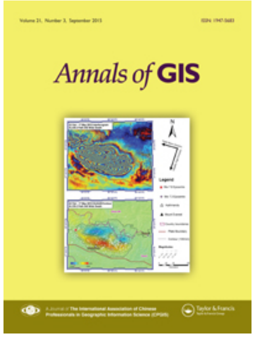

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Assessment of sand and stone mining along the coastline of Cape Coast, Ghana

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Mining of sand and stone from the coasts provides an inexpensive source of materials for the construction industry while providing income to contractors. However, these activities come at a cost to the coastal environment and pose a threat to the tourism industry along the Ghanaian coast. This paper identified the various types of coastal sand and stone mining activities, the level at which they are undertaken and covers the trends in coastal erosion along the coast of Cape Coast, Ghana. ArcGIS (ESRI, Redlands, CA, USA) and Digital Shoreline Analysis System (DSAS; ESRI) tools were used to determine short-term (2005–2012) coastline changes using 2005 and 2012 coastlines data. This study estimates that tipper-truck-based beach sand mining activities alone account for the loss of about 285,376 m^3/year of sand from the littoral zone in the Cape Coast area. It was also established that the average erosion rate for the Cape Coast area within the seven year period is 0.85 m/year with two areas recording high erosion rates of 4.35 m/year and 4.25 m/year. The study concludes that sand mining is the main cause of erosion along the coastline of Cape Coast.

Keywords: coastal erosion; coastal management; human factors; Ghana

1. Introduction

Two-thirds of the world's major cities contain 60% of the world's population and are located in coastal zones (Cai et al. 2009) known to be the cradle of human development (Boateng 2006a). The global average sea level has been rising over the last 100 years and by 2100, the sea level is projected to be approximately 50 cm higher than it is today (Cai et al. 2009). These anticipated effects of climate change will greatly amplify risks to coastal populations with the projected global sea level rise leading to the inundation of low-lying coastal regions and inducing more frequent flooding during storm surges and beach erosion (Cai et al. 2009).

In economic terms, sandy beaches are amongst the most valuable natural assets, underpinning many coastal developments and related industries (Klein, Osleeb, and Viola 2004). Coastal zones have nurtured humanity through countless centuries serving as a source of food, salt, construction material for housing and employment to the people (Mensah 1997). Notwithstanding the many economic benefits gained from the coast, the area primarily serves as a natural protection and armour for coastal communities against storm surges and waves (Mensah 1997) with coastal dunes playing an important role in regulating coastal groundwater by serving as a barrier for landward saltwater intrusion (Carter 1991).One of the major challenges that confront coastal countries today is how to control coastal erosion, since at least about 70% of sandy beaches across the world have been found to be retreating (Bird 1985; Hanson and Lindh 1993; Cai et al. 2009). This global challenge in dealing with the erosion problem may be due to the varied range of causes that encompass both natural- and human-related factors. Beaches seem to be trapped in a 'coastal squeeze' between the impacts of human-related factors on the terrestrial side and manifestations of climate change at sea (Schlacher and Thompson 2007). Unconstrained, beaches are resilient, changing shape and extent naturally in response to storms and variations in wave climate and currents (Schlacher and Thompson 2007); however, human modifications of the coastal zone severely limit this flexibility (Nordstrom 2000) bringing with it a range of largely unknown and less understood consequences to the coastline. Natural factors contributing to coastline retreat include climate-change-induced sea level rise and increased storminess (Carter 1991; Slott et al. 2006), river watershed changes (Cai et al. 2009), the actions of the wind, waves and tides causing littoral drift of sediments while human-induced factors include urbanization in the active dune areas, shore armouring, sand mining and construction of jetties

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(Esteves et al. 2003). The contribution of overwash to severe erosion has also been extensively discussed by Park and Edge (2011).

Human-related causes of coastal erosion have been widely associated with activities that interfere with the coastal sediment budget. Along the Spanish coast, Alonso, Alcántara-Carrió, and Cabrera (2002) and Sanjaume and Pardo (2005) identified the widespread beach erosion as a direct consequence of development of tourism resorts, road widening, sand mining, construction of dams, jetties and breakwaters. Hsu, Lin, and Tseng (2007) identified similar human interventions to significantly contribute to coastal erosion along the Taiwanese coast. Damming-induced coastal retreat has been widely reported in many delta and coastal areas all over the world including the Nile (Stanley 1996), Mississippi (Day et al. 1995), Yangtze (Chen et al. 2005), Ebro (Sanchez-Arcilla, Jimenez, and Valdemoro 1998), Rhone (Day et al. 1995), Volta in Ghana (Ly 1980) and Skokomish (Jay and Simenstad 1994) and Trinity (Phillips, Slattery, and Musselman 2004) in the United States.

In recent years, several studies which focused on Ghana's coastline have attributed the retreat of the coastline and the general deterioration in the quality of beaches to the widespread practice of beach sand mining (Biney et al. 1993; Mensah 1997; Boateng 2006b; Appeaning, Walkden, and Mills 2008; Appeaning 2009; Armah 2011; Oteng-Ababio, Owusu, and Appeaning Addo 2011; Boateng 2012). Some studies have also provided estimates regarding the rates of retreat of various stretches along Ghana's coastline. For the Accra area, Appeaning, Walkden, and Mills (2008) estimated an average long-term historic rate of erosion to be about 1.13 $m \cdot year^{-1}$, whilst Armah (2011) projected that the rate of erosion would increase to 6.1 $m \cdot year^{-1}$ by 2015 and further rise to about 30.2 $m \cdot year^{-1}$ by 2020. Boateng (2012) subdivided Ghana's coasts into four case studies, from the eastern to the western coast. He identified case studies One, Two and Three to have retreated an average of 3.9 $m \cdot year^{-1}$, 2.9 $m \cdot year^{-1}$ and 1.6 $m \cdot year^{-1}$, respectively, while case study Four experienced a net accretion of 0.05 $m \cdot year^{-1}$ over the same period. Boateng (2012) noted that the serious threat of coastal recession and flooding along the eastern coast was due to the soft geology, low-lying topography and the reduction of sediment supply from the Volta, while he attributed the erosion in other areas to the construction of buildings and jetties. Appeaning, Walkden, and Mills (2008) and Armah (2011) used sea-level rise estimates to model and predict future erosion rates for the Accra area. Though all these studies recognized the contribution of sand mining to Ghana's retreating coastline, they did not provide information about the kinds and magnitude of sand mining activities that are practised. In contrast to the natural causes of beach erosion, sand mining directly causes a net loss in available sand volume to the littoral system. This makes it essential for coastal managers to identify the various types and magnitude of sand mining activities in order to develop workable management strategies to protect coastal assets.

This study focuses on the coastline of Cape Coast and adjoining sections. It identifies the various coastal sediment mining activities that are practised and discusses their contribution to the erosion of the coastline. The study also discusses the current management strategies in place to deal with coastal sediment mining practices and erosion issues.

2. Materials and methods

2.1. Study area

The study was carried out at three adjoining communities: Elmina, Cape Coast and Moree in the Central Region of Ghana (Figure 1). Latitude 05°07′50.0″N and Longitude 001°38′20.0″W (Elmina) and Latitude 05° 13′91.2″ and Longitude 001°19′07.4″W (Moree) represents the limits of the study area with a total coastline length of about 25 km.

The area is generally undulating with batholiths as a dominant feature and the slopes of the hills here are steep in many parts. In between the hills are valleys of various shapes, some occupied by rivers and streams including the Kakum – the major river in the study area and many of the minor streams end up in wetlands at the coastline.

The coastline is made up of stretches of sandy beaches intermittently separated by cliffs or rock outcrops. It is also home to several communities with fishing being the major economic activity. Along the coast are several tourist facilities including beach resorts and restaurants. Two important national tourist facilities, the Cape Coast and Elmina Castles, are also located along this coastline. The unemployment rate is 11.3% with about 63% of the total population working in the private informal sector (CCMA, 2010). This situation compels most of the youth along the coast to engage in beach sand mining activities to augment their income. Several communities within Elmina, Cape Coast and Moree were amongst the earliest settlements in Ghana. Houses in these communities were mostly constructed with clay and wood before or during the early part of the twentieth century. In recent years, most of these buildings have been renovated making use of concrete blocks moulded with sand. New buildings in these communities are constructed with concrete making use of readily available beach sediments along the coast to provide affordable housing for residents.

2.2. Field surveys

Field surveys were conducted along the entire stretch of the study area (i.e. Elmina, Cape Coast and Moree coastline) from November 2010 to November 2012. Field observations were carried out by visiting all the beaches in the area to identify ongoing human activities and the state and nature of the coast. Observations were recorded and photographs taken along the entire coastline stretch.

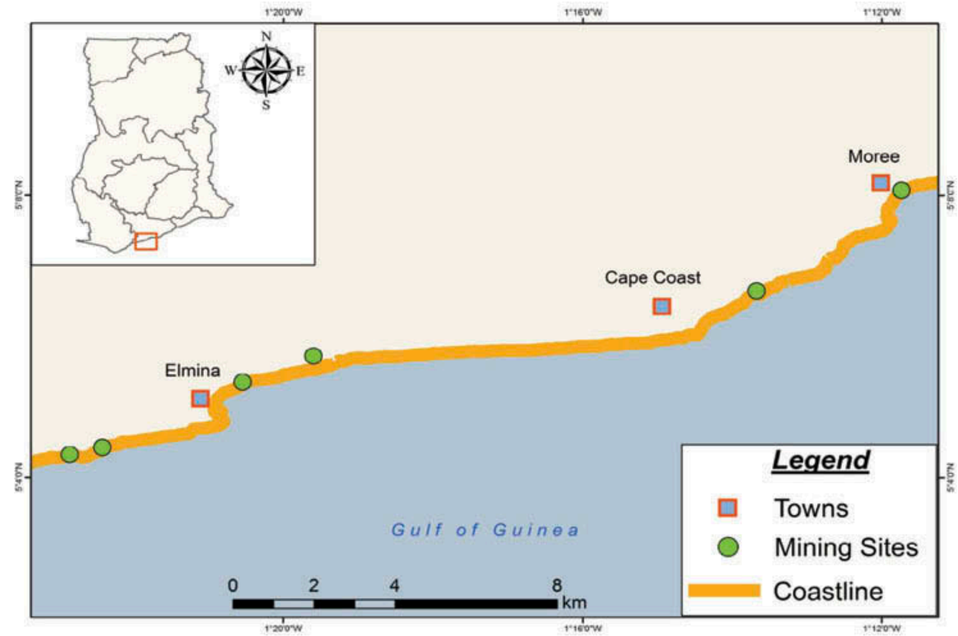

Figure 1. Elmina, Cape Coast and Moree coastline showing commercial sand mining sites.

2.2.1. Coastal sand and stone mining survey

Sand mining surveys were carried out to estimate the quantity (volume) of sand that is lifted from the study area in a given period. Preliminary observations indicated that six beaches were used by tipper-truck-based sand miners for their operations along the study area. Three of these sand mining sites were located in Elmina with two sites located in Cape Coast and one site at Moree. These six sites were surveyed concurrently, by counting the number of trucks that exited each site carrying a load of sand over a seven-day period. Observers were placed at vantage points where the movement of trucks to and from the various mining sites could be seen. Surveys were conducted from 5:00 am to 6:00 pm each day. At one of the sites called Mbofra Akyinim, sand mining activities was mostly done at night to avoid detection from local authorities. Hence, observation was extended to 11:00 pm for that particular site. Varying truck capacities were used for sand mining in the study area. However, eight cubic meter (8 m^3) trucks were observed to be commonly used. Hence, the 8 m^3 truck capacity was assumed to be the standard truck size and was used in the determination and calculations of sand volumes mined from the study area. In order to estimate the volume of sand mined, the number of tipper trucks recorded were multiplied by the standard truck capacity.

2.3. Measuring short-term coastal erosion

Anfuso and Pozo (2009) described periods less than 10 years as short term when undertaking shoreline change studies. To obtain an accurate depiction of permanent and short-term coastal erosion, an analysis of the coastline changes over a seven-year period (2005–2012) was conducted for the area using ArcGIS (ESRI, Redlands, CA, USA) and Digital Shoreline Analysis System (DSAS; ESRI) tools. Two data sources were used: a 2005 orthophotograph of the study area and a 2012 GPS shoreline data obtained by traversing the entire coastline stretch of the study area using a Garmin 60Cx GPS (Garmin, Olathe, KS, USA). The high water line (HWL) proxy (Anders and Byrnes 1991; Crowell, Douglas, and Leatherman 1997; Farrell et al. 1999; Fenster and Dolan 1999; O'connell and Leatherman 1999; Zhang et al. 2002) was used to define shoreline positions. The HWL was first identified at one end of the study area and closely followed to obtain the shoreline data. This was done on the 2005 orthophotograph in ArcGIS and *in situ* at the coast during the 2012 GPS shoreline acquisition (conducted from 8 May to 10 May, 2012) to obtain the two respective shoreline data. These were then incorporated into ArcGIS environments and DSAS used to calculate the rate of change (End Point Rates [EPR]) statistics by following the procedure described by Himmelstoss (2009). On the DSAS settings, a default uncertainty of ± 6 m was adopted to represent the uncertainty in the acquisition of shoreline data.

3. Results

3.1. Types of coastal sand and stone mining identified along the Cape Coast coastline

Sand mining activities were observed on almost all the sandy beaches in the study area with stone quarry mainly

Table 1. Sand and stone mining activities identified along the coastline of Cape Coast based on the type of product mined, observed quantity taken by miners, the equipment used and the medium of transporting the product.

Category	Sub-category	Nature	Description
1. Beach sand mining	Tipper-truck-based	Commercial, in large scale	This includes sand transported by tipper trucks
	Low capacity truck-based	Small scale non-commercial to large scale commercial	This includes those transported by low capacity trucks, for example, pickups, kia trucks, etc.
	Manually transported	Small scale non-commercial to small scale commercial	This is made up of all kinds of sand mining activities where sand is manually transported without the use of mechanized transport including the use of pushcarts, wheelbarrows, basins, buckets, etc.
2. Beach gravel mining		Commercial, in small to large scale	Sand and pebbles are gathered from the beach or sifted from incoming waves by using cane baskets, graded to sizes and transported by tipper trucks and other large capacity trucks
3. Coastal stone quarry		Commercial, in large scale	Rocks are broken off rocky and cliffed areas and crushed for the construction industry

practised at Amoakofua. Gravels are mined at several locations including Amanful, Amoakofua, Ekon and Moree. A classification of the sand and stone mining activities based on field observations is presented in Table 1. This classification is based on the type of product mined, observed quantity taken by miners, the equipment used and the medium of transportation of the product (Figure 2).

Figure 2. Coastal sand and stone mining activities identified in the Elmina, Cape Coast and Moree coastline. (A) is an example of a tipper-truck-based sand mining activity, (B) shows pebbles gathered at a beach awaiting transportation, (C) is non-tipper truck-based sand mining activities where cement blocks are moulded on the beach and transported by low capacity trucks, (D) is an example of a manually transported beach sand mining activity using a pushcart.

3.2. *Quantity of sand lifted by commercial sand miners*

For the six tipper-truck-based sand mining sites, the weekly averaged volume of sand mined in the study area was 686 m^3. From this weekly average, a projected 285,376 m^3 of sand is mined annually from the study area through the use of tipper trucks alone (Table 2). During this field survey, Moree was identified to be the most intensely mined site with a projected annual sand mining volume of 133,952 m^3, whereas Amoakofua site was identified to be the least mined site currently with a projected volume of 11,648 m^3 of sand mined annually.

3.3. *Short-term coastal erosion rates*

The shoreline change analysis indicated that the average short-term coastline rate of erosion for Cape Coast, based on 2005 and 2012 data, is $-0.85\text{m} \cdot \text{year}^{-1}$. The highest short-term rates of change recorded were $-4.35\text{m} \cdot \text{year}^{-1}$ and $-4.25\text{m} \cdot \text{year}^{-1}$ at Mbofra Akyinim and Amoakofua, respectively (Figure 3). At Mbofra Akyinim, only tipper-truck-based sand mining activities was being undertaken while at Amoakofua, tipper-truck-based sand mining, beach gravel mining and coastal stone quarry were all being undertaken.

4. Discussion

4.1. *Types of sand mining activities*

The intensity of all the identified types of mining activities is dependent on the demand from the specific end users. Tipper-truck-based sand mining operations are fully commercial ventures undertaken by contractors whose business

Table 2. Estimated volume of sand mined (m^3) along the Elmina, Cape Coast and Moree coastline based on tipper truck load.

Day	Moree	Amoakofua	Elmina Bridge	Akotobinsin	Mbofra Akyinim	Ankwanda	Total
Monday	416	32	32	64	72	248	
Tuesday	376	48	64	48	88	272	
Wednesday	392	24	48	48	56	264	
Thursday	336	40	48	56	72	232	
Friday	368	48	40	48	112	288	
Saturday	312	32	56	48	48	216	
Sunday	368	0	0	24	56	40	
Daily averages	368	32	40	48	72	224	784
Weekly averages	2576	224	280	336	504	1568	5488
Annual Estimation	133,952	11,648	14,560	17,472	26,208	81,536	285,376

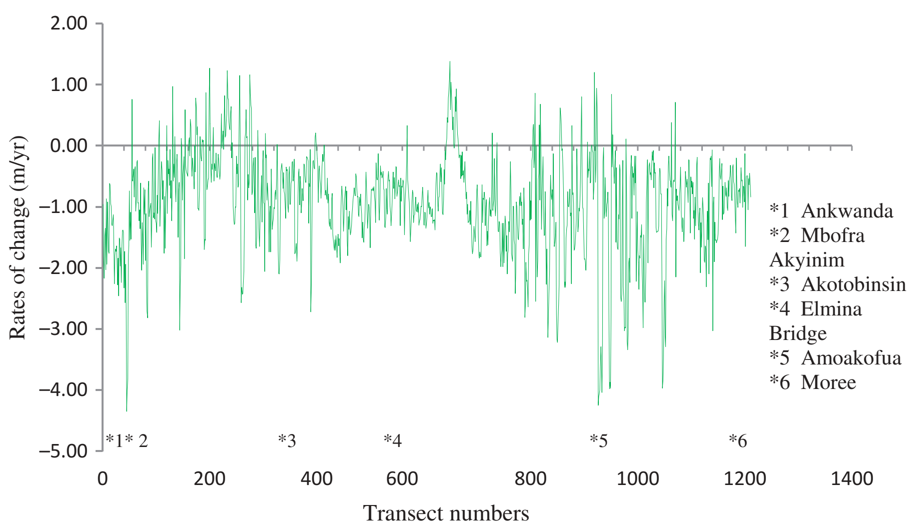

Figure 3. Short-term (2005–2012) coastline rates of change (m/yr) for the Cape Coast area with sand mining sites indicated by (*). Values below 0.00 indicate erosion whilst values above 0.00 indicate areas of accretion.

is solely to supply building materials to builders. They supply products within the vicinity of the coast or to locations several kilometres away. These contractors usually engage the services of youth residing in nearby communities to scoop the sand into the trucks for a fee. In contrast, the operations of low capacity truck-based sand miners span from small-scale non-commercial to large-scale commercial activities making use of small pickup trucks to low capacity non-tipper truck vehicles. This type of mining activity is undertaken by residents, who may use their personal vehicles to go for beach sand for their own use, or by contractors who do not have access to tipper trucks and use such vehicles to transport their products.

Sand obtained from manually transported sand mining activities is usually used within the vicinity where it was taken. Coastal residents engage in these activities to satisfy small construction needs. Some youth within such communities are sometimes paid minimal amounts to provide these building materials to residents who are unable to collect sand personally from the beaches.

With regard to beach gravel and coastal stone quarry operations, contractors usually purchase products along the coasts from residents who would have already sorted and graded stones into different size categories. Residents who are engaged in these activities usually use cane baskets to collect gravels from the beach and incoming waves. Those engaged in stone quarry obtain their products by chipping the sides of cliffs or breaking beach rocks into smaller sizes for sale.

In a bid to avoid detection and arrest by authorities, several miners prefer to undertake their activities at night. This was observed at Mbofra Akyinim, with tipper-truck-based sand mining operations, and at several communities, with manually transported sand mining operations. However, most of the other types of mining activities were done only during the daylight hours.

4.2. Sand mining along the Cape Coast coastline

Illegal coastal sand and stone mining is widely practised along the coast of Cape Coast to meet the demands of the construction industry (commercial and medium scales) and to reduce the cost of construction or renovations by poorer coastal inhabitants. Coastal sand mining has been practised in Ghana dating back to the 1970s as has been noted in earlier studies by Biney (1982), Sackey (1991), Biney et al. (1993), Mensah (1997) and Boateng (2006b). Mensah (1997) suggested socio-economic factors such as inadequate employment, high profit margins, ease of access to the coast and low environmental awareness of residents as the main reasons why people engage in coastal sand mining. Regardless of the reasons for engaging in sand mining, it is clear that this practice has gained its current widespread nature mainly due to the lack of enforcement of environmental regulations by the legally mandated agencies such as the Environmental Protection Agency (EPA), the Ghana Police Service and the local Metropolitan and District Assemblies.

It was observed in this study that there was some form of sand mining activity along the entire coastline of Cape Coast. Similar observations were contained in an *ad hoc* committee report (CCMA 2011). This *ad hoc* committee was set up by the CCMA following the requirement to protect the beaches from degradation through illegal sand mining and its consequent sea erosion in the area. The committee had membership from the EPA, Ghana Police Service, Bureau of National Investigations, National Disaster Management Organization and the Metropolitan Assembly. They observed widespread sand mining activities along the coastline and made recommendations for immediate actions. However, following the release of this report, no sustained regulatory and enforcement activities have been observed in the area to curb the practice. The inactions of these statutory institutions coupled with the high demand for beach sand and stones may very well be the major reason for the widespread practice of beach sand and stone mining in the area.

4.3. Volume of sand mined in the Cape Coast area

Field surveys conducted during this study indicated that, presently, about 285,376 m^3 of beach sand is mined annually by commercial sand miners alone; they use tipper trucks for their operations in Cape Coast. This value may be higher in previous years, since earlier surveys (from November 2010 to May 2011) conducted at two of the sites surveyed for this study, Amoakofua and Mbofra Akyinim, recorded higher sand mining activities. Average sand lifted at Amoakofua during that period was 384 m^3/day whilst a 4-hour survey at Mbofra Akyinim in February 2011 recorded about 176 m^3 of sand lifted from that area (Jonah, personal observation). The current reduction in the level of the activity at Mbofra Akyinim and Ankwanda may possibly be attributed to an operation led by the National Security Council in November 2011 where they placed boulders on the access routes to the beaches. Others may have also resorted to undertaking their activities at other locations. Also, the beach at Amoakofua has now developed high erosion scarps and exposed underlying rocks on the beach making it difficult for most trucks to access the beach leading probably to the low recorded mining outputs during the survey.

Whilst this survey did not consider the seasonal, socio-economic and cultural factors that may affect the construction industry, these may also contribute to the temporal variations in volume of activity on the coastline. This survey was conducted during the minor rainy season; there may still be possible variations in sand mining activities recorded in other periods of the year, since sand mining activities are driven by demand from the construction industry. Hence, there may be a higher demand during the dry season and a lower demand during the major rainy season.

The projected annual volume of sand obtained by this study is a substantial portion of the total volume of sand that is mined from the Cape Coast area though it is just one sub-category of the beach sand mining activities in the area. The other sand mining sub-categories account for the remainder of the volume of sand lost to the littoral zone of Cape Coast.

4.4. Sand mining and coastal erosion impacts

The study also quantified the short-term recession rate of the Cape Coast shoreline and found that there is a relationship between sand mining activity and the rate of local coastline erosion. Based on the 2005 and 2012 shoreline data used, it has been found that the average short-term coastal erosion for the Cape Coast area is 0.85 m/year. This rate of erosion is less than the average historic long-term shoreline rate of erosion of 1.13 m/year estimated by Appeaning, Walkden, and Mills (2008) for the Accra coastline and other reported rates in several previous studies for other parts of Ghana's coastline including the 2.1 m/year erosion rate estimated by Mensah (1997) for the Ahanta West area in the Western Region.

Zhang, Douglas, and Leatherman (2004) identified three factors being responsible for coastal erosion, namely sea level rise (SLR), change of storm climate and human interference. All the human-related causes of coastal erosion, including sand mining, construction of dams, jetties and breakwaters and urbanization in the active coastal zone (Alonso, Alcántara-Carrió, and Cabrera 2002; Sanjaume and Pardo 2005; Hsu, Lin, and Tseng 2007), interfere with the natural sediment transport and budget of the coast. The construction of the Akosombo Dam on the Volta River leading to the significant reduction in sediment supply to the coast has been associated with the widespread erosion along Ghana's eastern coast (Ly 1980; Boateng 2012). It is obvious that coastal sediment mining activities cause permanent negative sediment budgets on the coasts. When there is a negative budget, a dissected dune system characterized by erosional landforms such as blowouts, deflation hollows and plains, reactivation dunes and erosion scarps may be formed (Carter and Stone 1989).

The current low short-term erosion rates recorded for the Cape Coast area is probably due to the area's characteristic undulating and cliffed coastal features together with the pronounced formation of high erosion scarps along the coastline, which repel and resist the full force of sea waves preventing accelerated erosion. These erosion scarps may not be able to continuously resist the action of the waves. As more and more sand is mined on the beaches, the level of the beach is further lowered allowing stronger sea waves to attack the base of the scarps. After sometime the toe of the scarps may wear away allowing the upper portions to fall over unto the beach. Griggs and Savoy (1985) observed that sand mining reduces the shore-connected shoals that are prevalent along shorelines, which protect the beach by dissipating the storm wave energy within the surf zone. Thornton et al. (2006) argue that this lack of shore-connected shoals would allow the wave energy to reach the shore more easily and erode the beach and dune face.

The suggestion that sand mining causes beach erosion (Boateng 2006b; Oteng-Ababio, Owusu, and Appeaning Addo 2011) is also confirmed by this study. Erosion rates for Mbofra Akyinim and Amoakofua sand mining sites averaged 4.35 m/year and 4.25 m/year, respectively. These two areas have previously been identified as major sand mining hotspots in the area (Cape Coast Metropolitan Assembly (CCMA) 2011). Currently, erosion around Amoakofua has exposed extensive rock formations on the beach where there used to be only sand. There are also erosion scarps as high as 5 m at some points on the beach making it inaccessible to vehicles. These observations confirm the destructive nature of the practice of beach sand mining and could explain the high erosion rate recorded for these areas. This study corroborates the observation by Boateng (2006b) that the widespread unregulated practice of beach sand mining or 'winning' for building purposes is one of the reasons that has led to starvation of beach sediments and consequent retreat of Ghana's coastline.

The impacts of sand mining may not necessarily be experienced *in situ.* Dean and Dolan (2004) argued that sand extraction can be viewed as 'digging a hole' in the surf zone; and it would be expected that sand would be drawn from both upcoast and downcoast as well as onshore and offshore to fill the hole. Hence, sand from other areas along the coastline will naturally move to fill the void that was created. Since net direction of alongshore sediments is generally to the east along the western section of Ghana's coast (Boateng 2006b), sediments are carried up-drift towards the eastern end of the Cape Coast coastline. Through alongshore currents, areas of intense sand mining activities may become filled with sand from adjoining beaches some hours after sand miners finish their activities. Other sources of sediments to the beaches in the area are the perennial Kakum River and offshore sand sources. Adjoining beaches, with no sand mining activities, may eventually experience the 'knock-on' consequence of the practice.

The natural process of longshore drift mechanism may possibly explain why most sand miners in Cape Coast deem their activities harmless. They perceive sand resources along the coast as infinite, since the holes they create are subsequently filled up within a short time. To most, it is only when the coast becomes too degraded to allow them access that they become fully aware of the consequences of their activities.

Coastal erosion and degradation eventually leave coastal communities and investments vulnerable to destruction by the sea. Several communities along the coastline of Cape Coast have in the past few years had some structures washed away by the sea, especially during the major raining season. Other coastline stretches have had to be reinforced with rock revetments and other sea defence mechanisms in order to protect roads and beach front facilities from being washed away. Several of these efforts to protect investments along the Cape Coast coastline have had little success as sea defence measures have fallen over sometimes a few weeks after construction. A few of these failed sea defence measures are located between Ankwanda and Mbofra Akyinim sand mining sites making it obvious the reason for the accelerated erosion.

5. Conclusion

There is widespread coastal sand and stone mining taking place along most part of the coastline of Cape Coast. The estimated levels of sand lost to sand mining activities are substantial and sand mining activities are directly related to the rate of local coastline erosion. The main areas of concern along the coastline of Cape Coast are the Mbofra Akyinm and the Amoakofua mining sites. At the current level of sand mining, the Cape Coast area may eventually experience a loss of most recreational beaches which may eventually lead to a loss of the beach tourism industry as well as make coastal communities vulnerable to flooding. Until the causal factors of erosion are dealt with, the government will just be wasting resources in undertaking costly engineering-based sea defence projects to protect communities.

Disclosure statement

No potential conflict of interest was reported by the authors.

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