Climate Change and Immovable Cultural Heritage in Kenya: Impact and Response Strategies

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Abstract

Immovable cultural heritages represent past human life that links the past, present, and future landscapes. Protection and preservation of authenticity and integrity of these built heritages is a major challenge in the twenty-first century. Increased number of extreme weather events associated with climate change is a major concern in management and conservation of cultural heritage around the globe. This study assessed climate change impacts on immovable cultural heritage and the response strategies being employed along Kenya's coastline. Two

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counties in the coast region (Mombasa and Kilifi) were chosen for the study because of their rich cultural heritage surrounded by natural hazard-prone environment which has seen some of the sites listed to be in danger due to climate change. Through engagement with practitioners responsible for management of the sites, the following elements were looked into: sea level rise, coastal flooding, temperature rise, coastal winds, coastal erosion, increased precipitation, and increase in acidity levels. Data was collected through observation, interviews, and administering of questionnaires in the eight immovable cultural heritage sites in Mombasa and Kilifi counties. Findings indicate that the immovable cultural heritage sites are greatly affected by the climatic changes. Presence and growth of plants, corroded metallic parts, cracks, fallen walls, rotten wooden parts, submerged structures, and flaked walls have been acerbated by extreme weather-related events. Furthermore, despite climate changes being a major threat to these sites, it has not been included in cultural management plans. Inadequate resources are the main barrier in adapting to climate change. Structural and managerial strategies employed in the management of heritage sites in the region are highlighted.

Keywords

Climate change impacts · Immovable cultural heritage · Adaptation strategies · Conservation · Management · Kenya

Introduction

Climate is the principal resource for tourism. Climate of the earth has been changing throughout history, but today, concern over climate change issues is increasing because it is clear that humans are responsible for the change (UNWTO 2007). Climate change is defined as any change in climate whether due to natural variability or human activity over a period of time (Hegerl et al. 2007). Global warming is a result of emission of greenhouse gases in large quantities which prevent emission of heat into the outer space. Greenhouse effect is due to high level of carbon IV oxide molecules and other gases in the atmosphere forming a sort of "blanket" layer that traps the heat (NASA 2017). According to IPCC, most of the global warming occurred in the past 35 years with 2011 being the 16th of the 17 warmest years on record (IPCC 2015). The year 2016 was declared the warmest year with 8 months from January to September except June out of the 12 months has been the warmest on record. Intergovernmental panel on climate change estimates a rise in global mean sea level by 10 to 20 cm with an annual increase of 3.2 mm over the past 20 years. This is twice the average speed of the past 80 years (O'Neil et al. 2017). Climate change is projected to likely have higher impacts at the coastal zones and mountainous regions (IPOC 2007).

The African continent is more vulnerable to climate change as per the statistical analysis of climate change obtained from historical records of rainfall, temperature,

mountain glacier coverage, and sea level rise (Parry et al. 2007). Estimated impact of climate change in Africa is moderately-strongly negative, and the level of tourism and climate change knowledge is extremely poor (Hall 2008). The Southern and Eastern coastline of Africa (consisting of coasts of South Africa, Mozambique, Tanzania, and Kenya) is projected to be affected by cyclones and other weather events that pose risk to the development and infrastructure of these countries (Pielke et al. 2007).

Kenya is ranked among countries producing a small percentage of global greenhouse gas (GHG), but with its attainment of Vision 2030 development goals, it will contribute a higher percentage of the emissions. Kenya Meteorological Department argues that rainfall patterns have shown increase in irregularities and variability with total annual average decreasing as shown in the long rainy season of March to May. According to researchers, Indian Ocean sea level has been rising by 2.2milimetres annually (Mwakio 2016). Climate change impacts vary depending on the coastal structure (Edward and O'Sullivan 2007); however, those on low-lying coastal areas and near high water points require urgent concerns. Furthermore, research findings indicate that a rise of sea level by 30centimetres will result in submergence of Mombasa, while 17% of coastal areas with a population of 267,000 people are at a risk of flooding by 2030 if no measures are taken. About 40% of Mombasa with a population of 2.4 million people will be exposed to sea level rise at the end of the twenty-first century, while 64% of Lamu Island, a UNESCO heritage site, is prone to flooding (Omondi and Ochanda 2014). According to the World Bank report (2015), about 2.6% of Kenya's GDP is estimated to be used in dealing with floods and drought cases by 2030 with long-term effects on the larger environment and economy (Besley 2015).

UNESCO in 1972 distinguished two types of tangible cultural heritage: the moveable that include paintings, manuscripts, and sculptures and the immovable that include monuments, buildings, and archaeological sites. The coastal stretch of Kenya has a number of immovable cultural heritages dating back to the exploration period. They include religious sites, monuments, historical buildings, graves, historic towns, and pillars. Large numbers of cultural world heritage sites are located in the coastal areas since human activities have traditionally concentrated in these locations (Reimann et al. 2018). However, extreme weather events such as prolonged droughts and frequent flooding have been increasing since the year 2000 (Njoroge 2015). Coastal heritage sites are also threatened by increased coastal erosion, coastal flooding, rising sea level, increase in acidity levels, increase in precipitation, and frequent strong winds (Erlandson 2012; IPCC 2007; UNWTO and UNEP 2008). Despite the current trend of annual increase in the number of cultural heritage sites at risk of climate change, vulnerability assessment methodologies are still preliminary (Carter et al. 2007; Jopp et al. 2010). Existing research focused on the effects of natural hazards such as landslide, floods, and climate change impacts on a particular UNESCO world heritage site globally, without taking climate change directly into account (Reimann et al. 2018). To address the knowledge gap, research was anchored on the climate change impacts on the immovable cultural heritage along the Kenyan coastline.

Kenya is among the popular destinations in Africa attracting millions of tourists annually. Vision 2030 blueprint recognizes tourism as one of its key pillars in achieving middle-income status. The country's diverse tourism resources include coastal beaches, cultural heritages, wildlife, natural vegetation, and beautiful landscape. Tourism in Kenya is a source of income which helps reduce overdependence on other sectors like agriculture which is subjected to market conditions. According to the Ministry of Tourism report, Kenya's tourism earnings in 2018 rose by almost a third from the previous year to (US$1.55billion) after the visitor number rose by 37%. About 8–10% of Kenya's national income is generated from tourism industry; this fund helps in diversifying the economy and development of infrastructure. Furthermore, the tourism industry provides direct and indirect employment to thousands of people within the country.

Old structures are reference point in which people learn and analyze the past. They provide evidence that is important in educating the society over time in the history and identity of a community (Watson 2013). However, less effort has been put up by the government in protecting the heritage sites from human encroachment and other destructions despite the evidence on the potential of the coastal region as a home to the history and archaeology of Kenya (Namunaba 2003). Currently the efforts to protect the sites are still limited. There is a need for a proactive adaptation planning especially for heritages in coastal areas to reduce their vulnerabilities and promote effective responses to climate change (Fatoric and Seekam 2017). Strategies on reducing climate change impacts on cultural heritage are still inadequate especially in Kenya where the protection strategies have begun only recently at Fort Jesus in Mombasa as reported in the local dailies. The World Heritage Convention can provide a voice on climate change that points out on the irreversible damage and the loss of biodiversity on these heritages due to climate change (WHC 2008). Preservation of immovable cultural heritages is the wheel to sustainable growth and progress.

Climate change is affecting the environmental and social conditions around the globe. Consequently, climate change is also affecting the immovable cultural heritage through biological, physical, and chemical processes. Many researchers have identified causes of cultural heritage deterioration to include hydrogeological factors (Piao et al. 2003), microbiological factors (Garg et al. 1995), air factors (De la Fuenta et al. 2011), and environmental factors (Wang and Song 2006). Every human has a right to cultural heritage according to article 27 of the United Nations Universal Declaration of Human Rights (Mitsakaki and Laoupi 2009). Vulnerability assessment is crucial to changing climate although assessing the immovable cultural heritage is complex. Detailed analysis of building materials requires a lot of human and financial resources (Romãoa et al. 2016). Simplified, reliable, and efficient methodology has been proposed by some researchers including Romãoa et al.'s (2016) methodology which was usedin this research. The United Nations Framework Convention on Climate Change (UNFCCC) addressed the importance of mitigating and adapting to climate change. Mitigation involves setting up measures to minimize emission of greenhouse gases (Keohano and Victor 2016). On the other hand, adaptation refers to adjustment in the overall system to cope with changes in

the environment (Carmichael et al. 2017). Mitigation was initially given attention with the formation of many conventions that regulated emissions from developed countries and travel sector. Since the late 1990s adaption research gained greater interest in the topic since climate change impacts will continue to be felt, therefore the need to adapt to the unavoidable (IPCC 2015). Assessment of climate change impacts on the world heritage was first carried out by UNESCO World Heritage Centre in 2005.This issue was brought forth after the World Heritage Committee noted that climate change is most likely to affect many world heritage properties (Matiz 2016). Despite this, the solution to the problem is still debated. Cultural heritage can mitigate through improving energy efficiency of the buildings and adapt through constant monitoring and maintenance. Degradation of the cultural heritage sites is inevitable; therefore, development of sustainable adaptation strategies must be based on the vulnerability assessment of the sites.

Global climate policies have also changed to accommodate the cultural heritage. The Fifth Assessment Report of IPCC (2013–2014) for the first time mentioned the need to take care of the cultural heritage in climate change adaptation policies (IPCC 2015). Therefore, it is the duty of every party state to identify cultural heritage at risks and develop climate strategy for their cultural heritages. Cultural heritage adaptation to climate change involves setting up measures and strategies that aim at moderating the impacts of climate change (WHC 2006). Cultural heritage adaptation may be in two forms. First is the change in policies and guidelines that oversee monitoring and maintenance. Second is physical adjustment in the original state of the heritage by changing construction materials or building barriers (UNESCO 2015). Every cultural heritage is exposed to a different level and degree of risk, therefore making it difficult to generalize available adaptation options. Implementation of adaptation strategies is also a challenge. Adaptation requires intense financial and human resources, which are often limited. Other factors hindering adaptation implementation include technical barriers, institutional barriers, and loss (Scott et al. 2016). Therefore, it is best to assess the challenges and opportunities resulting from adapting and choosing the best adaptation method. The study aimed at assessing the risks, impacts, and available adaptation options. The study was confined to the setting of impacts from coastal climate change within Mombasa and Kilifi counties.

Climate Change and Heritage

According to the Facing the Future Report (Historic England 2015), climate change is an acknowledged threat to both the natural and historic environment**.** According to UNESCO there was less scientific evidence of changes in climate. The study of climate change impacts has only attracted attention in the recent years on the diverse cultural sites such as archaeological, historic monuments and cultural landscape (Cassar et al. 2006; Harvey and Perry 2015). However, knowledge is still growing in reference to climate change and cultural heritage. There is a need for more research on the effects of climate change on both physical and the social and cultural

processes that they are part of (WHC 2006). Majority of the researches globally have been done by the cultural heritage institutions such as UNESCO, ICOMOS, and ICCROM. These organizations often join hands with universities and research institutes in publishing on cultural heritage-listed world properties. Noah's Ark is an example of a global-scale project that focused on the effects of climate change on Europe's built heritage and cultural landscape over the next century. The study focused on changes in ground water levels, increased storm, increased thermal stress, wind damage to buildings, and structural and biological damages due to changes in moisture content as a result of flooding (Sabbioni et al. 2006).

Regionally, a multidisciplinary research done by a partnership of organizations, countries, and individuals named "Africa 2009" report focused on the conservation of immovable cultural heritage in sub-Saharan Africa. Africa 2009 was a 12-year program aimed at improving the management and conservation of immovable cultural heritage in sub-Saharan Africa. The research survey was carried out in 1996 which 32 African countries responded and launched the program in 1998 in Cote d'Ivoire. The outcome of the research saw an increase of African cultural heritage inscribed on the World Heritage List rising from 17 out of 444 in 1998 to 45 out of 714 in 2010.

Furthermore, Tillya (2003) studied the role of climatic factors in the deterioration of immovable cultural heritage, a case study of Tanga coastal region in Tanzania. The study aimed at finding out whether climate was a factor bringing about deterioration of the heritages. The study covered the historical buildings and landscape scene in Tanga region. Research findings indicated that climatic factors contributed both directly and indirectly in the deterioration of the immovable cultural heritages. Climatic agents such as humidity, rainfall, temperature, and wind contributed directly to cracking, peeling off, and corrosion of iron sheets, falling of some parts, and decay of wooden parts. Climatic conditions also contributed indirectly to deterioration of immovable heritages through provision of conducive environment for pests, plants, and microorganisms to thrive. The study concluded that climatic conditions play a major role in the deterioration of immovable cultural heritage along the coast of Tanga; therefore, regular survey, rehabilitation, and maintenance of the sites were recommended.

Kenya has eight of its natural and cultural sites listed in the World Heritage List, namely, Fort Jesus in Mombasa, Kenya Lake System in the Rift Valley, Lake Turkana National Park, Lamu Old Town, Mt. Kenya Natural Forest, the Sacred Mijikenda Kaya Forests, and the recently added Thimlich Ohinga ruins and Kit Mikayi rock. Lamu Old Town and Fort Jesus are the immovable cultural heritage on the list, while some like Mombasa Old Town are in the tentative list. Therefore, with impacts of climate change being more in the coastal areas, it calls for a study of preservation of the sites. A study on conservation problems facing UNESCO heritage like Fort Jesus and those not in the World Heritage List has not been assessed in relation to climate change impacts. According to UNESCO carrying out a study on the cultural heritage without status is the duty of the party state. Countries like the United Kingdom have produced several reference materials for its

cultural heritages through the English Heritage and Historic Scotland, while others like Kenya almost have none.

Monuments, buildings, and archaeological treasures of heritage sites are permanently tied to locality of a place (Australia ICOMOS 2013). Most of these architectural features have a high artistic and cultural value, but they are immobile entities subject to different types of disruptions (Canuti et al. 2009). Climate change impacts are already being witnessed and experienced as highlighted in the 2007 report of the Intergovernmental Panel on Climate Change (IPCC 2007). Scientists claim that most of the observed changes in the global temperature are a result of human activities (IPCC 2014). Systematic observations of climate elements are done by the national meteorological departments and other specialized centers. Observations are taken at standard pre-set times and place; variables include rainfall, temperature, sea level rise, sea surface temperature, wind speeds, and cyclones.

The World Heritage Committee at its 29th session in 2005 recognized that impacts of climate change are affecting many world heritage properties and are likely to affect more. In 2006, experts from the heritages and climate change came together and produced a report on "predicting and managing the effects of climate change on world heritage." Later on, the World Heritage Committee also produced a report to guide the heritage destination in implementing appropriate management responses. As a result of this initiative, few researches have been completed on climate change and the heritages, the Noah's Ark and the Climate for Culture funded by the European Commission. A number of world heritage properties both cultural and natural have been highlighted to be in danger. Some studies are currently being conducted in various sites (Matiz 2016).

Climate change elements that alter the original state of the heritage include changes in temperature, sea level rise, and change in atmospheric moisture, precipitation, and wind (UNESCO-World Heritage Centre 2007). Their continued preservation requires understanding of these impacts to their outstanding universal value and responding to them effectively. Rise in sea level causes damage to the historical building and the social fabric of the historic sites, due to increase in soil moisture, hence rise in saline crystallization which damages the decorated surfaces. Increase in humidity may lead to the buildings subsiding or ground heave (UNESCO 2006). Heritage preservation involves the conservation of both tangible and intangible resources for their adaptive reuse and recycling for the future.

Cultural resources lose a part of their importance when they are moved; once lost they are gone forever (Jarvis 2014). Heritage structures are vulnerable to climate change (extreme wind and rainfall, saltification, damping, sea level rise, and coastal erosion). Old structures are more porous; they easily draw water through capillarity and lose it through evaporation causing salt weathering. Change in soil moisture and water temperatures destabilizes the structures' foundation. Building materials include timber frames, solid bricks and mortar walls, earthen walls and floors, lime-plastered walls and ceilings, decorative finishes, daub panels, and wattles (English Heritage 2008). Water is the most destructive agent of decay. Heavy downpour results in flooding that may result in catastrophic destruction of all elements of historic environment. Organic materials like timber suffer from pest

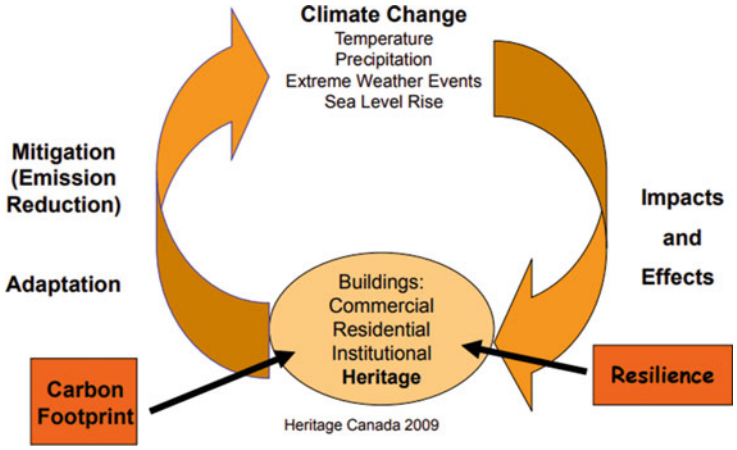


Fig. 1 Climate change and heritage (Source: Chiotti 2009, P. 5)

and fungal infestation when they get dumpy and split when exposed to high temperatures (historic England 2015).

On the other hand, Longfield and Macklin (1999) argue that the inorganic materials suffer from erosion and contamination when salt content and water together with the materials undergo chemical reaction due to different varying conditions they are exposed to. Although most of these cultural heritages are made of stone which is assumed to be a strong material, it is not always true (Hambrecht and Rockman 2017). Goudie (2016) reveals the worrying vulnerability of stones under the influence of moisture and vegetation. Rock types such as limestone and soapstone are soft rocks; hence they get eroded more quickly (Geological Survey of Finland 2006). Fig. 1 demonstrates the processes.

Climate Change Impacts on the Individual Immovable Cultural Heritage

Fort Jesus

Fort Jesus was built in the sixteenth century (1593–1596) by the Portuguese to protect Mombasa town from invaders. The fort was design to take the shape of a man and stands still on spur of coral rocks. The port was used as a watchtower to see enemies from afar before attacking. The Portuguese first inhabited the fort, but in 1698, the Oman Arabs took control. In 1895 the British transformed the fort into a prison where slaves were held captive and tortured. Later on the Portuguese recaptured the fort. The fort has since then been refurbished several times revealing Portuguese, Arab, and British influences. In 1858 the fort became a national park, and in 2011 it became a UNESCO world heritage site, inscribed on the list due to its brilliant and unique structures from the sixteenth century. The fort displays mainly

Fig. 2 Fort Jesus (UNESCO heritage) (Photo taken by the authors 2019)

archaeological findings, and the old law court gallery hosts temporary exhibitions. The fort overlooking the entrance of Mombasa old port represents the sixteenth-century Portuguese military architecture. The base of Fort Jesus is being steadily eroded by the rising sea tides (Fig. 2).

Although the fort has been inscribed into the World Heritage List, it faces a number of factors that affect its authenticity and stability. The fact that the fort was built on a coral rock, its existence for the future generation is questionable amid climate change. Considering the location of the fort from the ocean and the predicted rise in sea level, it means the heritage is at risk of being lost. Fort Jesus is located in Mombasa Island which is a Low-Lying Coastal Zone (LLCZ) of about 10meters below sea level; hence the fort is prone to sea level rise and coastal flooding.

The Fort Jesus case shows that the heritage has been affected by a number of natural forces. The UNESCO world heritage site exhibited the following forms of deterioration. The walls of the fort exhibited cracks, peeling-off of plaster and paints, and splitting of some parts which are attributed to expansion and contraction of walls due to high temperatures, direct sunlight, high humidity, and direct rainfall. Presence of plant growth such as algae, moss, and lichens were visible on the walls and wooden parts. High humidity, warm temperatures, and heavy rainfall provide conducive conditions for the growth of plants and insect infestation on the wooden parts. The basement of the fort has been corroded with sea level rise and increase in acid levels in the water. The roofs and metallic parts exhibited rust on their surfaces which are caused by salt contents in the coastal winds and acidic rainfall.

Mnarani Ruins

The Mnarani ruins are a Swahili settlement dating back to the thirteenth century and are located on the south bank of Kilifi creek on Kenya's north coast. Mnarani settlement covered 16 acres of land containing vestiges of two mosques, several tombs and one with a striking pillar of about 10 meters high with incised decorated tombstones sitting on the basal construction course of the tomb, wells, and several mounds of what were residential buildings. The site flourished in the sixteenth century but was later abandoned in the seventeenth century and later on destroyed by warring Galla people. Today the site is covered with indigenous trees of high medicinal value, and Sykes' and vervet monkeys also take cover in the site.

Mnarani ruins indicated some form of deterioration on their remains. The lower part of the ruins had grown plants as a result of dampness which is caused by flooding. The site is prone to flooding when there is heavy downpour due to inadequate drainage systems to allow free flow of stagnant water. Parts of the walls that are still standing had visible cracks and other sections had already split. Destruction of the walls is due to the exposure to direct rainfall, high temperatures, high humidity, and spread of plant roots to the ruins.

Jumba La Mtwana Ruins

"Jumba la Mtwana" (large house of slave) is the remains of a twelfth-century settlement believed to be built around 1350, inhabited and then later abandoned. The ruins are believed to have been inhabited by the Muslim evidenced by the existence of four mosques, a water cistern, and a washing platform. These houses are identified as the House of the Cylinder, the House of the Kitchen, the House of the Many Pools, and the Great Mosque. Jumba boost of magnificent remains of domestic houses, mosques, tombs, and curved niches. The ancient town covers 12acres of land, and available ceramics depict evidence that the town was abandoned in the fifteenth century due to wars and diseases. The ruins were excavated in 1972 by James Kirkman, and in 1973, it was opened to the public and gazetted in 1982 as a national monument.

Jumba la Mtwana being located on the seashore is affected by constant coastal erosion that has resulted in the loss of the ruins next to the beach. The ruins located in the inland are facing deterioration from different forces of nature. The walls of the ruins have been weakened by the growth of plants such as algae, lichen, and moss that develop on the walls. The parasitic plants thrive because of conducive environment with warm temperatures, high humidity, and rainfall.

Gede Ruins

The Gede ruins, a twelfth-century Swahili village, are located deep within the Arabuko Sokoke forest, 16 km south of Malindi. The Gede ruins represent the

remains of a prosperous town which flourished until its abandonment in the seventeenth century due to water shortage, civil wars, and diseases. The ruins lie on 45 acres of land with original forest reflecting a unique architectural style and wealth of many Swahili towns of that period. The site was excavated in the late 1940s and 1950s where many domestic, religious, and commercial structures were unearthed. The site has numerous ruins of palace, palace annex, houses, elaborated tombs, and mosques which evidence that Gede had a large and wealthy population. In 1948 Gede was declared a national park, and an archaeologist was appointed as a warden until in 1969 when the administration was taken over by museum trustees.

Despite the ruins being justified for their outstanding universal value under criteria (ii), (iv), and (iii). According to the national museums of Kenya, the Gede ruins present unique evidence of a historic city with complex architectural design at this period in history. Furthermore the historic city represents a testimony to the social and economic inhabitants of Gede around the thirteenth century. The historic city ruins' deterioration has accelerated in the twenty-first century due to the global threat of climate change. The ruins were built from coral stones that were obtained from dead coral reefs and mixed with lime mortar.

Most of these ruins are not roofed, hence very fragile to climate change that speeds up the rate of weathering. The main areas such as the king's palace and mosques have developed cracks on the wall linings caused by expansion and contraction during high temperature, direct rainfall, high humidity, and acidic rains. Other vegetation and parasitic plants have grown on the ruins, and these weaken the building materials, hence the collapse of some parts. The ruins are surrounded by 35 hectares of coastal forest with over 50 indigenous species of trees. Strong coastal winds act as agents of destruction in that they break the branches of trees that fall on the ruins causing destruction.

Portuguese Chapel

The Portuguese Chapel is a spectacular monument built in the sixteenth century with its eastern side bearing the pulpit. The chapel lies along the seafront near Malindi museum few meters from the famous Vasco da Gama Pillar. A Portuguese graveyard lies outside the chapel; among those buried there are pioneer commander Mr. Lawford of the famous Lawford Hotel and the first British DC of Malindi Mr. Bell Smith. The history of the chapel is obscure but is believed to be the first Christian church in east Africa built in the 1490s. After the Portuguese left Malindi in 1593, the chapel was deserted until the arrival of the British in 1893. The chapel was gazetted as a national museum in 1935.

The first church in east Africa is a grass thatched house with a cemented wall painted with lime. The roof grass rot during heavy rainfall, therefore requiring constant change of the roof. There is also a presence of faded lime especially in the Portuguese chapel due to direct sunlight and rainfall. Insect infestations are visible on the wooden parts especially the roofing frames.

Vasco da Gama Pillar

The Vasco da Gama Pillar was built in 1498 by the Portuguese explorer Vasco da Gama in Malindi and is the oldest remaining European monument in tropical Africa. The pillar with a sign of the cross on the top (known as padro) was made from Lisbon limestone and bore the arms of Portugal (still faintly visible). The pillar was erected on a hilly ground so as to provide direction for the seafarers. The pillar was gazetted in 1935 as a national monument. Tourists from Germany, Portugal, and Italy visit the pillar as an architectural treasure.

The Vasco da Gama Pillar, being one of the main attractions in the coast region of Kenya, has recently been highlighted to be in danger of being lost due to climate change. The pillar built on the coral rocks on the ocean shores in Malindi is under threat from rising sea levels. Increase in sea level and increase in acidity levels cause coastal flooding, coastal erosion, and storm surges. The basement pillars enforced to support the Vasco da Gama Pillar have been eroded by sea water. Destabilization of the foundation has caused the development of cracks that are visible on the pillar. Plants have also grown on the basement as a result of conducive conditions of high humidity and warm temperatures. The lime on the pillar is still faintly visible. Direct rainfall on the pillar washed away the lime (Fig. 3).

Mombasa Old Town

Mombasa Old Town started in the sixth century and covers an area of 180 acres. Mombasa Old Town consists of ancient buildings with architecture design of Arabs. The old town is on the tentative list to qualify for inclusion in the World Heritage

Fig. 3 Vasco da Gama Pillar in Kilifi

List. The town basically describes the time when Mombasa was under heavy influence of Arab culture. Mombasa retained its special character under the influence of a variety of rulers such as the Portuguese, Arabs, and British and managed to survive as a thriving community. The place is famous for tourists because of its antiques and souvenirs. The old town is predominantly Muslim and there are several fine old mosques. Listed buildings within the old town include Fort Jesus, Mombasa Club, Africa Hotel, Mandhry Mosque, an old post office, an old port, Sanaa Gallery, Bohra Mosque, Leven house and steps, Reitz house, a probable site of old Portuguese church, Mombasa house, a white house, Lookmanji Curio Shop, Ali's Curio Market, Jubilee Hall, Mazrui graveyard, Datoo's sale rooms, Pigott place, Basheikh Mosque, Treasury Square, Swahili Cultural Centre, and alien registration buildings.

The old town of Mombasa is made up of buildings with carved doors that are over 100 years old and are of Arabic and Indian influence in their design. The Mombasa Old Town consists of residential houses, administrative offices, and government buildings made with unique architectural design of both Islamic and foreign influence. Most of the buildings are in bad condition due to climatic conditions. Roofs of the buildings are highly corroded due to salt and high humidity. Corroded iron sheet allows penetration of rain water into the structure increasing the level of dampness that affects the building materials. Fungi growth is also visible on the doors, windows, rafters, and other wooden parts. Some of the walls have disintegrated, cracks are also visible, and plaster has peeled off in some buildings. Furthermore, there is presence of termites and other insects' infestation on the walls, windows, and doors evidenced by the presence of the off brown mud-like materials on the buildings. The old town has been put in the tentative list for its unique and authentic designs of the twenty-first century. Majority of the buildings had flakes, blakes, and cracks developed due to contraction and expansion of walls as a result of high temperature, direct rainfall, and high humidity. Iron sheets were brown and corroded from acidic rainfall and salt content carried by wind. Abrasion of plastered walls and peeling off of paints were visible on the buildings due to direct rainfall.

Watamu Monument

Watamu Monument is a historical site dating back to thirteenth century when Gede and Malindi were occupied. The monument is located on the beachfront of the Temple Point hotel in Watamu. The monument is visible from the beach especially to those visiting Watamu marine parks. The monument has a hidden history behind it pending archaeological excavation to reveal the truth.

Wind and rainfall are the major agents of destruction to the ruins. Located within the temple point, the ruins are surrounded by trees which have accelerated the rate of damage especially during the time of monsoon winds. Part of the ruins have completely fallen off due to breakage from tree branches that fall on them. Warm temperatures and high humidity have provided conducive environment for plants to thrive in (Table 1).

Table 1 Summary of the level of damage per the cultural heritage site

Immovable cultural site	Level of damage	Percentage of response
Fort Jesus	Moderate	40.6%
Mombasa old town	Moderate	43.8%
Gede ruins	Minor	56.2%
Vasco da Gama	Major	40.6%
Jumba la Mtwana	Moderate	40.6%
Mnarani ruins	Moderate	40.6%
Portuguese chapel	Minor	31.2%
Watamu monument	Minor	34.4%

Field data (Authors 2019).

The summary of the findings was based on the qualitative rate scale for impacts adapted from the standard ISO 31000 and technical norms for risk management as shown in the following table. All the immovable cultural heritage sites exhibited forms of deterioration with majority having some damage (Table 2).

Graph 1 indicates the mean impact of climate change elements on the immovable cultural heritage, referring to Likert scale where 1 = insignificant, 2 = minor, 3 = moderate, 4 = major, and 5 = catastrophic. The level of impact of other hazards on the immovable cultural heritage is below 1 which means that there is no damage on the structures as a result of other factors that are not climate related. Increase in precipitation causes minor impact on the cultural heritage with its mean impact at 2. Temperature rise, coastal flooding, coastal erosion, frequent strong winds, and increase in acidity levels have a mean impact of more than 3 which means they cause moderate impact on the structures. In circumstances where the occurrence of hazards is frequent, the impact is very likely to increase, hence becoming major and catastrophic.

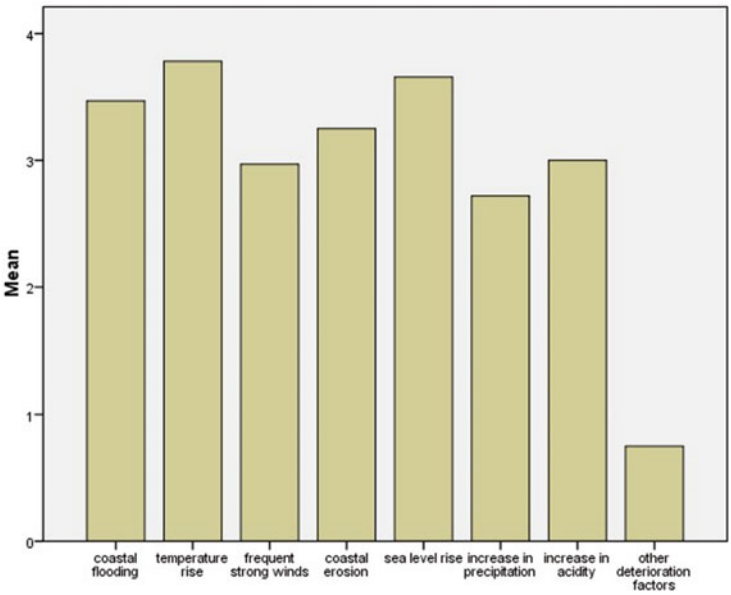
Adaptation Strategies at the Immovable Cultural Heritage Sites

The study sought to identify adaptation strategies by different stakeholders in the immovable cultural heritages. Every culture has a heritage, and therefore there is a need to protect these heritages irrespective of their origin culture. In order to preserve and protect the site from all aspects of danger, conservation goals must be a priority over its economic value. It's our mandate as humans to conserve them since we have to grow with them. Majority (93.8%) of the respondents agreed that the deterioration of cultural heritage will affect negatively the tourism industry. This is because 5% of tourism is driven by cultural heritage (O'Brien et al. 2015). Heritage provides employment and has economic value that drives the tourism industry; therefore, it should be preserved for the future generation to get the same economic benefit (Phillips 2015). Therefore, loss of heritage is a threat to tourism and also a source of income (Harvey 2016). In relation to this 84.4% of the respondents indicated that it is possible to protect the immovable cultural heritage from climate change. Adaptation

Table 2 Qualitative scales for impacts of hazards

Qualitative scales for impacts		
Rate	Descriptor	Description
1	**Insignificant**	**There is no damage**
2	**Minor**	**There is slight damage**
3	**Moderate**	**There is some damage**
4	**Major**	**There is considerable damage**
5	**Catastrophic**	**Significant danger or loss**

Source: Adapted from the standard ISO 31000 and technical norms for risk management (ICONTEC, 2004 and ISO, 2007) cited in Matiz (2016, P.82)



Graph 1 Comparison of mean impact of climate change elements on cultural heritages. (Field data Authors 2019)

strategies have already begun in some of the sites. Cultural heritage adaptation may be in two forms: first, change in policies and guidelines that oversee monitoring and maintenance and second, physical adjustment in the original state of the heritage by either changing construction materials or building barriers (UNESCO 2015). The strategies were classified into structural adaptations and managerial and policy adaptations. Structural adaptation involves changes in the structural appearance of the immovable cultural heritage. Changes may involve construction of buffer zones or practical change in the physical appearance of the structure. The following adaptation strategies were identified during the study.

Structural Adaptation

Construction of a Sea Wall

Fort Jesus is the only immovable cultural heritage that has begun the construction of a sea wall apart from Vasco da Gama Pillar and Jumba la Mtwana which have the same plans in place. These three sites are located along the seashore, hence are affected by sea level rise, coastal erosion, and silts deposits. Due to erosion of the fort basement, two hectares of land was reclaimed from the sea where the wall was constructed. The wall is yet to be completed. Fort Jesus being a world heritage, it took the efforts of the local government, national government, UNESCO, and other European sponsors to have the wall constructed so as to save the heritage. The wall will act as a barrier to protect the fort from not being in direct contact with the ocean water; thus cases of erosion will be minimized. Materials used in the construction are marine friendly which include marine cement and iron bars; hence the strategy is believed to be very effective. The sea barrier will counteract water waves, silts, and water speed that would cause damage to the fort (Fig. 4).

Painting of Buildings

Painting is one of the maintenance activities done on regular basis to enhance the physical appearance of the buildings. Heavy precipitation and direct sunlight cause the fading of wall paints, therefore speeding the rate of deterioration of building materials. Complete buildings such as Fort Jesus and Mombasa Old Town have the structures painted to maintain the authenticity of the structures.

Fig. 4 Construction of sea wall at Fort Jesus (Authors 2019)

Fig. 5 Repaired wall at Gede Ruins (Authors 2019)

Restoration of Fallen Walls

In Mnarani and Gede Ruins, fallen parts of the important sections have been repaired. Ruins are being repaired with coral rocks and lime. Repairs are done on frequent basis and are only repaired to their original position (Fig. 5).

Renovation and Refurbishment of some Structures

Some parts of Fort Jesus and Mombasa Old Town have been renovated. Renovation is the change of the entire materials to be replaced with new ones that are resistant to the hostile environment. Renovation prolongs the life of a building; therefore, it is preserved.

Placement of Blocks to Reduce Water Speed

Massive blocks have been placed near Vasco da Gama Pillar to counteract the effects of waves. This is one of the strategies in place to protect the pillar from coastal erosion that has seen the loose of the basement (Fig. 6).

Creation of Drainage Systems

Drainage systems have been opened up in the immovable cultural heritage sites to allow easy flow of water. Availability of good drainage systems reduce water blockage that could increase dampness in the structures increasing rate of deterioration. Drainages have been enlarged to cope with increased rainfall. Gutters have been enacted to collect water into a designated storage area.

Fig. 6 Blocks placed at Vasco da Gama Pillar (Authors 2019)

Managerial and Policy Adaptations

Involvement of Local Community

The local community needs to be involved in the decision-making process on the adaptation strategies that are to be put in place in the site. Local communities through the barazas are made aware of what to expect and the proposed plans in place. Locals have participated in beach cleaning exercises and tree planting within the sites.

Regular Maintenance

Monitoring on the areas where the impacts are severe and maintaining the surrounding environment. Activities such as cutting of long grass in the site, uprooting of plants grown on the structures, and cleaning the sites through sweeping maintain the overall appearance of the cultural heritage. Growth of plant and other materials on the structures acts as agents of deterioration.

Education

Knowledge and information has been disseminated among the staff and management so as to be prepared on the climate changes and have response strategies in place. Every site has educational programs that they use to educate people on the importance of preserving and protecting the heritage sites. Brochures are also available at the front desk for visitors to learn more about the heritage.

Inclusion of Climate Change in the Management Plans

Since the beginning of the twenty-first century when the adverse impacts of climate change began being felt, majority of the sites have included it in their management plans. Policies exist but their implementation is a problem due to barriers such as

inadequate resources. Management needs to make changes to the plans and work on those that require urgent attention.

Enactment of Policies to Protect the Sites

Rigid policies need to be enacted so as to protect the sites from both natural and human factors. Some sites such as the ruins have enacted policies that prohibit visitors from stepping on the ruins. This policy helps in maintaining the ruins as they are without losing other important parts.

Mitigation Strategies

Immovable cultural heritage also support the protection of natural environment. Staff at the sites participates in tree planting activities within the site which act as wind breakers. Trees also help the sites indirectly in regulating gases in the atmosphere that cause global warming.

Conclusion

Following the results of the study, the main cause of immovable cultural heritage deterioration along the Kenyan coastline is climate change. Historic buildings have been subjected to a number of threats such as sea level rise, heavy precipitation, high temperatures, frequent strong winds, coastal flooding, rise in acidity levels, coastal erosion, ocean currents, and changes in seasonality. Immovable cultural heritage are exposed to different environmental factors depending on their locality. The rate of deterioration on the immovable cultural heritage depends on the materials used for construction. The study explored the assessment of climate change impacts and response strategies on the immovable cultural heritage along Mombasa and Kilifi coastline. The historic buildings included Fort Jesus, Mombasa Old Town, Gede Ruins, Mnarani Ruins, Vasco da Gama Pillar, Jumba la Mtwana, Portuguese Chapel, and Watamu Monument. The sites faced direct deterioration from climate change through splitting, formation of cracks, peeling off of paints and walls, and erosion of basement. On the other hand, climatic factors may indirectly contribute to deterioration of the immovable cultural heritages through provision of conducive environment for growth of plants and infestation of insects.

Apart from climate change being a major factor in the deterioration of the immovable cultural heritage, other factors include old age and human factors. Majority of the history buildings were constructed between the twelfth and the fifteenth century. Materials used for construction can no longer withstand the external environment. The immovable cultural heritage sites require renovation and refurbishment of the materials. Some of the sites especially the mixed cultural heritages like Mnarani Ruins, Gede Ruins, and Jumba la Mtwana are also threatened by human factors. These factors include vandalism and local community cutting down trees within the site which in turn fall on the ruins causing collapse of some walls. Adaptation for immovable cultural heritage is possible, and the future for our heritages is bright if adaptation is embraced within individual sites. Therefore it is

necessary for the government and other stakeholders to come up with a national framework and policies to address the impacts of climate change on immovable cultural heritage.

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