



The Effects of Climate Change on Coastal Erosion in West Africa, Takng (Ghana as the Case Study)

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I. INTRODUCTION

Global climatic changes have contributed to significant degradation of the environment. The current anthropogenic activities have also transformed the planet which has brought about uncalculated effects to the natural ecosystem (K. K. McKenna 1999).

Issues of coastal erosion are a worldwide problem. Research indicates that about 70% of sandy beaches around the globe are recessional. It also shows that almost 85% of US East Coast barrier beaches have been eroded during the last 100 years and serious erosion has been recorded in other places. This has drawn the attention of various international organizations and governments to deal with this situation by instituting different coastal erosion management strategies and policies. However, many other places, especially third world countries, still experience severe coastal erosion.

According to Bird E.C.F. (1985), coastal erosion is probably the most serious environmental problem facing West African coast. This phenomenon is particularly more pronounced in Ghana especially on the eastern shores. Specifically, the most severe and internationally known areas are in the Volta estuary basin, at Keta and Ada in both the Volta Region and the Ga eastern part of the Greater Accra Region respectively. This poses great challenge to the nation Ghana. In the early years, these cases were seen by most Ghanaians living along the coast as a natural phenomenon; hence, much attention was not given to its development.

However, the recent devastating effects have brought intense worries to the nation, especially the adversely affected communities. Some coastal inhabitants engage in activities like uncontrolled sand mining along various sections of the coastline for a variety of uses such as construction of estates, highways, and bridges as well as irrigation and water work. There is also the occurrence of mining of alluvial gold in some of the rivers within the coastal plains. These activities are increasingly exposing the coast to erosion with its associated problems. Not only that but also the aesthetic value of the beaches is declining. Regrettably, the problem of coastal erosion has been given little or no attention. The coastal municipalities have ignored the adverse condition of the coast largely due to ignorance. Mostly, the inhabitants are uneducated so they barely care or understand what their activities will cause. It is quite unfortunate to note that while millions of dollars are being spent by the government to combat erosion along coastal areas of Ghana, some communities are actively encouraging coastal erosion. Overall, there is little concern for the sustainability of the fragile coastal environment for both the present and future generations. However, with about almost half of the population in the regions along the coast in Ghana living in the coastal municipalities, the idea of strategic coastal planning and stretched integrated coastal zone management should become an integral component of regional spatial planning for effective coastal protection. As of now, very limited studies have been done to quantify the damage caused by coastal erosion despite the detrimental effects of this phenomenon in the country.

Hence, this study seeks to provide a comprehensive review and bring to the attention of stakeholders the issues of coastal erosion and its climatic implications not only along the coast of Ghana, West Africa but also to the global world at large.

1.2 BACKGROUND OF THE STUDY

Climate change has been occurring on the planet for billions of years since its inception. Many people, organizations, scientific organizations, institutions, governments, and other world leaders have expressed concern over the current occurrence of climate change. "Climate change is no longer some far-off problem; it is happening here, it is happening now," said by Barack Obama, the President of the United States of America during international conference on the Arctic held in Alaska, USA. While some pundits argue that climate change is caused by human activity, some voices also question the validity of such assertions and prefer to cast doubt on the preponderance of such evidence stressing that it is a natural occurring phenomenon.

However, while there were natural causes to climate change over the earth's history, the fact still remain that human activities contribute to climate change by causing changes in Earth's atmosphere in the amounts of greenhouse gases, aerosols (small particles), and cloudiness (IPCC 2007). In fact, the Intergovernmental Panel on Climate Change (IPCC) emphatically stated that the largest known contributing human activity comes from the burning fossil fuels that release carbon dioxide gas into the atmosphere. Greenhouse gases and aerosols affect climate by altering incoming solar radiation and outgoing infrared (thermal) radiation that are part of Earth's energy balance. Along with the change in temperatures come heat waves, new wind patterns, worsening drought in some regions, heavier precipitation in others, melting glaciers and Arctic ice and rising global average sea levels.

1.3 STUDY AREA

Ghana is located in latitude 8°N and longitude 2°W in the west of Sub-Saharan Africa. It lies almost in the centre of the nations along the Gulf of Guinea. Its southern coast extends between latitude 4°N at cape three points and 6°N in the extreme east along the equator. Ghana is boarded by Ivory Coast, Burkina Faso, and Togo to the west, north and east respectively and to the south by the Gulf of Guinea and the Atlantic Ocean. It has a total land area of 238,535 km², 3.5% of this being covered by water. The country enjoys a typical tropical climate. It experiences two main seasons, namely, rainy, and dry seasons. The average minimum and maximum annual precipitation are about 900mm and 2000mm occurring around the Southeastern and Southwestern portions of Ghana respectively. The range of the annual average minimum and maximum temperatures is 20°C - 22°C and 29°C -34°C respectively. The annual average evapotranspiration rate is 190mm (high) in Northern Ghana and 80mm (low) in the southern part.

The coastline consists primarily of sandy beaches that expand to about 560km. It is lined with coconut palms, merging seamlessly with mangrove vegetation, high evergreen forest reserves, diverse wildlife, and a people whose vibrant culture you can sample in the fishing villages. The sandy coastline is characterized by a coastal plain with several rivers and streams. Ghana has four of its ten regions having its cities along the coast. The major cities include Tema, Accra, Winneba, Cape Coast, Elmina, and Sekondi-Takoradi. Primary activities along the coast include fishing, which is mostly the main occupation of the people living there.

1.4 STATEMENT OF THE PROBLEM

Climate change is already affecting the planet and society and will continue to do so for generations to come. The physical and chemical changes of human activities are being felt in natural ecosystems on land and at sea, on farms and ranches, and in cities and suburbs, but the changes are not happening uniformly. Differences in how regions are affected by varying degrees of warming, precipitation, and changes of animal and plant species are likely to get even more extreme as climate change continues. Some areas may get a bit cooler for a while! Similarly for rainfall, some parts of the planet will get drier, while others will get more precipitation in more extreme events; with Africa being one of the most vulnerable continents to climate change. This situation is further worsened by its poor state of economic development and low adaptive capacity. Extreme poverty, frequent natural disasters such as droughts and floods, and heavy dependence of agriculture on rainfall further increases the continent's vulnerability. Climate Change affects us all; but it does not affect us equally. Its biggest impact will be on poor African farmers who have done least to cause the problems. That is why we need adequate policies and resources to build resilient food systems (#OYW Kofi Annan). "Climate change hits the poorest the hardest, and our challenge now is to protect tens of millions of people from falling into extreme poverty because of a changing climate." Sub-Saharan Africa is by far the region most vulnerable to climate change (World Bank).

1.5 OBJECTIVE OF THE STUDY

This paper presents an overview of research on the effects of climate change a background for specific presentation on coastal erosion in West Africa, using Ghana as the case study. It also highlights the major causes of the coastal erosion as well as the adverse impacts and suggests prudent measures in effective monitoring and controlling its occurrence in Ghana.

1.6 RESEARCH QUESTIONS

This study seeks to answer the following key research questions:

1. What are the causes of coastal erosion in Ghana?
2. What are the factors that drive coastal erosion in Ghana, West Africa?
3. The effects of climate change on coastal erosion in Ghana, West Africa
4. Measures to address African Coastal area.

1.7 OVERVIEW OF THE CURRENT COASTAL EROSION IN GHANA

The coastline, which is described as the physical interface of water and land is constantly changing as it seeks to achieve and maintain equilibrium among many opposing natural and human induced forces in the coastal regions. Coastline changes, which are a natural phenomenon with respect to the changes in relative sea level, climate and ecosystem may be influenced by recent human activities. Coastal erosion is the wearing away of land or the removal of beach or dune sediments by wave action, tidal or wave currents. The causes of this disturbing phenomenon could be both natural and man-made. It involves a redistribution of sand from the beach face to offshore. It commonly occurs during coastal storms and strong wind action which may take the form of long-term losses of sediment and rocks, or merely the temporary redistribution of coastal sediments. The erosion in one location may result in the pile-up of sand or sediments elsewhere.

Erosion is a chronic issue along the Ghanaian coastline, where high erosion rates are adversely affecting coastal infra-structure and valuable cultural resources. The current eroding state of Ghana's coastline raises serious concerns. The extensive erosion along the beaches has greatly impacted the surrounding environment. Due to the total negligence on the part of the surrounding communities and the government of Ghana as a whole, the situation is growing worse every day.

According to estimates, the ocean claims 1.5 to 2 m of the 560 km coastline annually: with the most risky areas recording 4 m. This has become so severe that the government of Ghana has no option than to institute a Sea Defense Project which seeks to construct a sea defense wall along the coast to protect the people in the area from the ravages of the sea. It must be noted that a tremendous amount of sand is just offshore many beaches. However, this resource is unprecedentedly exploited causing a severe range of coastal environmental problems. For instance, in Accra, the capital city of Ghana, an estimated 82% of the beach is eroding at a rate of 1.13 m/yr. At some points, scarps and undercut asphalt are revealed indicating high rates of erosion. Also, there are coconut palm trees which characterized most beaches in Ghana; these palm trees are beginning to fall and disappear. A serious case is recorded at Elmina coast. These come from a short stretch about 4km west of Elmina town, where there exist popular beach resorts that include Coconut Grove, Elmina Bay and Stumble Inn. The sea is eating its way towards these resorts with subsequent dire effects on the tourism sector of the country. Recently, one serious situation was also recorded at Ada Foah Beach located at the Ga eastern part of the Greater Accra Region of Ghana. It was estimated that the coastline in the area is eroding at a rate of 4m annually. Hence, in response to this gravely eroded coastline, the government of Ghana had no choice but to embark on a costly and controversial project to the building of an estimated 68-million-euro, 30 km Ada Sea Defense Wall along the 44 km-stretch of the Ada coastline. This project was undertaken to ensure maximum protection of the people and the infrastructure as well as the environment. It is also recorded that many structures such as hotels and restaurants where foreigners especially tourists reside along the coast has to be evacuated due to danger the erosion is posing. Occasions like beach recreational activities especially during festive seasons have also been affected because foreigners and even locals are no more attracted to the beach. It was reported that the age-long devastating coastal erosion had turned many investors away for fear of losing their investment as a result. Also, residential houses have been washed away by the ocean. In an effort to render the country with a broad in scope database to assist in tackling the current situation, various organizations have willingly decided to embark on some small studies. Example is the Department of Oceanography and Fisheries of the University of Ghana who have mapped the following cities in the Greater Accra Region with red flags indicating that those places are experiencing severe cases of coastal erosion: Kokrobite, Bortiano, Labadi, Teshie, Nungua, Tema, Prampram, Old Ningo and Ada. The Office of Naval Research (ONR) is also investing and partnering in research that could lessen the impacts of Ghana's eroding coastline such as loss of structures, human life, and economic well-being. Nevertheless, these situations continue to exist and even are becoming more serious.

1.8 WHAT ARE THE CAUSES OF COASTAL EROSION IN GHANA?

Various causes of coastal erosion are identified which include both natural and man-made induced phenomena.

1.8.1 Man-made induced causes of Coastal Erosion

Sand Mining is a kind of open-cast mining that provides material in Ghana for the construction industry. The construction sector in the coastal areas of Ghana relies heavily on coastal sand and pebbles in the building of houses, bridges, and roads. The world's beaches are being mined for sand for a variety of uses (aggregate in concrete, fill, beach renourishment). The practice is often very destructive and poorly managed, and this is not

different in Ghana. Although sand mining is banned along beaches in the country, it continues to be a source of sand supply for the real estate sector. The activities of the sand miners who are desperate to make their living, vent their irascibility on the volumes of sand on the country's beaches. This theft of beach and dune sand is a direct cause of erosion along many shorelines. Since coastal sand serves as a barrier between the sea and the land, uncontrolled sand mining causes a range of coastal environmental problems. Specifically, it is very damaging to the beach fauna and flora, ruinous to beach aesthetics, and frequently causes environmental damage to other coastal ecosystems associated with the beach such as wetlands. In a time of rising sea level, the sand is sorely needed as a storm energy buffer. The process of sand mining has accelerated coastal environmental degradation to an alarming rate and the extent of the impairment is obvious in many areas. Another major impact of beach sand mining is the loss of protection from storms surges associated with tropical cyclones. Some communities affected by the 2004 tsunami in the Indian Ocean had higher storm surges probably due to beach sand mining resulting in human death.

1.8.1.1 Inadequate Coast Management

Over the years, there have been cases of poor management at the coast, especially by the inhabitants of the coastal communities. Obviously, the locals there are not fully concerned about the problem their activities can bring on the coast. These include building indiscriminately along the coast which is properly not checked.

In recent years, some communities even continue to undertake activities such as sand mining as a means of financing local development projects. Even though there may exist logistics to ensure that this does not happen, the authorities concerned have turned a blind eye to them. Unplanned and unwise land use developments have resulted in higher erosion rates, in some areas. Dredging of canals and Protective building are normally done to help saltwater reach further inland and to direct other water sources to the sea. This activity causes death of trees and vegetation that would normally stabilize the coastline. Trees or vegetation along shorelines of water bodies have been scientifically proven to help stabilize and protect shoreline against cases of flood and erosion. Wind blowing along the canals creates waves that erode the coast and create storm surges. Also, it has been noticed that some of the coastal inhabitants dike their buildings and properties which they believe lie in low-level areas by building seawalls.

These structures are mostly not properly constructed, and they sometimes prevent sand from restoring the coastlines. This implies that the structures that are built to curb the menace rather create further erosion in the long-term.

1.8.1.2 Modification of ecosystems

In the past, the coastline in Ghana was surrounded by green forests and thick trees. However, over the years, activities like deforestation as a result of population growth and urbanization have resulted in those areas being cleared for infrastructural development. These activities have increased the susceptibility of the sea to global climate change and natural occurrences like winds which can cause severe waves and tides to wash away the coast. The over exploitation of mangroves in Ghana and the damming on the Volta River in Volta Region has also contributed to the menace.

1.8.1.3 Mineral mining

Some rivers and streams within the coastal areas along the coastline in different regions are noted for some alluvial gold mining as well salt mining. Illegal small-scale mining (Galamsey) operations along the coast are noted to cause havoc to the ecosystem within coastal areas. These activities leave the land prone to coastal erosion where the sand and other land material believed to possess the mineral is washed away. Even though Ghana is not noted for ocean disasters like tsunamis and cyclones like in other nations, the sand along the shore protects the nation from strong storm surges as it serves as a storm energy buffer. If this sand is scooped away, the coastal communities will be devastated if such a disaster should ever happen in Ghana. This in effect is going to cost the nation economically, socially, and environmentally if nothing is done about it immediately.

1.8.2 Natural causes of Coastal Erosion

Sea level rises and heavy storms Coastal erosion has been greatly affected by the rising sea levels globally. The anticipated rise in sea levels due to climate change will result in coastlines receding worldwide through erosion. This is a known phenomenon that can, in principle, be calculated and predicted based on a given sea-level rise, by means of the so-called Bruun effect. Also, cases of heavy storm situation coupled with severe wind blow can affect the coast within a short period. Coast regions like Greater Accra have experienced severe heavy storms during the rainy season in June and July which resulted in flooding in areas below the coastal areas.

1.8.2.1 Waves

Large storm-generated waves typically cause coastal erosion, which may take the form of long-term losses of sediment and rocks, or merely in the temporary redistribution of coastal sediments. Wave action is observed to contribute to coastal erosion by breaking on cliff faces at the shore and slowly erode it (abrasion). The rate at which cliff fall debris is removed from the foreshore depends on the power of the waves crossing the beach. The waves cause loose pieces of rock debris to collide with each other, grinding and chipping each other, progressively becoming smaller, smoother, and rounder. The rock debris also collides with the base of the cliff face, chipping small pieces of rock from the cliff or similar to sandpapering. This scenario is paramount in the Central Region of Ghana along the coastline where there exists a lot of soft material which is easily eroded by this action.

1.8.2.2 Weathering and transport slope processes

Limestone cliff faces which are found in most of the regions along the coastline especially in Cape Coast and Elmina both in the Central Region of Ghana, which have a high pH, are particularly affected by chemical weathering when the sea's pH (below pH 7.0) corrodes rocks on a cliff face. Wave action also increases the rate of reaction by removing the reacted material.

1.9 WHAT ARE THE FACTORS THAT DRIVE COASTAL EROSION IN GHANA, WEST AFRICA?

Many factors, both natural and human related, drive coastal erosion. The main causes are the depositing and removal of sediment, which occur via natural processes, such as coastal drift and river discharge. Human activity can exacerbate erosion in multiple ways. It can affect the removal of sediment, through direct extraction or the creation of surfaces that disrupt the natural processes. Much more important is the disruptive effect on the supply of sediment, caused largely by dams, which interrupt the natural flow of rivers, preventing sediment from reaching coastal areas. The decline in coastal mangrove populations, which trap sediment where it is needed also contribute to coastal erosion, and climate change can affect natural resources such as these through changing temperatures, increasing salinity of groundwater and coastal estuaries, and alterations in river dynamics. The combination of these factors has led to severe land and shoreline loss. The socioeconomic impacts are massive, because coastal areas are home to millions of people and billions of dollars of infrastructure. In addition, rising sea levels, intensifying storm surge, and extreme precipitation are likely to accentuate coastal erosion events. By 2100 average sea levels are projected to rise 0.26–0.63 meters in low-emissions scenarios and 0.33–0.82 meters in high-emission scenarios (IPCC 2013). Sea-level rise will not be uniform across regions, however, because of factors such as land subsidence. Sea levels along the West African coast are expected to rise faster than the global average (UEMOA 2010). In addition, changing precipitation patterns could decrease annual rainfall in the region, reducing river flows and the concomitant delivery of sediment to coastal areas. Population growth, urbanization, and migration have led to the concentration of populations, infrastructure, and economic assets in the coastal areas of Ghana, West Africa, increasing stress on natural resources. Climate change could exacerbate these trends, as droughts inland which are expected to become more frequent and intense as a result of higher temperatures and changing precipitation patterns drive rural populations from the hinterland toward the urban centers of the coast in search of economic opportunity.

2.1 THE EFFECTS OF CLIMATE CHANGE ON COASTAL EROSION IN GHANA, WEST AFRICA.

The effects of climate change from changing precipitation patterns to rising seas will exacerbate the coastal erosion already affecting Ghana, West Africa, increasing the exposure and vulnerability of the people and assets located there. Given the importance of the coastal zone to the region as a whole, it is critical that policy makers consider the effects of future climate change in the decisions they make today.

Rising sea levels, intensifying storm surge, and extreme precipitation are likely to accentuate coastal erosion events, with significant socio-economic impacts. Also, changing precipitation patterns could decrease the overall rainfall volumes in West Africa, which would further reduce the flow of rivers in the region, thus leading to a decrease in sedimentation deposits, in turn causing increased erosion rates.

Besides, the combination of higher temperatures, and the increasing salinity of coastal estuaries and groundwater resources, alterations in river dynamics from changes in rainfall may continue to exacerbate loss of natural ecosystems and resources located along the coast.

Quite apart, the effects of climate change can affect the security of a nation as conflicts brew over competition for water, food, and land. The prospect of large groups of climate refugees migrating across borders is a concern for governments as well as for organizations devoted to reducing risk and helping those who are living in poverty and in vulnerable regions.

2.1.1 MEASURES TO ADDRESS AFRICAN COASTAL AREA.

In thinking about the resilience measures available to address the challenges facing Ghana, West African coastal areas, it helps to use a conceptual framework. One intuitive method for doing so groups potential measures into five categories: 1) policy development and planning 2) hard measures (infrastructure) 3) soft measures (including ecosystem and community-based adaptation) 4) capacity building 5) knowledge management and climate information services.

Resilience measures can be integrated into programmes and investments by modifying the intervention to account for climate change by scaling up monitoring systems for climate events or changing the design of infrastructure to account for future floods, for example.

Local adaptation actions are important to the communities they serve, but they are a piece of a much bigger puzzle. Long-term resilience needs to be addressed at the national and regional levels, because activities in one part of the region can affect areas elsewhere. Development of long-term land use that accounts for climate change and direct development away from areas with high exposure to climate-related hazards will be critical. Coupled with conservation efforts, particularly for mangrove forests, it will help reduce coastal erosion.

Regional cooperation is challenging, but it has been successful in many places, particularly where the issue addressed presented an existential challenge to the countries affected. Efforts to build trust and coordinate efforts will help policy makers protect the lives and livelihood of the people in the region and allow their countries to build on the development gains made in recent years rather than see them rolled back as a result of climate change.

Also, mitigation measures to curb this canker will include education, improved research, Soft Protection for places where immediate control or remedy cannot be provided maybe due to lack of funds or prioritization, building seawalls, creating a buffer around the coast by authorities where certain activities such as sand and mineral mining will not be allowed and many others.

3.1 CONCLUSION AND RECOMMENDATION

This study reviewed the causes and impacts of the coastal erosion in Ghana as well as the appropriate mitigating measures needed to curb the menace. It was observed that Ghana as of now is recording severe cases of coastal erosion along its coastline due to changes in climatic conditions. Various cases of occurrence of this event and key facilitating sources of this problem were identified and discussed. It was established that proper management policies and attention is needed to mitigate the situation. The issue of coastal erosion can be minimized or prevented if the necessary planning and efficient measures are taken and ensured. The Ministry of Environment and all other related agencies involved should take a more holistic approach to preserve and maintain not only the coast but to also prevent human activities leading to climate change.

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