

Coastal zone management challenges in Ghana: issues associated with coastal sediment mining

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Abstract Coastal erosion is a serious environmental problem that has caused the loss of private infrastructure and national assets along Ghana's coast. Several hard engineering measures have thus been used to protect some communities and vital state assets when they became threatened. Regardless of this problem, sediment mining activities are increasingly practiced along most of Ghana's coast, further exacerbating coastal erosion intensity and degrading coastal ecosystems. This paper provides an overview of the activities of coastal sediment miners along four administrative Districts in the Central Region of Ghana and identifies how issues arising from the practice are managed at the local community level as well as by state environmental regulators. The study uses a mixed-method approach, involving individual and group interviews, administration of a set of structured questionnaire and field observations, to identify coastal sediment mining and emerging management issues. Overall, three main categories of coastal sediment mining activities were identified in the area. Results indicate that coastal sediment mining is widely practiced by both commercial contractors and community members, giving rise to the high perception among residents that it is the reason for the degradation of the coastline in the studied areas. The study also established that state environmental

regulators have weak inter-agency cooperation leading to poor enforcement of environmental laws and non-prosecution of offending individuals. The paper suggests that since each identified sediment mining activity has its own peculiar issues and mode of operation, coastal managers should address each category independently in order to derive lasting impacts in curtailing the practice.

Keywords Coastal sediment mining · Enforcement · Coastal management · Coastal erosion · Ghana's coastline

Introduction

The coastal zone is a unique geological, physical, and biological area of vital economic and environmental value (Byrnes et al. 2004a). Despite their immense utility, coastal zones and their associated ecosystem services are increasingly threatened due mostly to coastline retreat in recent decades (Bird 1985; Viles and Spencer 1995). At the global level, three reasons have been advanced as factors responsible for the observed erosion along coastlines, viz., sea level rise, change of storm climate, and human interference (Zhang et al. 2004).

The major human interferences influencing coastal erosion include construction in the active coastal zone, road widening, sand mining and construction of dams, jetties and breakwaters (Alonso et al. 2002). In the United States of America for example, the leading human cause of coastal erosion is sand and gravel mining (Magoon et al. 2004). Thornton et al. (2006) noted that sand mining was practiced along some sections of the California coast in the United States until 1990 when it became evident that the activity was a significant contributor to coastal erosion. As such, several environmental regulations were enacted that enforced to govern and manage sand and gravel mining operations (Byrnes et al. 2004b).

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Despite the increasing acceptance that beach sand mining is a leading cause of coastline erosion (Sanjaume and Pardo 2005), sand mining is still practiced in many coastal countries around the world and is periodically reported not only in national and international media but also through published studies (e.g. Armah 1991; Appeaning-Addo 2009; Diop et al. 2011; Jonah and Adu-Boahen 2014; Adotey et al. 2015; Jonah 2015 and Jonah et al. 2015).

In Ghana beach sand mining activities have been identified as common and widespread (Boateng 2012) and are known to have been practiced as far back as the early 1970s (Dei 1972; Biney 1982). Even though it is illegal (Ministry of Environment Science and Technology 2014), the widespread nature of the practice and poor environmental regulation regime by the relevant state authorities has consequently created the perception among coastal communities that the practice is acceptable, with the coast having an infinite amount of natural resources including sand and stone. Also, these activities are relied upon to provide raw materials for the local construction industry particularly along the coastal parts of the country. Indeed it has become acceptable also partly because the practice contributes to income and employment of the youth along the beach sand mining value chain (Mensah 1997; Jonah and Adu-Boahen 2014). In this study all materials mined along the coast and used in the construction industry are classified broadly as coastal sediment mining.

Jonah et al. (2015) were convinced that coastal sediment mining is the major cause of the high erosion rates along most sections of the 25 km Elmina, Cape Coast and Moree coastline between 2005 and 2012. Jonah et al. (2015) estimated that tipper-truck based sand miners alone were responsible for the loss of about 285,376 m³ of sand from six beaches in the Elmina, Cape Coast and Moree area, estimated to be worth three million and five hundred thousand United States Dollars (US\$3.5 million) in 2012 alone.

Several recent studies have established that Ghana's coast has been eroding over the last few decades. Appeaning Addo et al. (2008) studied the Accra coastline and identified the area to be eroding at an average rate of 1.13 myear⁻¹. Studies conducted by Jonah (2014) on the Elmina, Cape Coast and Moree coastline established that the area had retreated at an average rate of 1.22 myear⁻¹ between 1974 and 2012. In 2012, Boateng analyzed coastline changes along the entire stretch of Ghana's coastline spanning the period 1885 to 2002, and identified that only few areas showed stability or accretion with most of the coast having retreated in the period of analysis. Boateng (2012) subdivided Ghana's coasts into four case studies, from the eastern coast to the western coast. He identified the three eastern areas to have retreated an average of 3.9 myear⁻¹, 2.9 myear⁻¹, 1.6 myear⁻¹ respectively, while the fourth case study experienced a net accretion of 0.05 myear⁻¹ over the same period.

The contribution of the coast to Ghana's economy cannot be underestimated since it supports the livelihoods of millions of Ghanaians (Atta-Mills et al. 2004). Along Ghana's 550 km coastline are dotted about 40 former slave castles and forts which are used as museums and tourists sites (Boateng 2012). Other tourism infrastructure has also been developed along many sections of Ghana's coast in recent years. These varied ventures along coastal Ghana depend heavily on the country maintaining a stable and attractive coastal environment. Beach sand mining is known to leave beaches denuded (Mensah 1997; Esteves et al. 2002) making them less attractive to tourists (Fig. 1b and d). Also, because most Ghanaian fishers are engaged in small-scale artisanal fisheries mainly employing the use of wooden canoes launched from the beach, exposed beach rocks as a consequence of beach sand mining, is a direct threat to the sustainability of the local fishing industry which is the main occupation of coastal folks (Kruijssen and Asare 2013) (Fig. 1c).

Recent studies about Ghana's coast have mainly focused on assessment of the extent of erosion (Wellens-Mensah et al. 2002; Appeaning Addo et al. 2008; Wiafe 2011; Boateng 2012; Jonah et al. 2015), the management of risk (Oteng-Ababio et al. 2011), analysis of beach elevations for monitoring coastal erosion (Adotey et al. 2015) and alternative coastal management approaches (Boateng 2012). Though these studies identified sediment mining as being a contributor to coastal erosion, they did not consider how to manage the practice or the issues that the practice generates at the community level. This study assesses how to control the anthropogenic rate of destruction of coastal ecosystems resulting from mining at the community level and suggests entry points for management and enforcement necessary for the needed reforms to be implemented.

The study area

Ghana is divided into 10 administrative regions which are subdivided into districts municipalities and metropolitan assemblies. There are four administrative coastal regions, namely Volta, Greater Accra, Central and Western Regions. The current study area encompass four adjoining coastal administrative units within the Central Region of Ghana. These administrative units are the Komenda Edina Eguafɔ Abirem Municipality (KEEA), Cape Coast Metropolitan Assembly (CCMA), Abura Asebu Kwamankese (AAK) and Mfantseman Municipality. They span about 96.34 km and lie between Latitude 5° 8' 0.820" N and Longitude 1° 34' 56" W to the north-west and Latitude 5° 13' 24" N and Longitude 0° 47' 49.4" W to the south-east along the Gulf of Guinea.

The area is made up of gentle sloping shorelines interspersed with sandy and rocky coast types. Along most of the sandy beaches, various forms of sediment mining activities are known to occur (Jonah et al. 2015). Several other businesses such as

Fig. 1 Beach sediment mining and consequences along several beaches in the Central Region of Ghana



small scale salt industries, trading shops and tourist centres, fish landing sites are located within this area.

The study area, like the rest of the coast of Ghana, has a long history of artisanal fishery making use of small to medium sized wooden boats carved out of tree trunks or constructed with wood slabs. Fishers mainly launch their canoes from fish landing sites along most sandy stretches of the country's coast. This type of fishery has proven to be much more viable than the industrial and semi-industrial sector since the 1960s and is relied upon as a major source of fish for the local Ghanaian market (Atta-Mills et al. 2004; Aheto et al. 2012).

Tourism is another important industry along the coast which according to Boateng (2012) is being threatened by coastal degradation and erosion. Three important tourism sites in Ghana, designated by UNESCO as World Heritage Sites, namely the Cape Coast Castle, St. George's Castle and St. Jago Fort are located within the study area.

Methodology

This study is based on field studies conducted between October 2010 and June 2014. The study used a mixed-method approach, including qualitative interviews, quantitative surveys and field observations. Interviews were structured around the following themes: assessment of coastal sediment mining activities, coastal environmental change, the social and ecological impacts of coastline changes as well as the governance and management of the coastal zone.

In-depth interviews (total = 65) were conducted with chief fishermen ($n = 8$), hotel managers ($n = 4$), community youth leaders ($n = 7$), District Assembly officials ($n = 4$), community members = 18, academics ($n = 6$) Environmental Protection Agency officials ($n = 3$), Police Service ($n = 1$), sand miners ($n = 9$) and local assemblymen ($n = 5$). In addition 6 focused group discussions were facilitated with groups of 3–5 community members at Elmina, Cape Coast, Moree and Anomabo. The survey part of this study included a random sample of coastal residents in each of the four communities. Structured questionnaires were completed by 126 participants made up of 37.3% females and 62.7% males with an average age of 43.7 years.

Results from the interviews were analyzed by first organizing them under the various themes: perception of coastline change, causes of coastline changes, impacts of coastline changes on livelihoods and investments, types and intensity of coastal sediment mining and knowledge of management or governance of coastal lands. Frequency distributions were generated for the data obtained through the questionnaire survey by employing the use of Microsoft Excel and IBM Statistical Package for Social Scientists softwares.

In addition to the interviews and questionnaire administration, field observations with the help of Tremble Juno SD Global Positioning System receiver (GPS) helped to map the beaches and locate sediment mining sites. The field surveys were conducted at Elmina, Cape Coast, Moree, Anomabo and Saltpond coastline from November 2010 to November 2012. The geographic coordinates from the GPS were processed and used to create sediment mining maps (Figs. 2 and 3).

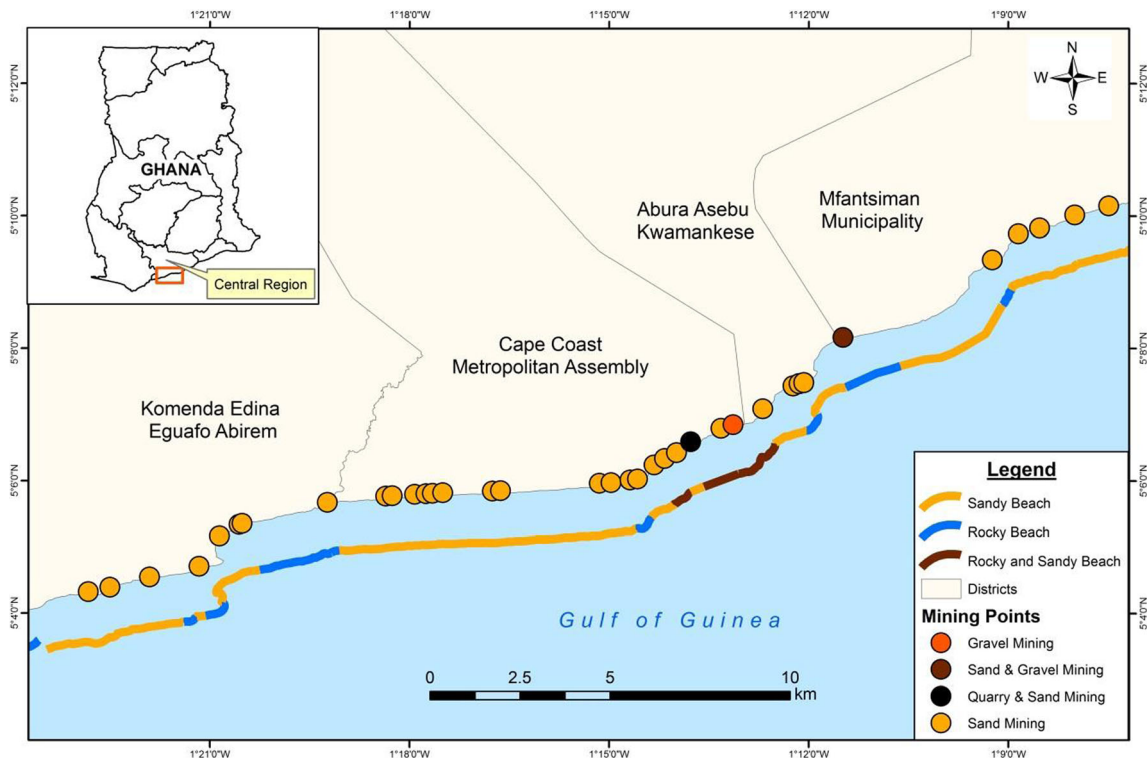


Fig. 2 Map of Komenda Edina Eguaf Abirem, Cape Coast, Abura Asebu Kwaman Kесе and Mfantsiman Districts indicating types of coasts and identified sediment mining types

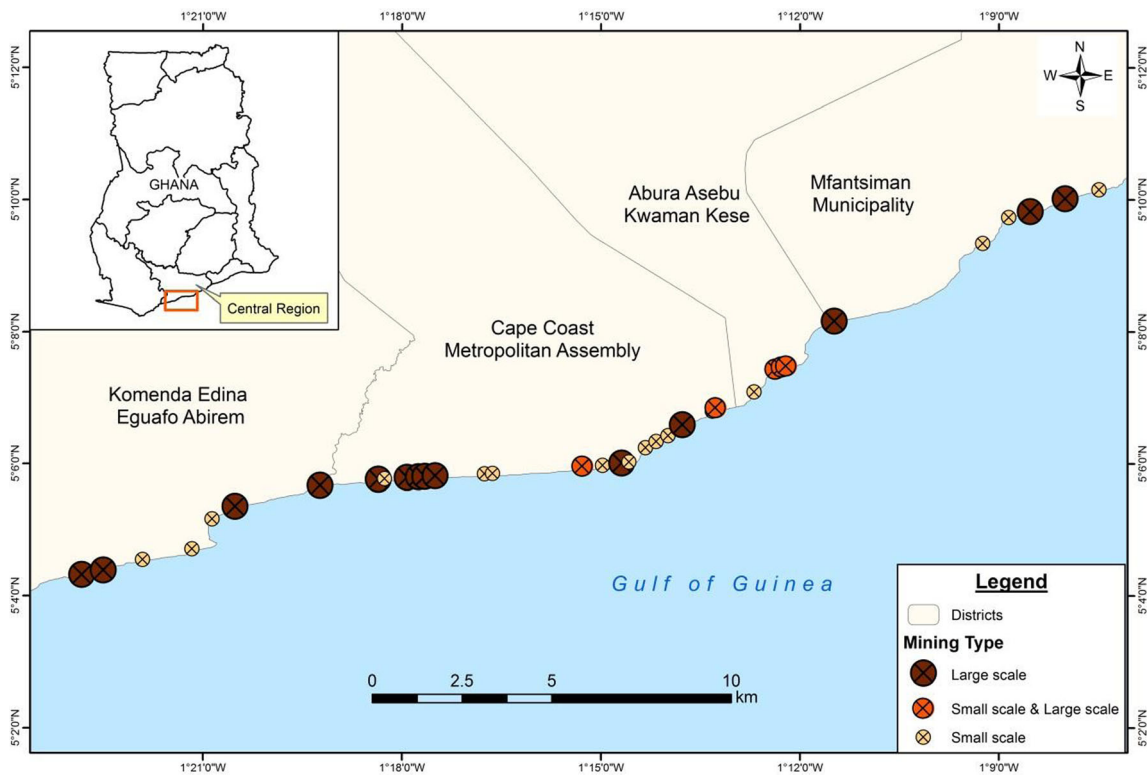


Fig. 3 Coastal sediment mining intensity along the coast of Komenda Edina Eguaf Abirem, Cape Coast, Abura Asebu Kwaman Kесе and Mfantsiman Districts in the Central Region of Ghana

Results

Coastal sediment mining activities

Three types of sediment mining practices were identified, namely beach sand mining, beach gravel mining and coastal stone quarrying (Table 1). The mining locations are shown in Fig. 2. Figure 3 illustrates the study area as indicated by the levels and types of transport methods utilized at the sites. 'Large scale' mining activities involves those that are undertaken by full time contractors who employ the use of tipper or articulated trucks. 'Small scale' mining operations usually involve community youth who transport sand in pushcarts or in basins and sometimes mould building blocks on the beaches for direct sale. Whilst some mining sites have both small and large scale mining operations, most sections are either used only by small scale or large scale operators (Fig. 3). It was also observed that most large scale commercial mining operations are undertaken at the outskirts of communities or along undeveloped sections of the coasts, while small scale mining operations are usually undertaken along developed coastlines, close to settlements (Fig. 3). The results also revealed that coast type usually determined the type of mining operation that is normally undertaken, thus rocky or cliff sections have coastal quarry operations, sandy beaches have beach sand mining activities whilst beaches with gravels have beach gravel mining undertaken there.

Field observations and interviews indicated that the use of tipper-trucks or articulated trucks to transport sediments

usually indicate that the product will be used for projects outside the community, sometimes several kilometers away. The use of pushcarts, basins and other small receptacles on the other hand, suggest that sediments will be used for minor, locally based, community project.

Moulding of blocks on beaches for building was also found to be widely practiced by sand miners. Interviews and focused group discussions indicated that these are preferred by local youth since these require less investment but with high revenue for those who engage in them. Such high economic gains are achieved through value addition of block making and the subsequent sale of the finished product at near regular market price.

Also, 83% of the questionnaire respondents mentioned that they had used beach sediments for their personal projects in the past. During the focused group discussions, the participants agreed that the use of beach sediments for construction activities was mostly accepted, so far as the sediments are used for minor projects that benefit only local residents. However, participants agreed that coastal communities frowned upon those individuals who engage in the practice as a business venture.

Coastal sediment mining and degradation of coastlines

Most of the community members who were interviewed, together with participants of the focused group discussions agreed that sediment mining in the communities is responsible for the degradation of the beaches, including

Table 1 Types of coastal sediment mining activities in the four adjoining coastal administrative units in the Central Region of Ghana

Category	Sub-category	Nature and scope of operation	Description	Occurrence
1. Beach sand mining	Tipper truck-based	Commercial, in large scale	This includes sand transported by tipper/ articulated trucks	Occurs within communities with settlements within close proximity to sandy beaches
	Low capacity truck-based	Small scale non-commercial to large scale commercial	This includes those transported by low capacity trucks e.g. pick-ups, 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, medium to large scale	Sand and pebbles are gathered from the beach or sifted from in-coming waves by using cane baskets, graded to sizes and transported by tipper trucks and other large capacity trucks	Evident within and outside communities i.e. occurring in the outskirts with preponderance of gravels, pebbles at the beach
3. Coastal stone quarrying		Commercial, in large scale	Rocks are broken off rocky and cliffed areas and crushed for the construction industry	Undertaken at the outskirts of communities or along undeveloped sections of the coasts with rock and/ or cliff environments

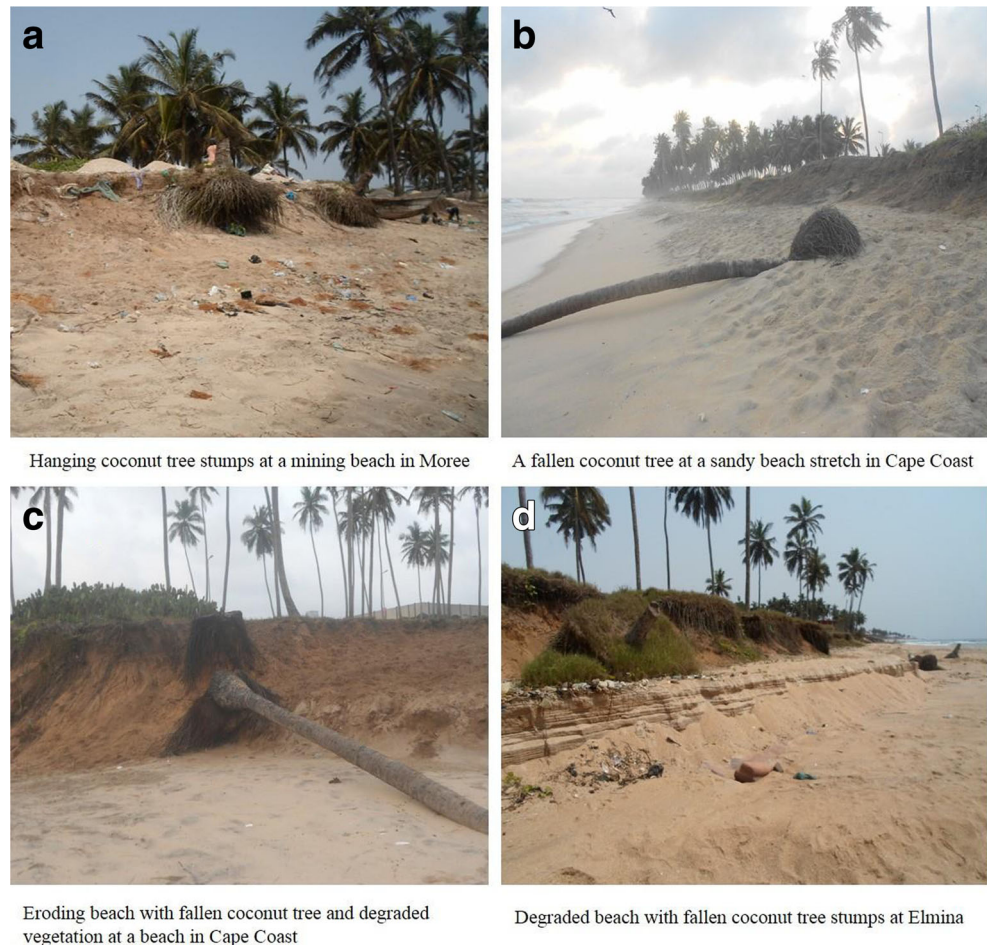
the exposure of rocks and the erosion scarps that has characterized most beaches in the area. These views echoed with the responses by the questionnaire respondents, about 94% of whom also thought that beach sand mining was responsible for the erosion and the degradation of the coastline. During the focused group discussions, older residents maintained that prior to the commencement of sediment mining activities in the early 1970s, there were wide sandy beach buffers along most stretches of the coast, inhabited by coconut trees. Field observations showed that most sandy beach stretches are narrow with several areas having coconut trees that have either fallen over or have their roots exposed and hanging on erosion scarps (Fig. 4).

The questionnaire respondents and interview participants provided estimates of the length of coastal changes, which were discussed during the focused group discussions. Using various structures as reference points, focused group discussion participants estimated that sections of Cape Coast had lost up to about 100 m of coastland, while Elmina, Moree, Biriwa and Anomabo had also lost up to about 60 m of beach at some sections.

Responsibility for managing coastal sediment mining

In all four District Assemblies, officials identified beach sediment mining as illegal and expressed the need to curb it. However, all four local assemblies did not have action plans to manage the practice. According to the Environmental Protection Agency officials, they have only one centralized office in Cape Coast that supervises environmental regulation and enforcements activities across the entire Central Region of Ghana, noting that this makes them incapable of undertaking continuous monitoring of coastal sediment mining issues at all times. The officials mentioned that the Environmental Protection Agency relies on the District Assemblies to undertake environmental monitoring and surveillance to safeguard the environments within their jurisdiction. Both the Environmental Protection Agency and Local Assembly officials noted that such enforcements activities are only possible with the support of the Ghana Police Service, which is the legally mandated state institution to prosecute environmental offenders. These officials also noted that local traditional leaders including chiefs have some responsibility in ensuring that coastal sediment mining activities are regulated.

Fig. 4 Fallen coconut trees along sandy beach stretches adjacent sand mining areas within the studied districts



With regards to the questionnaire respondents, 39% of respondents suggested that local traditional leaders are responsible for managing the coast, 30% identified land owners as being responsible, 18% identified Districts Assemblies and 13% identified the Ghana Police Service. Individual interviews and the FDGs produced mixed responses, as participants noted that all the above mentioned groups of individuals have unique responsibilities in managing the coastal zone.

Identified management issues in coastal sediment mining in Ghana

Local traditional influences in sediment mining activities

Residents identified that at Biriwa in the Mfantseman District and Moree within the Abura Asebu Kwamankese District, local Chiefs had instituted a ban on commercial exploitation of beach sand. Local residents noted that these decisions by local traditional rulers were taken as a result of complaints made by other users of the coast including fishermen and tourism operators about the possible effects of the sediment mining activities. Such decisions were made known to community members through public address systems, informal channels and during community forums such as during religious services and durbars. Such bans however, allowed community members to use sediments for their small construction projects within the communities. Focused group participants were generally of the view that such tolerance was necessary to get community members to benefit from the available resources whilst identifying those community members who attempt to exploit the resource in commercial quantities for punitive actions.

In contrast, field surveys at Elmina, within the Komenda Edina Eguafo Abirem Municipality, suggested that local traditional leaders rather encouraged commercial beach sand mining practices along that coastline. Some questionnaire respondents even identified that the local traditional council was obtaining direct monetary benefits from the commercial beach sand mining activities in some instances. Similar assertions were made by some hotel operators who had knowledge of the amount paid to the local Traditional Council per tipper truckload of sand mined in that area. The Environmental Protection Agency officials also mentioned the attempts of the Elmina Traditional Council to obtain licenses to legitimize sand mining operations along the coast of Elmina; confirming local resident's perception of the culpableness of the Traditional Council.

Apathy of environmental regulators to coastal sediment mining issues

Results from focused group discussions and individual interviews indicated that most residents were of the opinion that

legitimate state authorities had not done enough to halt the sediment mining practices along the coast. Hotel operators especially had issues with the level of commitments of the Ghana Police Service, Local Assembly authorities and the Environmental Protection Agency in dealing with such issues. Although several police checkpoints are mounted along the major roads in the study area, it was suggested that commercial sediment miners can convey their product without being arrested. Moreover, near Bakaano in Cape Coast several beaches are actively mined for sand even though there is a Police Station nearby.

However, residents admitted that occasionally the Police arrest some miners in the communities, but offenders are often released without being prosecuted. These offenders eventually go back to engage in the mining activity thereof. On their part, Environmental Protection Agency officials mentioned that their work of enforcement depended largely on the cooperation of the Ghana Police in arresting and prosecuting offenders. They noted that their jurisdiction ends when offenders are arrested since it is the duty of the Police to make a case for prosecution, during which they could be asked to testify.

Sand mining and conflict with competing users of the coast

Residents noted that there is high potential for conflict occurring between sediment miners and other competing users of the coast. Residents observed that sediment mining degrades important tourist beaches, strip coastal vegetation and exposes underlying rocks on sandy beaches. Residents mentioned several instances where community members, tourism operators and fishermen have confronted sediment miners to get them to halt their operations. This is because miners are often also resolute in their ways, residents noted that there had been several instances where such confrontations had ended in clashes.

Discussion

Minimizing risk of coastal flooding and property damage

The contribution of coastal sediment mining to erosion along most coasts around the world has been widely accepted (Wong 2003; Thornton et al. 2006), making the practice a very inappropriate. Since, coastal sediment mining activities have been practiced in Ghana dating back to the 1970s (Dei 1972), it can be argued that these have influenced the rate of erosion that has been experienced along several sections of the coast since then. Ly (1980) identified that coastline changes in the Cape Coast area between 1948 and 1973 were not marked. However, Jonah (2014) identified an erosion rate of 1.22myear^{-1} for the Cape Coast area between 1974 and 2012, coinciding with Dei (1972)'s observation of the

commencement of the practice of coastal sediment mining. These erosion trends may perhaps be responsible for the periodic coastal flooding experiences by the many low-lying coastal communities in Ghana.

Since, coastal features such as beaches, rocks and cliffs are the first line of defence for coastal properties against storm surges (Mensah 1997), the rapid exploitation of these sediments only serve to make communities and investments more vulnerable to the sea. If the impacts of the various predicted sea level rise scenarios, including the one-meter rise by 2100 predicted by IPCC (2007) or the two-metre rise by 2100 predicted by Pfeffer et al. (2008), are to be minimized, it is crucial that coastal sediment mining practices are immediately halted as a matter of priority. Developing proactive measures will help coastal Ghana and other countries with similar activities to become better prepared for climate change impacts while saving huge sums of monies that may otherwise go into coastal defence and relief programmes.

Suggested strategies for managing coastal sediment mining in Ghana

The identified types of coastal sediment mining activities present coastal managers with several management options. Each category exhibits different peculiarities which must be addressed independently if all the coastal sediment mining issues are to be successfully managed. This requires an understanding of how each activity is undertaken, the purpose to which the products are to be used and the underlying reasons behind their practice. Addressing the practice from such narrow perspectives may lead to identifying effective strategies to deal with the entire practice. This may require the commitment and collaboration of coastal managers with various state and non-governmental stakeholders including the Ghana Minerals Commission, District Assembly authorities, the Environmental Protection Agency and the Ghana Police Service.

Beach gravel and coastal stone quarry operations are undertaken in a similar manner and usually by the same group of people. These are also undertaken by local residents who gather products on the beach berm until a time when sufficient quantities have been obtained. Beach gravels are obtained by sifting of sediments on the beach or through sifting sediments being carried by incoming waves using cane baskets. Coastal stone quarry operations are undertaken by breaking exposed beach rocks into smaller pieces. Products are then directly sold to contractors. Gathering these products into sufficient marketable quantities can take several weeks to achieve and hence may be considered as a small-scale practice for local residents. However, contractors move across locations to purchase products from these small scale miners.

Several reasons may account for local contractors' preference for beach sediments. Due to the fact that such activities

are illegal, they do not require miners to submit formal proposals for permit acquisition and commencement of operations. There is no need for impacts assessments before operations and similarly no requirements for land reclamation and restoration post operations. Residents have noted that beach sand commands higher prices as compared to inland sand, due to the perception that the former has better binding and finishing properties during construction. Furthermore, no taxes are 'officially' paid to the state making it more profitable to contractors. Contractors are also free to relocate to different locations to exploit materials with little or no restrictions. Such reasons may appeal to operators who desire to make high profits from the practice.

Mensah (1997) argued that beach sand mining should not be banned completely but instead only local communities should be allowed to utilize resources to build houses, until a time when the coastal environment has regained healthy environmental conditions, at which time commercial operations could be reactivated. Even though several studies have identified that allowing local communities to sustainably exploit available natural resources makes them more keen in helping conservation efforts, Mensah (1997)'s argument does not seem applicable now looking at the present rate of reported coastal erosion rates in Ghana (Appeaning Addo et al. 2008; Boateng 2012; Jonah 2014; Jonah 2015) and predicted climate change impacts (IPCC 2014). Mensah (1997)'s suggestions also presents several questions that coastal managers need answers to before acceptance and possible implementation. Such questions include: 'at what level should community members exploit beach sand? how much sediment can each individual take and how frequently can they mine? who qualifies to mine sediment from the coast? what criteria will be used to determine that the coastal environment has regained healthy environmental conditions?'

Though it is laudable to allow local residents to benefit from the available natural resources, allowing continued exploitation of coastal sediments will rather exacerbate the already degraded and eroding Ghanaian coast, with further financial and social costs in remediating the situation. More so because large scale contractors are now working in cooperation with small scale miners in exploiting the resource. Hence, both local residents and commercial exploitation should be disallowed, contrary to the recommendations of Mensah (1997). Current state of knowledge about coastal dynamics has sufficiently proven that beach sediment mining is detrimental to coastal stability.

Tipper truck-based sand mining locations can easily be identified by the level of activity at the beaches and the tracks they create to access beaches. Several strategies could be used to halt this particular activity. During discussions with Environmental Protection Agency and local assembly officials, various appropriate inland sand mining operations were mentioned that contractors could opt for. This presents coastal

managers with the option of identifying and engaging tipper truck-based beach sand miners to change to inland sand exploitation. Sand miners could be helped through the processes to acquire and operate such in-land sand mining businesses. However, if miners still refuse to relocate then prosecution could be used as a last resort to deter miners.

Managing medium- to small-scale sand mining operations however requires a more concerted and coordinated management approach involving multiple stakeholders, interest groups and agencies. As noted above, these mining operations are usually undertaken by residents who believe they have a right to benefit from the available natural resources. Attempting to completely ban or prevent resident from engaging in the activity right from the onset may make residents more recalcitrant and devise innovative ways to exploit the resource. Managers could use a participatory resources management approach to engage community members to arrive at a consensus on how to locally manage the intensity of mining activities in the community. These could include engaging local community leaders and residents through educational forums and dialogue meetings. Through such methods, community members may come to understand the effects and consequences of their activities and desire to halt those activities.

In managing beach gravel mining and coastal stone quarry operations, coastal managers could go into dialogue with contractors to source for their products from inland legitimate quarries. Contractors would have to be made to understand the essence of sustainable and ethical procurement. Contractors using sand and gravels from sources that do not destroy the beaches are securing the beach ecosystem and their businesses in the long term. However, once coastal residents continue to engage in gathering stones and gravels along the coasts, the practice will remain attractive to contractors. Hence, it is crucial that managers completely halt such operations by local coastal residents. Halting such practices may require that residents are provided with alternative livelihood opportunities, of which the local District Assemblies would be important in dealing with.

Furthermore, accessibility to the coast seemed to influence the type of sediment mining and its intensity. Contractors and miners usually have unrestricted access to the beaches, which are public areas. For undeveloped coastal areas, there is usually no clear ownership of such lands. Hence, coastal managers do not deem such areas as vital in attracting management interventions since coastal erosion and degradation in those areas do not directly interfere with or jeopardize human investments. However, these assertions have been proven to be false since research has shown that the knock-on effects of sediment mining operations could be experienced several kilometers away (Özhan 2002; Boateng 2006). In Ghana, the ownership of land is vested in the President with management

delegated to public institutions such as Lands Commission and the Metropolitan, Municipal and District Assemblies and the Office of the Administrator of Stool Lands (Kasanga and Kotey 2001). Local Metropolitan, Municipal and District Assemblies therefore have a responsibility for land use planning in areas under their jurisdiction. Blocking all access routes used by contractors to these uninhabited coasts may prevent further exploitation of these sediments from the coasts until a time that proper land use plans has been developed.

Conclusions

The primary objective of this study was to evaluate the categories of coastal sediment mining within the Central Region of Ghana in order to provide entry points for management and enforcement of regulations necessary for the needed reforms to be implemented at the policy and community levels. Field observations, key informant interviews and focused group discussions involving state actors and opinion leaders at the community level were undertaken. The study revealed that coastal sediment mining is widely practiced along the Central Region's coastline with three main categories of activities being practiced and the type of coast usually determines the type of sediment mining activity that will be carried out there. Also, most of the intensive sediment mining activities are carried out along undeveloped coastal stretches where commercial operators have the uninhibited opportunity to mine as much products as they need and to freely move to new locations without any hindrance resulting in extensive shoreline degradation and retreat.

Beach sand mining is a direct cause of coastal erosion. The practice also impacts local wildlife. For example, sea turtles nest in sandy beaches, and therefore sand mining has led to undesirable impacts on their populations and conservation. The disturbance also causes turbidity in water, which is harmful for marine organisms. Turbidity destroys fisheries leading to problems for livelihoods that depend on fisheries. This paper therefore argues that the search for solutions should be prompt and not lag behind the rate of shoreline degradation due to sand mining activities. If nothing is done about it, there would be further catastrophic impacts on the coast and then substantial financial investments would have to be committed for the re-construction of basic infrastructure such as roads and housing located in coastal areas that may be lost to flooding or other related impacts.

Entry points for management and regulatory enforcement

The study has revealed an alarming rate of unrestricted beach sediment mining along the coast of the Central Region of Ghana. Sand and gravel mining is regulated by law in the country referring to the Minerals and Mining Act 2006, Act 703, which addresses the issue of mining lease and license for

prospecting. Despite this regulation, beach sand and gravel mining is still often done illegally. The laxity of enforcement of the regulation and the general lack of clarity in the environmental management of beaches should be fully addressed. It is generally difficult for persons to comply when breaking the rule is profitable and when penalties, if applied at all, is not deterrent enough to stop the practice. Although regulations are unique to particular settings and countries, lessons could be drawn from elsewhere in Africa for the purposes of managing the menace in Ghana. In South Africa for instance, a sand miner generally needs to obtain a mining permit or mining right from the appropriate authority. If the applicant wishes to trade the sand he/she generally needs a scheduled trade permit from the municipality and possibly other permits e.g. a tree removal permit from the Department of Fisheries and Forestry according to their National Forests Act (1998). The regulation makes a clear distinction between a mining permit and a mining right. Mining permits are issued to mines that occupy less than 1.5 ha and operate for a maximum of five years. Indeed, most sand mines fall in this category. The environmental requirements for this type of permit are less rigorous. In this instance, the prospective sand miner does not have to conduct an environmental impact assessment (EIA) but is required to submit an environmental management plan (EMP) that indicates mining impact and associated rehabilitation procedures.

On the other hand, a mining right is needed when a sand miner wishes to extend the mining concession beyond 1.5 ha or mine for up to 30 years. These bigger and more permanent mines need to conduct an EIA by law and submit both an EMP and a social mitigation plan (Chevallier 2014). An adoption of best practices or modification of such an approach for use in the regulation of the sector may be necessary in Ghana since this allows for regulation and voluntary compliance rather than coercive enforcement that completely declares sand mining as an illegal activity.

This paper also strongly argues that the commercial exploitation of sand from beaches could be rendered a disincentive only if the market demand and use of beach sand for construction purposes is discouraged publicly, and the economic, social and ecological ramifications made known. This is possible through sensitization of individuals and estate companies on the negative effects of using beach sand for construction through targeted media and social campaigns, and involving scientists in the process. These approaches are necessary because when sand is extracted in quantities higher than is sustainable, changes take place in the ecosystem, physical habitats and food webs. Education of the coastal population is needed because apart from causing depletion, sand mining also damages nearby riparian habitats through the destruction of vegetation and wetland systems; altering their ecological health and fragmenting ecological corridors. The practice broadly impacts marine biodiversity and destroys habitats

for fisheries and crustaceans. Real-time monitoring of the trucks using aerial surveillance is called for in order to promote efforts toward land rehabilitation of degraded areas. If unregulated, sand mining could result in the creation of deep pits left after excavation that could pose severe hazards to local people especially the elderly and children. Such open pits could also distort non-consumptive uses of the beach such as coastal tourism and use as traditional fish landing sites by small fishing households.

State institutions such as the Environmental Protection Agency, the Ghana Police Service particularly the Marine Police and District Assemblies must heighten their inter-agency cooperation and strengthen their internal procedures to curb this menace through the prosecution of offenders. Local traditional leaders must be sensitized to take authority in the enforcement by providing them with the required education and support including the introduction of skills training and supplementary livelihoods in the communities. This will encourage them to move towards voluntary compliance and desist in the share of profits resulting from sediment mining that are facilitated by outside contractors at the local level. Often, these authorities have supported the contractors and protected them making it difficult to curtail the practice at the local community level.

Recommendations for further studies

Certain research needs are required to be fulfilled as follow-up to this work. An evaluation of the cumulative impacts of sediment extraction in the study areas is urgently needed in order to inform decisions on sand mining in the region. Studies should also be commissioned to look into the regulated use and sustainability of the resource in view of natural sediment replenishment of the beach system. For the governance of the sector, further clarity is needed on the spatial extent to which beaches are subjected to environmental degradation due to sand mining and the required regulation needed along the entire coastline. An independent appellate authority to address the problem in the region is proposed in this regard. Cost-benefit analysis and assessment of the ecological impacts of sand removal from beaches as well as investigating into other sources of sand for the construction industry is most desired. This study provides lessons for managing coastal sediment mining activities in the country. The study has also shown that there are categories of sediment mining with site-specific peculiarities that need to be addressed separately. Government urgently needs to step up enforcement, considering the non-payment of royalties to the state and the ecological and social damage being created without recourse to any restoration programme. Management schemes should target each mining category separately if long term success is to be achieved.

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