life (Table 1).

Table 1: Climate related extreme events and impacts on Bagamoyo coastal areas, 1969-2009

Year	Event	Affected places	Human deaths, loss or damage of properties
1969	Coastal storm surge	RC Church and some few coastal places	There were structural destructions at the RC Church and some ancient buildings, for instance, the *cock symbol* at the top of the church was destroyed, and some *roofs*, *walls* at the ruins were destroyed.
1976	Rise of sea water levels	Kaole village and some parts of Bagamoyo town coastline	Houses were destroyed, 9 people died and dhows were destroyed as a result of strong winds and strong waves.
1997/ 1998	El Niño associated with excessive rainfalls	Most parts of Tanzania including Bagamoyo coastal areas were inundated, crop destructions and outbreak of diseases such as cholera, dysentery and malaria	Inundation of some parts, the road to Kaole ruins was impassable, Kaole ruins were somehow destroyed through water *infiltration* leading to *cracking of the ruins* (this affected tourism sector).
2005	Storm surge and heavy winds	Ancient German buildings, Arab Tea House were dilapidated, roofs destroyed	Destruction of tourist attractions (heritage sites)
2007	Storm surge associated with abrupt rise of sea levels	Areas around Paradise Holiday Resort and Bagamoyo coastal areas	Destruction of sea walls around Livingstone Club and Paradise Resort. Disrupted tourism activities
2008	Droughts	Coastal parts of Bagamoyo	Drying up of crops, occurrence of human diseases , such as malaria, boils, dysentery, skin rashes
2009	Storm surge and sea level rise	The whole of Bagamoyo coastline, as well as occurrence of marine accidents around Customs and BADECO areas	Nine people died, boats and dhows were destroyed because of heavy blowing winds, and the rise of sea levels. This disrupted tourism activities.

Source: *Antiquities Department and RC Museum (2009).*

Rainfall and temperature trends based on empirical data

Local perceptions of farmers with respect to changes in temperature as well as increasing rainfall variability revealed close relationship to empirical analysis of rainfall and temperature trends using the data obtained from TMA. About 28.9 percent out of 133 respondents in Kaole village complained that nowadays the rains come at an unexpected seasons and they are erratic. This has often caused crops to dry up in the farms. The respondents in Dunda village (34.9%) were of the same opinion that rainfall trend is going down compared to previous years. About 24.4 percent of the respondents in Kaole reported that they were now experiencing high temperatures compared to previous years. The case was more significant in Dunda village whereby about 41.8 percent of the respondents reported of increased temperatures causing discomfort to both tourists and local communities.

Trend analysis of rainfall data shows that annual rainfall has fluctuated to an average of about 1100 mm in 1950s to about 850mm in 2007 (Figure 2), indicating a decline of about 23 percent over this period. However, it is noted that as from 1970s to 2008 rainfall has been decreasing over time. The decrease from the annual average of about 1000mm to as low as 600mm in recent years is significant, and an issue for concern. In addition, there was a concern on an increase in temperatures as confirmed by TMA temperature data (annual average temperature increase of 1°C from 1970-2008 (Figure 3). The trends cited in Figures 2 and 3 do not only confirm the local people's perception that there have been changes in their environment, but have implications on the main economic activities in Bagamoyo such as small-holder farming, artisanal fishing, livestock keeping and mariculture (Mkama et al., 2013), that provide supplies to the local tourism-related investments such as beach hotels. These economic activities are climate dependent (Gautum, 2009). Thus, changes in rainfall and temperature can affect the coping strategies of not only the local communities but of various sectors, including tourism (URT, 2007).

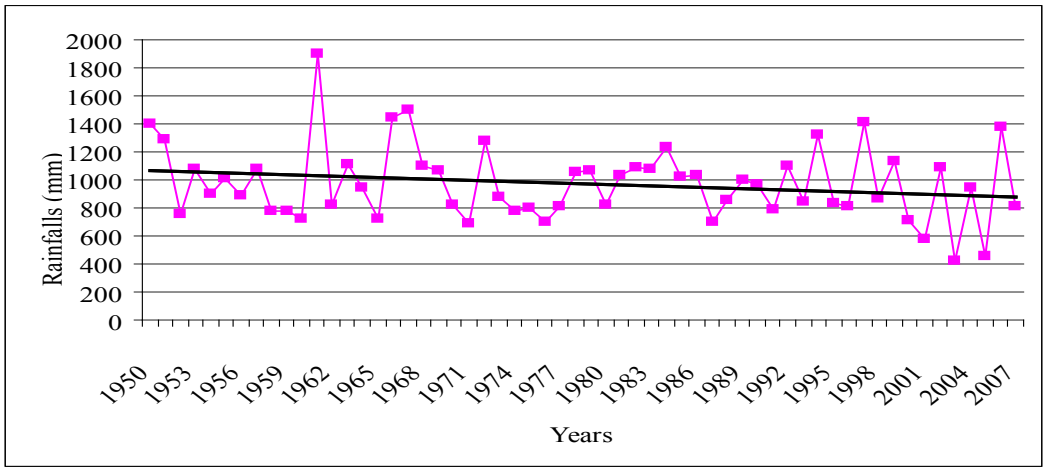

Figure 2: *Annual rainfall variability for Bagamoyo 1950-2007*

Source: *Computed from Tanzania Meteorological Agency (2009) data*

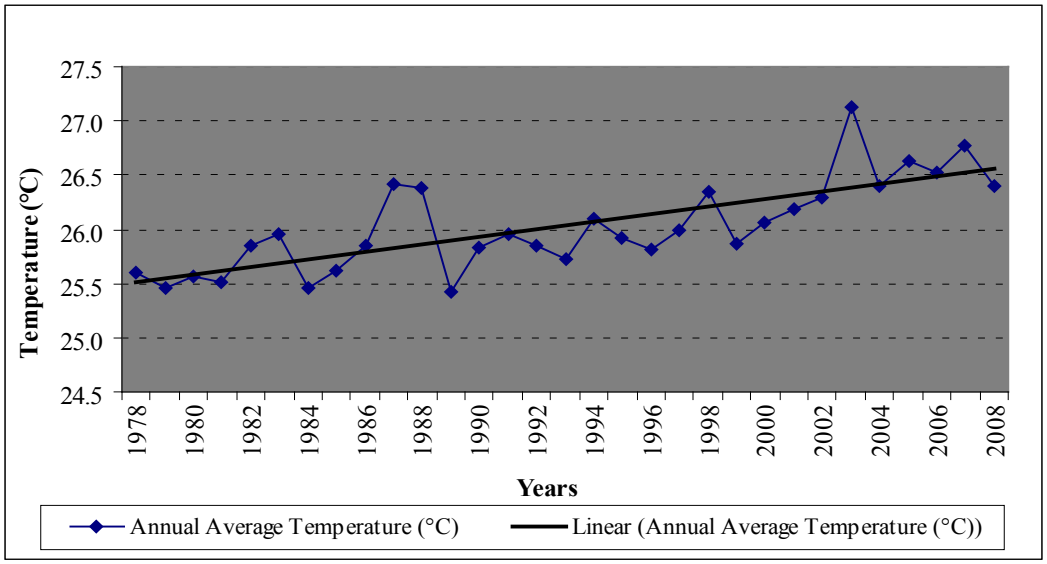

Figure 3: *Average annual temperature for coastal areas of Bagamoyo*

Source: *Computed from Tanzania Meteorological Agency (2009) data*

The increasing temperature trend was also confirmed by respondents during household surveys. The respondents asserted that the area has become warmer throughout the year, cooler periods have become shorter while hot periods have become much longer. In addition, these respondents reported that this condition

has made them more vulnerable to diseases such as malaria, cholera, dysentery, boils, and skin rashes. While the observation by the respondents was not supported by hospital records regarding the prevalence of these diseases, studies elsewhere have confirmed that these diseases are enhanced by warmer climatic conditions (Viner and Agnew, 1999; Yanda et al., 2007; Olago et al., 2010). Given the confluence of increasing rates of tourism, increased awareness of environmental issues and significant interest in the conservation of coastal resources by Bagamoyo District, the time seems right to examine the status of tourism in the district in a changing climate.

The average annual temperature increased by 1°C over a period of 38 years from 1970-2008 (Figure 3). It can be seen from Figure 3 that during this period the average annual temperatures increased from 25.5°C to slightly above 26.5°C. Such a change validates that global warming can be revealed even at local scales.

Change detection of shoreline at Dunda and Kaole villages from GIS data

Participant observation was conducted to collect more information from the field and the people interviewed were asked about the status of the shoreline in relation to previous years. Their responses were in line with GIS analytical findings (Figure 4, 5 and 6) that showed changes in shoreline over the years, which are evident through the disappearance of indigenous trees as well as a decrease of land size resulting from the rise of the sea level, coastal erosion, and human activities. Figure 4 presents the analysis of coastline status between 1988 and 1995. The findings showed that during this period the coastline was much relatively intact with about 41 ha of land being recorded as natural vegetation cover (bushed grassland).

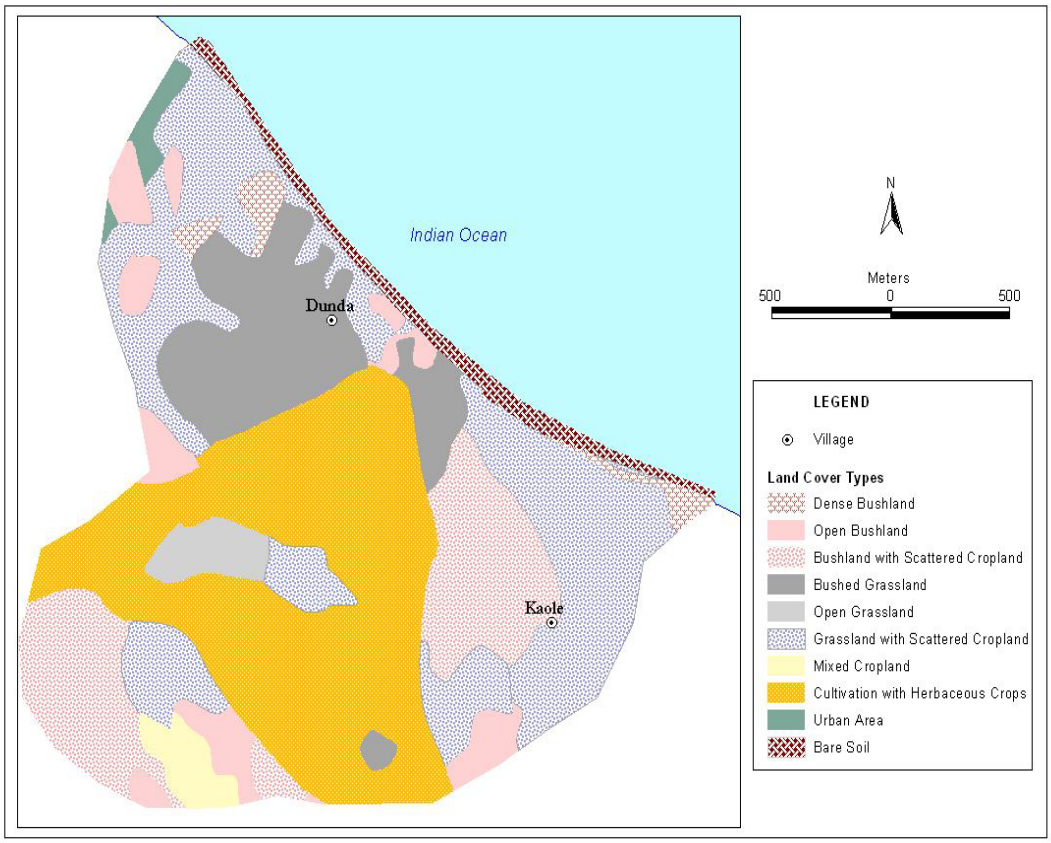

Figure 4: *Coastline status, 1988-1995*

Source: *GIS Lab (IRA)*

Figure 5 shows the coastline status between 1995 and 2000. About 5 ha of land equivalent to 31 percent was eroded and about 8 ha of water coverage advanced into the eroded land. The blue line in the map represents seawater and the dark blue line represents shoreline change. Much of the erosion occurred at the northern part of Dunda village. In addition, about 82 percent of vegetation cover was removed by different human activities in the area and according to the local narratives the impacts from the rise of seawater occurred during the period from 1995-2000.

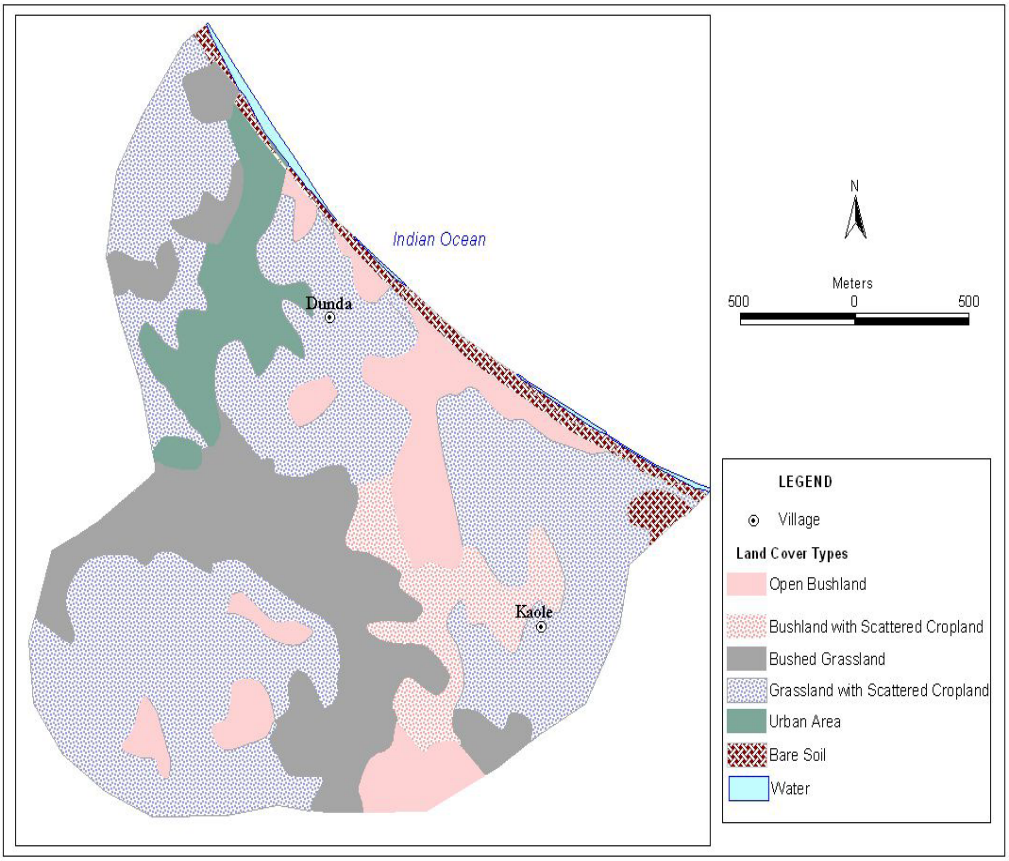

Figure 5: *Coastline status, 1995-2000*

Source: *GIS Lab (IRA)*

It was also revealed by the tourism operators and tour guides that these changes affect much of the coastal tourism activities in the studied areas. For instance, during the entire period of 1988-2000 (Figure 6), about 2 ha (17%) of land (bush land with scattered cropland) was eroded in the studied areas. Seawater intrusion into the land covered about 1 ha (13%) more than the coverage from the original shoreline. Most of these changes were locally associated with the rise of the sea water level. A study by Mkama et al. (2013) confirms that the natural resources related to coastal tourism in Bagamoyo are vulnerable to coastal erosion and shoreline changes, as evidenced by eroded beaches and shifting shorelines that affected old historical buildings and destructed beautiful beach sceneries (Figure 7). These changes in turn affect coastal tourism, one of the increasingly booming activities in Bagamoyo District (Mkama et al., 2013). GIS analysis carried out for

the present study demonstrate backward shifts in coastal boundaries due to the rise of sea level destroying infrastructure, fauna and flora, consequently disrupting coastal tourism activities of the area forcing the people to emigrate. Also, during the period covered by this study about 38 ha of bushed grassland were removed due to various human activities such as cutting down of mangroves and clearing of land for agricultural activities, thereby increasing the rate of erosion and reduction of beach areas.

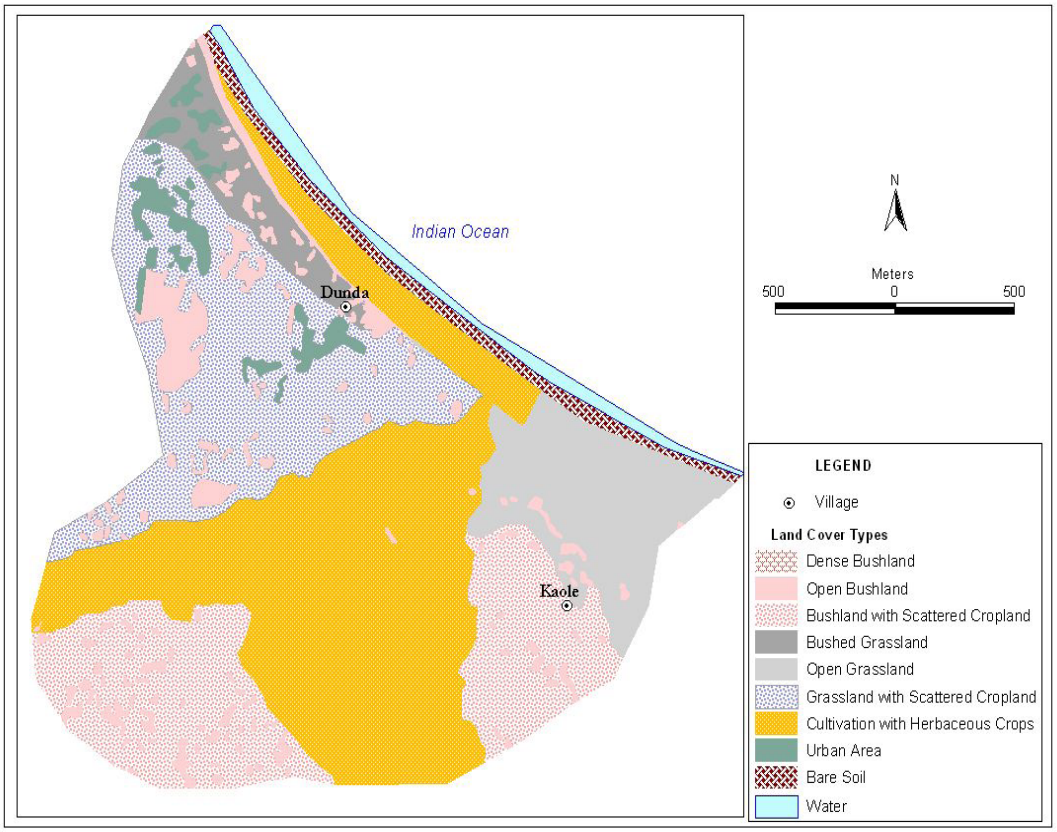

Figure 6: *Coastline status, 1988-2000*

Source: *GIS Lab (IRA)*

Data on tourism for the study area is scanty, however five year data for Kaole Ruins, located in one of the study villages, indicate that between 2005 and 2007 the number of foreign tourists increased and decreased thereafter until 2009 (Table 2). The latter period also experienced a decrease in rainfall and an increase in temperatures (see Figures 2 and 3), partly showing the link between tourism and

changing climate. On the one hand, other factors such as storm surges, heavy winds and the rise in sea levels have effects on coastal erosion and destruction of beaches and coastal investments thereby increasing the maintenance or mitigation of costs, which have to be recovered from the tourist operations. On the other hand, the rise in sea level has caused seawater intrusion into freshwater systems (URT, 2007) that have been used by native communities and could as well be used by visitors.

Table 2: *Number of visitors to Kaole Ruins, 2005-2009*

Period/Year	Foreign	Resident	
		Adults	Students
2005	605	1795	7729
2006	1230	10821	12659
2007	1485	5191	15184
2008	NA	NA	NA
2009	1263	3866	15962

Source: *Gautum (2009); NA=Not available*

Figure 7: *Beach erosion collapsing old Boma important tourist visit areas at Customs, Bagamoyo.*

Source: *Mkama et al. (2013).*

Local narratives on the impacts of climate change on coastal resources

Coastal natural resources of Bagamoyo are also used for tourism purposes. However, these natural resources are being impacted by various factors including human-led activities such as tourism development, sea level rise and increased temperature associated with global warming. Mangroves degradation is common in Bagamoyo District resulting from cutting down of trees for charcoal production, construction purposes, fuel wood, creation of wider expanses for beaches fronts and recreational purposes (Torell *et al.,* 2006). In addition, the results from key informants interviews and household surveys (Table 3) indicate that sea level rise and increased temperature have negative impacts on mangrove ecosystems because these ecosystems survive in a certain amount of salinity. Degradation of coral reefs is due to tourism activities and global warming, there is evidence of coral bleaching after the El Niño of 1997/1998 along the Indian Ocean. However, the results from household surveys indicated that only 8.2 percent of the respondents associated the impacts of climate change to corals, possibly due to limited knowledge on the impacts of climate change on marine resources such as corals. Dunda village had the least proportion respondents attributing the impact of climate change on corals (Table 3). Rather they linked the destruction of coral reefs in the areas to human activities. Similar concerns were also raised by Nelleman and Corcoran (2006).

Table 3: *Percent response on impacts of climate change on coastal resources*

Coastal resources impacted	Village		
	Kaole	Dunda	Average
Impacts on beaches	40.6	39.6	40.1
Impacts on mangroves	21.9	32.4	27.2
Impacts on fish availability	25.0	23.7	24.4
Impacts on Coral reefs	12.5	4.3	8.2

The impacts of climate change are also seen in the form of beach recession. The results showed that beaches are shrinking from the original state resulting from the rise in sea level, coastal erosion (Figure 8), and removal of mangrove forests.

Figure 8: *Exposed roots demonstrating beach erosion due to oceanic waves (top left), Sea wall defence at the Millennium Sea Breeze Resort (top right), Sea walls defence at Livingstone Club (bottom left) and Paradise Holiday Resort (bottom right).*

Source: *Mushi (2009).*

The findings from household surveys showed that the reduction of beach areas has affected tourism activities in these areas; for instance, movement of tourists nowadays is likely to be restricted to smaller area compared to previous years. Further discussion with Livingstone Club and Paradise Holiday Resort staffs revealed that beach reduction and increasing coastal erosion are threats to the tourism sector. Similar concerns are reported by Linden and Lundin (1995).

Fish availability is also declining with an increase of sea surface temperature as it was observed by local fishermen, and supported by Roessig *et al.* (2004) and Fick *et al*. (2005). According to the Bagamoyo District Fishery Department, this situation may cause shortage of nutritious food for local communities and tourists in the area, and may negatively affect the tourism sector, because fish is also a source of food for tourist hotels around Bagamoyo.

The vulnerability of coastal tourism to climate change

The whole of Bagamoyo town is a historical town with a history dating back to the 13th Century. Ruins such as those at Kaole of 13th century, German ancient buildings, Arab fort, Old market, and Old customhouse are among the historical tourist attractions. However, the destructions due to the changing climate are obvious nowadays especially with the German cemetery and Kaole ruins. The findings from this study showed that tourism activities in Bagamoyo are indeed threatened by the changing climate, particularly through its impacts on the rise of sea level. The most notable negative impacts on coastal tourism include the destruction of tourist infrastructures such as hotels and other recreational facilities, sea walls, boats, roads, cultural heritage sites (historical and archaeological sites). For instance, on 25th December 2007, the Paradise Holiday Resort management had to close down all activities around the resort because some parts of the hotel were surrounded by the sea water, an apparent indication of global warming associated with the rise of sea water (see Figure 7 and 8). This prompted the Hotel Management to reinforce the built sea walls. According to Bagamoyo Forestry Department, coastal erosion and the rise of sea level have led to shoreline changes leading to a decrease of beach areas, disappearance of indigenous trees such as *Casuarina trees*, *Coconut trees,* and *Terminalia trees,* and destruction of archaeological sites. All these phenomena contribute to the alteration of the natural appearance of the coastal environment affecting coastal tourism. The shoreline changes, beach erosion, unreliable rainfall, and an increase in temperature in dry seasons, not only affect the Bagamoyo community coastal agriculture and fisheries activities but also the booming tourism industry (Mkama et al. 2013).

Impacts of climate change on cultural, historical and archaeological sites

About 46.7 percent of the respondents in Kaole village indicated that the cultural heritage sites of Bagamoyo are being negatively impacted by climate change through the rise of sea level, coastal erosion (see Figure 8), increased temperature, and other extreme events such as storm surges, coastal flooding, and excessive rainfalls especially during El Niño of 1997/1998. If proper adaptation measures are not implemented, the deterioration of cultural heritage sites in Bagamoyo will continue to affect the tourism sector severely. This is because there are many tourists who come to Bagamoyo purposely for the history, cultural and archaeological sites of Bagamoyo (Kimaro, 2006). It was also reported by the Kaole Conservator that the

changing climate of the modern world, particularly the rise of sea level is a threat to the existence of Kaole ruins, which have stood the test of times and persisted against natural forces such as winds, rains, and temperatures over the centuries.

Impacts of climate change on seaside tourism activities

In Bagamoyo coast, seaside tourism is done in the sea, whereby tourists use hired boats to visit areas special for diving, snorkelling activities, watching ornamental fishes (*samaki wa mapambo*) around coral reefs and lagoons, and viewing water birds. On 18th February 2009, there was a sudden powerful storm, and an abrupt rise of sea level along the Bagamoyo coast, a situation that led to the deaths of 9 people and destruction of few boats. Although such extreme events may not necessarily be attributed to changing climate, extreme weather events have often associated with climate change (URT, 2007; IPCC, 2007), and may increase vulnerabilities in a context of multiple stresses. As a result, the following days all tourist activities on the sea were stopped. Basing on situations like this, the results from key informant interviews and focus group discussions in both villages indicated that seaside tourism activities would be among the highly impacted areas of tourists' activities with an increase of extreme climate related events as the ones witnessed nowadays, thus affecting coastal tourism, and causing loss of revenues and employments. The increased frequency of extreme weather events such as El Niño floods in 1997/98 and drought are few but important evidences of the effects of climate change in Tanzania (URT, 2007).

Coastal tourism adaptation to climate change

There is an increase of evidence that climate change will strongly affect low-lying coastal areas, and will be one of the challenging issues for future development and economic activities such as tourism (Huq *et al.*, 2004). In realising such challenges, the study revealed that tourism stakeholders, hoteliers and Antiquity department have established various climate change adaptation measures, the most notable ones being construction of sea walls in most of the hotels, and pilling up of sand bags, and enhancement and rehabilitation of ancient buildings and ruins. Hotels such as Livingstone Club, Paradise Holiday Resort, and Millennium Sea Breeze have constructed sea walls, although they are being destroyed every now and then by rising sea levels. The adaptation strategies used by Antiquities Department include the enhancement and rehabilitation of the ruins whenever destruction occurs.

4. CONCLUSION

The results from this study have shown that the impacts of climate change on coastal tourism along the coastline of Bagamoyo are becoming evident in various ways. Beaches are shrinking as a result of the rising sea levels, an increase of coastal erosion and coastal flooding leading to deterioration of coastal cultural heritage sites, which are among the major tourist attractions of Bagamoyo. The reported changes in the characteristics of the rainfall patterns and its unpredictability, and the increased annual average temperature are likely to cause considerable discomfort that may affect economic activities of the area, including tourism. Climate change and subsequent sea level rise are adding pressure on the coastal resources affecting coastal ecosystems, tourism infrastructures and other climate dependent economic activities, threatening the livelihoods of coastal population and growth of coastal tourism along the Bagamoyo coast. To address the challenges emanating from the impacts of climate change it is recommended that there should be a regular monitoring of coastal ecosystems to provide natural resource managers and the tourism sector with current information on the state of the coastal environment and to assess their vulnerability to climate change. Also institutional and policy frameworks that address the vulnerability of coastal tourism due to climate change have to be in place so as to enhance adaptation strategies and mitigate other potential impacts. On the other hand, coastal tourism stakeholders should provide more awareness campaigns regarding climate change impacts.

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REFERENCES

Agrawala, S., Moehner, A., Hemp, A., Van A., M., Smith, J., Meena, H., Mwakifamba, M., Hyera, T. and Mwaipopo, O.U. (2003). *Development and Climate Change in Tanzania: Focus on Mount Kilimanjaro*. Organisation for Economic Co-operation and Development; Paris. Pp 6-9

Barahona, C. and Levy, S. (2003). *How to Generate Statistics and Influence Policy Using Participatory Methods in Research*: Reflection on the Work in Malawi 1992-2002. IDS Working Paper 212, Pp 57.

Environmental Protection Management Services (2006). *Adaptation to Climate Change through Shifting of Shallow Water Wells Affected by Inundation on the Coast Regions-Bagamoyo*, South North Adaptation Team -Tanzania

Fick, A.A., Myrick, C.A., Hansen, L.J. (2005). *Potential impacts of Global Climate Change on Freshwater Fisheries*. A Report for WWF, Gland, Switzerland

Gautum, A. (2009). Profile of current coastal tourism in Bagamoyo District, Tanzania and opportunities for development of ecotourism. TCMP Technical Report. Tanzania Coastal Management Partnership for Sustainable Coastal Communities and Ecosystems in Tanzania. Coastal Resources Center, University of Rhode Island.

Hansen, J.R., Ruedy, M.S. and K.L. (2006), *NASA Goddard Institute for Space Studies and Columbia University*, Earth Institute, New York. Available at: http://data.giss.gov/gistemp/ [Accessed on 3rd September, 2008]

Huq, S., Reid, H., Konate, M., Rahman, A., Sokona, Y and Crick, F. (2004). *Mainstreaming Adaptation to Climate Change in Least Developed Countries* (LDC's). Climate Policy 4:25-43

IPCC (2007*). Climate Change 2007. Impacts, Adaptation and vulnerability*. Working Group II Contribution to the IPCC Fourth Assessment Report. Summary to Policymakers. Pp 16-34. Available online: http://www.ipcc.ch (Accessed on 3rd May, 2009).

Kairu, K and Nyandwi, N. (2000). *Guidelines for the Study of Shoreline Change in the Western Indian Ocean Region.* Manual and Guides 40. Intergovernmental Oceanographic Commission, UNESCO Workshops. Paris. Pp 98.

Kimaro, J.W.S. (2006). Cultural Heritage Management (CHM) in Kilwa: Towards a Sustainable Conservation and Management of Kilwa Kisiwani and Songo Mnara World Heritage Sites. University of Dar es Salaam. Pp 68-71

Linden, O and Lundin, C.G. (Eds.) (1995). *Integrated Coastal Zone Management in Tanzania,* Ministry of Natural Resources Tourism and Environment. Institute of Marine Science, University of Dar es Salaam. Dar es Salaam. Pp 31

Mkama, W., Msuya S., Mahenge, J., Mposo, A., Jason, A.N., Amanzi, A., Chausiku, A. and Kundengukila, F. (2013). Bagamoyo District coastal climate change rapid vulnerability and adaptive capacity assessment, Bagamoyo District, Tanzania. Coastal Resources Center, University of Rhode Island, Narragansett, RI, 26 pp.

Nelleman, C. and E. Corcoran (Eds.) (2006). *Our Precious Coasts: Marine Pollution, Climate Change and the Resilience of Coastal Ecosystems*. United Nations Environment Programme, GRID-Arendal, Norway, Pp 40.

Olago, D., Marshall, M., Wandiga, S., Opondo, M., Yanda, P., Kangalawe, R., Githeko, A., Downs, T., Opere, A., Kabumbuli, R., Kirumira, E., Ogallo, L., Mugambi, P., Apindi, E., Githui, F., Kathuri, J., Olaka, L., Sigalla, R., Nanyunja, R., Baguma, T. and Achola, P. (2007). Climatic, socio-economic, and health factors affecting human vulnerability to cholera in the Lake Victoria Basin, East Africa. *Ambio* 36(4): 350-358.

Roessig, J.M., Woodley, C.M., Cech, J.J and Hansen, L.J. (2004). *Effects of Global Climate Change on Marine and Estuarine Fishes and Fisheries*. Reviews in Fish Biology and Fisheries. pp 251-275.

Semesi, A.K. and Howell, K.M. (1999). *Coastal Resources of Bagamoyo District Tanzania*: Proceedings of a Workshop on Coastal Resources of Bagamoyo. Faculty of Science, University of Dar es Salaam. Dar es Salaam.

Simpson, M.C., Gössling, S., Scott, D., Hall, C.M. and Gladin, E. (2008). *Climate Change Adaptation and Mitigation in the Tourism Sector*: Frameworks, Tools and Practices. UNEP, University of Oxford, UNWTO, WMO: Paris, pp 13-19

TCMP (2001). *Coastal Tourism Situation Analysis*: Tanzania Coastal Management Partnership Support Unit. Coastal Tourism Working Group. Pp 6-15

Torell, E., Aviti, M. and Penny S. (2006), *Bagamoyo Governance Baseline*: Coastal Resources Centre, University of Rhode Island. Pp. 4-24

Toroka, N. (2003). *The Effect of Tourism in Tanzania:* The Case of Bagamoyo Coastal Area. University of Dar es Salaam. pp 5-77

United Nations - UN (2009). Tanzania: Bagamoyo urban sector profile. United Nations Human Settlements Programme. Regional and Technical Cooperation Division. 36 pp

UNFCC (2006). *Preparedness for Climate Change*: from Available at: http://unfcc.int/files/national_reports/non-annex_i_natcom/cge/application/ pdf/pfcc_2006-07_2p.pdf (Accessed on 02nd December, 2008)

United Republic of Tanzania - URT (2004). *National Report on Coastal Tourism*: Ministry of Natural Resources and Tourism, Tourism Division, VPO-Division of Environment. Dar es Salaam. Pp 1-15

United Republic of Tanzania - URT (2005). *Initial National Communication under the United Nations Framework Convention on Climate Change (UNFCCC)*, Vice President's Office. Dar es Salaam. pp 141

United Republic of Tanzania - URT (2006). *State of the Environment*, Vice President's Office, Division of Environment. Dar es Salaam. Pp 41-58

United Republic of Tanzania - URT, (2007). National Adaptation Programme of Action (NAPA), Vice President's Office, Division of Environment, Dar es Salaam.

United Republic of Tanzania - URT (2008). *State of the Environment Report 2008*. Division of Environment, Vice President's office, Dar es Salaam. pp 162-165

United Republic of Tanzania - URT (2015). Tanzania Livelihood Baseline Profile. Bagamoyo-Morogoro Maize and Sesame Midland Livelihood Zone (TLZ 08), March, 2015

Viner, D and Agnew, M. (1999). *Climate Change and its Impacts on Tourism*. Climatic Research Unit, WWF-UK. University of East Anglia, Norwich, UK. P 3

World Heritage Convention (2006). *The Impacts of Climate Change on World Heritage Properties*: UNESCO Headquarters in Paris March 16-17 2006, Paris, Pp 1-18

World Tourism Organization (2005). *Tourism Vision 2020*. World Trade Organization, Washington, District of Columbia. Available at: http://www.world-tourism.org /facts/wtb.html (Accessed on 23rd April, 2009).

Yanda, P.Z., Kangalawe, R.Y.M. and Sigalla, R.J. (2006). Climatic and socio-economic influences on malaria and cholera risks in the Lake Victoria Region of Tanzania. *ICIFAI Journal of Environmental Economics* 4(3): 44-70