

Survey of the extent of human-induced beach erosion problems in Tanzania

N. Nyandwi

Institute of Marine Sciences, University of Dar es Salaam
P.O. Box 668 Zanzibar, Dar es Salaam, Tanzania

ABSTRACT

An assessment of the coastal erosion problems along selected stretches around the Zanzibar coastline as well as along the mainland coastline of Tanzania, indicated a significant contribution to the problem by human activities. During the study, 56 eroding beaches were examined to assess the extent of anthropogenic activities to the problem. Human-induced erosion was observed at nine sites. By interfering with natural processes, human activities either initiated erosion or enhanced its rate. The activities identified fall into three categories namely, removal of beach material, removal of the protection against wave battering and obstruction of sediment supply.

The observed human-induced erosion has occurred as a negative effect resulting from poor understanding of the natural processes. It was found that sand extraction from the beach for road construction was taking place on Zanzibar because many thought that beach sand is more needed for the roads than it is for the stability of the beach itself. Similarly, mangroves are being cleared in front of newly constructed tourist hotels because the developers are mainly concerned with having a clear view to the sea and absence of mangrove leaf litter to improve the hotel site aesthetics. As such, the mitigation measures that are to be considered in such situations are expected not to be complicated. The findings suggest that the possible negative effects of any coastal development should be considered prior to its execution. In some cases coastal managers need only to establish a catalogue of activities that may not be permissible along a given stretch of coastline.

INTRODUCTION

Coastal erosion in Tanzania has become a serious problem dating back to the early 1970s (Beach Erosion Monitoring Committee, 1987). Usually concern over beach erosion problems has been raised in areas or cases where investments placed at the shoreline were threatened. In recent years, the development of tourism has seen increased construction

of expensive beach hotels and other related infrastructure, such as roads, close to the shoreline. Thus, with the increasing coastal development the erosion problem has become more apparent and consequently the need for its management more acute.

In order to properly manage the problem, erosion rates and causes need to be known. Until now erosion rates have been established in isolated cases only (e.g. Nyandwi, 1990) and efforts to identify the causes have so far remained inconclusive. Nevertheless, much of the observed coastal erosion in Tanzania has been attributed to natural processes of hydrodynamic and geologic nature including strong waves, tides, longshore currents and tectonics (Beach Erosion Monitoring Committee, 1987; Rossi and St Ange, 1986; Nyandwi and Muzuka, 1991; Mohamed and Betlem, 1996). On the other hand the influence of human activities has not been seriously considered in Tanzania. For instance, whereas it is already established that some human activities such as the extraction of beach sand for construction contribute to the problem of coastal erosion (Nyandwi, 1996), it has remained a strong speculation that destruction of the coral reefs through dynamite fishing accelerates shoreline erosion. Therefore, the management of the erosion problem should seek to identify those human activities that contribute to the problem.

It is due to the above mentioned concerns that this paper intends to crystallise the extent of the human contribution to beach erosion in Tanzania and suggest remedial measures.

GEOGRAPHIC SETTING OF COASTAL TANZANIA

Tanzania has about 800km of mainland coastline and a number of islets including major and inhabited islands of Zanzibar (Unguja and Pemba) to the northeast and Mafia in the south (Figure 1). Erosion problems have been reported along virtually the whole stretch of the mainland coast and around Zanzibar and Mafia islands. Areas known to be severely affected include the Dar es Salaam area, Mtwara-Lindi area to the south and Tanga area in the north. The east and west coasts of Unguja island experience similar erosion problems with tendency towards intense erosion on the east coast. Pemba Island experiences less erosion, as much of the shoreline is fringed by mangroves.

Much of the coastline of Tanzania is composed of quaternary formations, mainly unconsolidated raised beach sands, raised reef limestone and low-lying mangrove-covered sands. With the exception of the mangrove areas, all the rest are susceptible to erosion. Owing to demand pressure on mangrove products, most of the mangrove stands have decreased in size as compared to the recent past (Shunula, 1990). The Tanzania shoreline, like most of the East African region, is flanked seawards by a fringing reef which at localities stands exposed or just below sea surface at low tide. The tidal range of up to 4m in this region means erosion of the high beach would only be possible at high water springs superimposed by strong wave conditions. The region is swept by the monsoons which blow from the northeast during the southern hemisphere summer and from the southeast during the northern summer (Newell, 1957). The direction of the longshore currents follow the wind reversals.

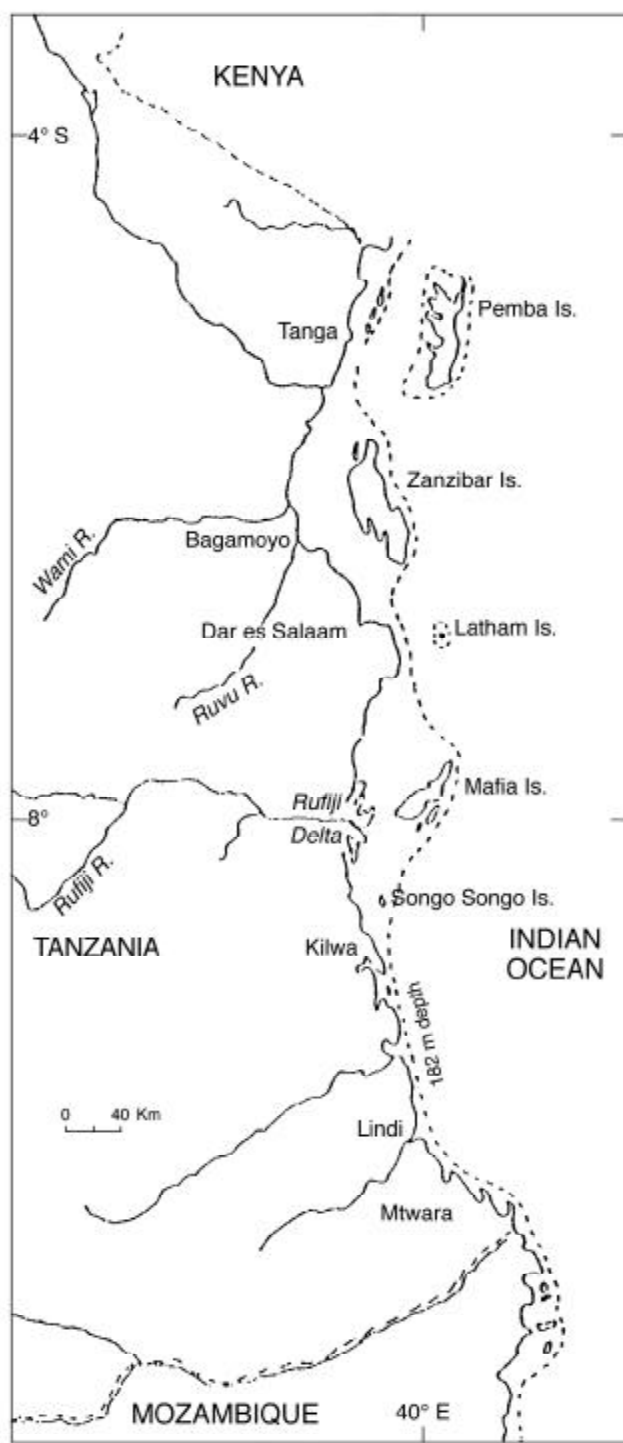


Figure 1. Map of coastal Tanzania

The economic activities of rural coastal dwellers are mainly associated with ocean resources, mainly fishing. It has been reported that some of the fishing methods, such as dynamiting destroy the coral reefs. Other uses of the ocean and nearshore resources include sand extraction for construction, lime making from coral rocks, salt pans, ports and harbours, mangrove cutting for poles, etc. Coastal erosion has in some cases been blamed on these activities (Francis et al., 1997).

METHODS

The information being presented here is a result of observations made through field surveys and data analysis. Three separate but related surveys were conducted between 1995 and 1997. Initially a field work group was formed and supervised by the Department of Environment, Zanzibar to make field observations on all beaches of Unguja and Pemba including small islets. Data were collected on among others, signs of erosion. Beach lengths were measured and features of every 500m and 50m of beach stretch recorded. Equipped with the data an assessment of the status of erosion on Zanzibar was made and problem areas related to human activities identified and visited.

Based on existing information on erosion some eroding beaches of Dar es Salaam, Bagamoyo, and Tanga on the mainland coast as well as those of Unguja and Pemba were visited. During the visits interviews were conducted with sections of the coastal community on the rates and known or suspected causes of erosion. Anthropogenic activities in the coastal zone with potential negative consequences to the shoreline stability were identified and assessed for their contribution to the problem. Issues such as sand extraction from the beach, coral boulder extraction for lime making, motorised traffic on the beach berm, construction of sea walls and jetties, cutting of mangroves, dynamite fishing, salt making, etc. were addressed.

Each shoreline visited was divided into a number of eroding beach stretches that are not connected to one another, being separated by features like headlands, mangrove stands, etc. A total of 56 eroding beach segments were recorded (31 on Unguja Island, 17 on Pemba and 3 in Tanga, 1 in Bagamoyo and 4 in Dar es Salaam).

Data were analysed on 56 contiguous segments of eroding beaches of Dar es Salaam, Bagamoyo, Tanga, Unguja and Pemba. Erosion was found to take place along sandy as well as cliffed shorelines. The cliffed shorelines that are undergoing erosion are mainly composed of raised coral reef and the erosion rates are very small except at Mwambani area in Tanga.

RESULTS

On 9 of the beaches visited, the erosion problems were observed as being clearly aggravated by anthropogenic activities. The activities that contribute to erosion problems were found to fall in the following categories: (i) obstruction of sediment supply or modification of the water flow (i.e. development of beach structures), (ii) removal of

beach material, (iii) removal of protection against wave battering, and (iv) poor planning. Each of these activities is described more fully below.

Effects of beach structures

Obstruction of sediment supply or modification of the hydrodynamics is brought about mainly by the construction of engineering structures. These include structures placed along the beach, e.g. sea walls and those placed quasi normal to the beach, e.g. jetties. Structures placed perpendicular to the beach impede longshore sediment transport, hence accelerated erosion downstream of the current. Sea walls on the other hand, protect areas behind them but the problem usually shifts to the unprotected ends of the wall. Poor design of the structures leads to failure and easy opening for further erosion. This is also the case when groynes are poorly spaced. Salt pans are usually connected to the sea by a channel which is closed to allow crystallisation. During the closure, water piles up at the channel mouth leading to erosion of adjacent areas especially when strong waves prevail. The following examples represent different scenarios that were encountered:

Mtoni area

A relatively long, jetty-like structure was erected in the 1980s at Mtoni area a few kilometres north of Zanzibar Town by the Kajima construction company for loading and offloading of construction materials. The structure, which is about 0.5m high, extends onto the tidal flats to the north of Maruhubi Restaurant. This wall can be said to have been wrongly placed because it impedes longshore sand supply. It appears that the intensive erosion at Maruhubi Restaurant to the south during the NE monsoon owes much to the structure.

Jambiani sea wall

The beach is mainly made of carbonate sand. At Kibigija, somewhat halfway between Jambiani and Paje on the east coast of Unguja a wall was constructed (in 1977) by the Government to protect a section of the beach from erosion. Although the wall can be said to have been effective for what it was intended, erosion has continued or shifted to the northern end of the wall where loss of land amounts to about 10m in width since 1977.

Maruhubi sea wall

A sea wall was constructed behind the Maruhubi Restaurant, to the north of Zanzibar Town, to protect the hotel. This wall has been renovated several times and it seems the place has seepage problems as well. The wall is very unstable. Erosion at the ends of the wall is continuing unabated.

Mkoani Jetty

The jetty at Mkoani in Pemba, is situated nearly E-W. On its northern side is a small mangrove stand which is a natural sediment sink. Immediate to the wall however, there are also signs of erosion taking place. On the southern side of the wall severe erosion is taking place. People in the area observe that intense erosion began after the construction of the jetty in the late 1980s. It appears that the erection of the jetty has led to concentration of wave energy leading to accelerated erosion. Southward longshore sediment transport does not appear to be important. Much of the sediment that is eroded from the beach is deposited on the tidal flats. It seems a sea wall may be inevitable to protect the little residential area available.

Removal of beach material

Sand for road construction in Zanzibar has been extracted from the beach. Although it is believed that sand is being taken from the western coast due to its abundance, there are all indications that the deposits are not that large. Beach sand is also extracted by local people at varying rates almost from every beach around Unguja (Mohamed and Betlem, 1996). The effects of sand extraction could be observed at one location as follows:

Unguja Ukuu

The beach located on the southern coast of Unguja is predominantly carbonate. Sand extraction has been going on for about two years (1994/95). Land loss over the two- year period amounts to a 5m wide coastal strip. According to the local people there has been a dramatic loss of beach sand and the remaining amounts are just a third of what they used to be before the beginning of the extraction. During the field visit, uprooted trees could be observed. A similar situation is expected at Chuini where sand extraction is taking place as well. Sand mining on the beaches was permitted by the Government due to lack of alternative source of quality sand required for the road construction projects. It should be pointed out that the sand that moves up and down the beach is necessary for beach stability against erosion. Its removal accelerates erosion.

Removal of protective mangrove forest

Mangroves have been cut for various reasons for centuries. However, the demand has now evidently surpassed supply and the stocks have dwindled with time. In some areas total loss of the forests has occurred. Mangroves are buffers against wave battering and slacken the tidal currents thereby enhancing sedimentation. Their removal generally encourages erosion. The following were observed:

Mbweni Beach

The area, a few kilometres to the south of Zanzibar Town, is experiencing serious erosion. Two activities both with negative effects are taking place here, namely mangrove cutting and sand extraction from the neighbouring beaches. Mangroves usually act as buffer against wave battering and their removal aggravates the problem.

Bagamoyo Beach Hotels area

The northern extremity of the area earmarked for tourist hotel development is fronted by mangrove stands. Some hotel owners have cleared the mangroves in front of their properties and the results are demonstrative. At such sites erosion rates of up to 3m in a year were observed.

Poor planning

Along most of the beaches of Zanzibar the current trend is to erect expensive beach hotels and residential houses directly on or very close to the beach. These structures are threatened by erosion right from the time of their construction. The hotels at Uroa, Chwaka and the bungalows at Uroa, both on Unguja Island, are an example. Similar situations exist in the Dar es Salaam area. Hotel Africana which was built on a dune had lost more than 50% of its residential huts by the late 1980s. Another hotel just to the north (Kunduchi Beach Hotel) was only 2m away from the fast-encroaching sea before reclamation was carried out in 1998 (Dubi and Nyandwi, 1999). The hotel was built on a dune in the 1970s. According to folklore, this dune emerged after the sea retreated about 2km seawards late in the 19th century to early 20th century.

RECOMMENDATIONS ON MANAGING MAN-INDUCED EROSION PROBLEMS

The general recommendations to be drawn are straightforward:

1. Sand extraction from the beach should be stopped and alternative sources, offshore or on land, should be explored. In the case of Unguja, it is possible that sand of good quality forms some of the beds in the Masingini series. This is implied by the abundance of quartz sand on the west coast where riverine supply is more pronounced. In the absence of the alternatives, importation from mainland Tanzania should be considered. Alternatively, it is possible to choose technology that does not require use of beach sand.
2. Mangrove cutting for any purpose should be discouraged and controlled more effectively. Mangrove replanting should be seriously considered.
3. Beach structures, though intended to protect the beach, may also lead to erosion. The construction of sea walls, jetties etc. must be based on both established stability criteria and effects on the environment.
4. Construction of expensive properties too close to the beaches should be discouraged. Most of the complaints and awareness of the problem come about largely because properties are threatened and not because the owners are concerned with the encroaching sea.

DISCUSSION

Although coastal erosion needs to be controlled, such attempts should be based on well established causes. In many parts of the coast, two types of management solutions which are scientifically questionable have been undertaken.

Dynamite fishing

This type of fishing destroys the coral reefs. Some section of the world scientific community believes that the blowing apart of the coral reefs accelerates shoreline erosion. The argument comes from the belief that the fringing reef or coral reefs of the coastal waters act as barrier against strong waves. This line of argument is spreading fast and coastal zone managers and government officials are pressing the fishing community to stop destroying the reefs so as to contribute in slowing the rates of erosion. Two pieces of evidence however, show that dynamite fishing does not accelerate shoreline erosion at least along the coastline of Tanzania. Firstly, dynamite fishing is a recent phenomenon dating not more than 20 years back (in the 1970s), yet erosion problems in the north of Tanzania (Tanga region) for instance, are reported (by coastal villagers) to have been of the same magnitude as today, more than 50 years back. Secondly, the large tidal range of up to 4m dictates that waves of about this height will pass over the fringing coral reef at high water springs. Waves of this size (3–4m) are strong enough to inflict damage to the shoreline. It is therefore, a dangerous conclusion to associate beach erosion with dynamite fishing in the East African region.

Mangrove reforestation

It is widely accepted that mangrove vegetation stops erosion. But it should also be understood that mangrove vegetation grows only in certain preferred environments. Replanting of mangrove trees has been encouraged in situations where indiscriminate cutting has resulted in loss of the forest. Reforestation efforts are being implemented in Tanga region (pers. observ.). However, in some places a lot of effort is being wasted as villagers are urged to plant mangroves in high energy environments where mangroves are not known to have naturally succeeded in the past. During the field work, uprooted as well as dead seedlings were observed at Kigombe in Tanga. There is no evidence of any human-induced erosion at this site. It is sad that the villagers have been made to believe that their shoreline is eroding because of the absence of mangrove forests.

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