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Coastal Hazards and Flooding Risk in Ghana's Western Region

Issue Brief 7 in series "Hɛn Mpoano: Our Coast, Our Future"

Hɛn Mpoano

THE UNIVERSITY OF RHODE ISLAND GRADUATE SCHOOL OF OCEANOGRAPHY

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Contents

List of Figures

Coastal Hazards and Flooding Risk in Ghana's Western Region

SUMMARY

Coastal flooding and shoreline erosion is increasingly impacting people, property and ecosystems in many parts of the Western Region's coast. Coastlines and flood plains are dynamic systems that have always posed risks as places to build, whether or not people recognize those dangers. As population grows and development intensifies in the region, demand for land is rising, even in increasingly risky shoreline locations. Poor citizens are pushed into marginal, unsafe flood prone areas to live. New residential and industrial developments are filling in any available land, reducing the ability of waterways to handle rising waters from storms. This sets up a vicious cycle that reduces public safety and increases the demand for costly shore protection and drainage works that may not actually solve the problems.

Better understanding of how the shoreline and natural drainage systems work needs to be combined with smarter choices about how to locate and carry out development is needed to break this cycle and improve our ability to both work with nature and achieve economic and social goals.

The Western Region needs to foster a common framework for addressing natural hazards, including reliable area-wide information about the location of vulnerable areas, the risks of building in flood plains, and the practices that exacerbate erosion. Policies such as setting building setbacks should be incorporated into all District spatial development and structure plans, land use zoning and building codes. They should also include designations of areas where shore defenses, flood control and drainage systems are required and permissible. These designations need to be based upon whether public purposes are served, and whether the use actually depends on a waterfront location. Any proposed shoreline hardening or stream channelization project should be well-engineered and have a high probability of addressing the hazard and be significantly more cost effective than options with lower environmental impacts.

Coastal Hazards and Flooding Risks are Urgent Issues

Coastal hazards are a major threat to the development and progress of the Western Region of Ghana. The coastal population is large and growing as a result of booming oil and gas industry. The largest urban centers and much of the economic activity are located along the coast, so flooding and coastal erosion pose a threat to development and well-being in the region.

Efforts to protect coastal economic activities and settlements from the damaging forces of flooding and erosion are not new in the Western Region. Much of the Takoradi and Sekondi coast is armored with shoreline protection methods ranging from seawalls and groins to make-shift solid waste rip-rap. Takoradi Port was built in the 1920s and includes a large breakwater to reduce wave impacts on ships and shore-side facilities. The Albert Bosomtwe-Sam Fishing Harbour constructed in 1998 has a similar overall design. Currently, new or expanded facilities are being constructed for the oil and gas industry and energy sector in Takoradi in the STMA, Aboadze in the Shama district, Funko and New Amanful in Ahanta West, and Atuabo in Ellembelle district. The support facilities and secondary operations

associated with these projects, many of which are not dependent on direct access to waterfront, also typically seek coastal land.

For centuries, fishers throughout the Western Region have sought safe refuge in protected coves and beaches. There are over 80 landing sites and beaches used to offload and process catch, moor or beach their boats and live in temporary camps. Over time these sites often grew into dense settlements that are perilously exposed to waves and flooding. In recent decades, many of them have been buffeted by waves and erosion to such an extent that shore protection structures have been installed. However, many of the structures did not adequately serve their intended function or have simply failed, such as in Axim, Princes Town, Dixcove, Aboadze, and Shama.

Finally, the Western Region's coast has become increasingly attractive for tourism facilities, expanding coastal settlements and increasing urbanization, especially in the STMA. Some investors are marketing ambitious facilities that include dramatic schemes to lure Ghanaian and international visitors with landscape-altering features such as golf courses, recreational boating in artificial harbors, lodging on or over coastal waters, and private beaches.

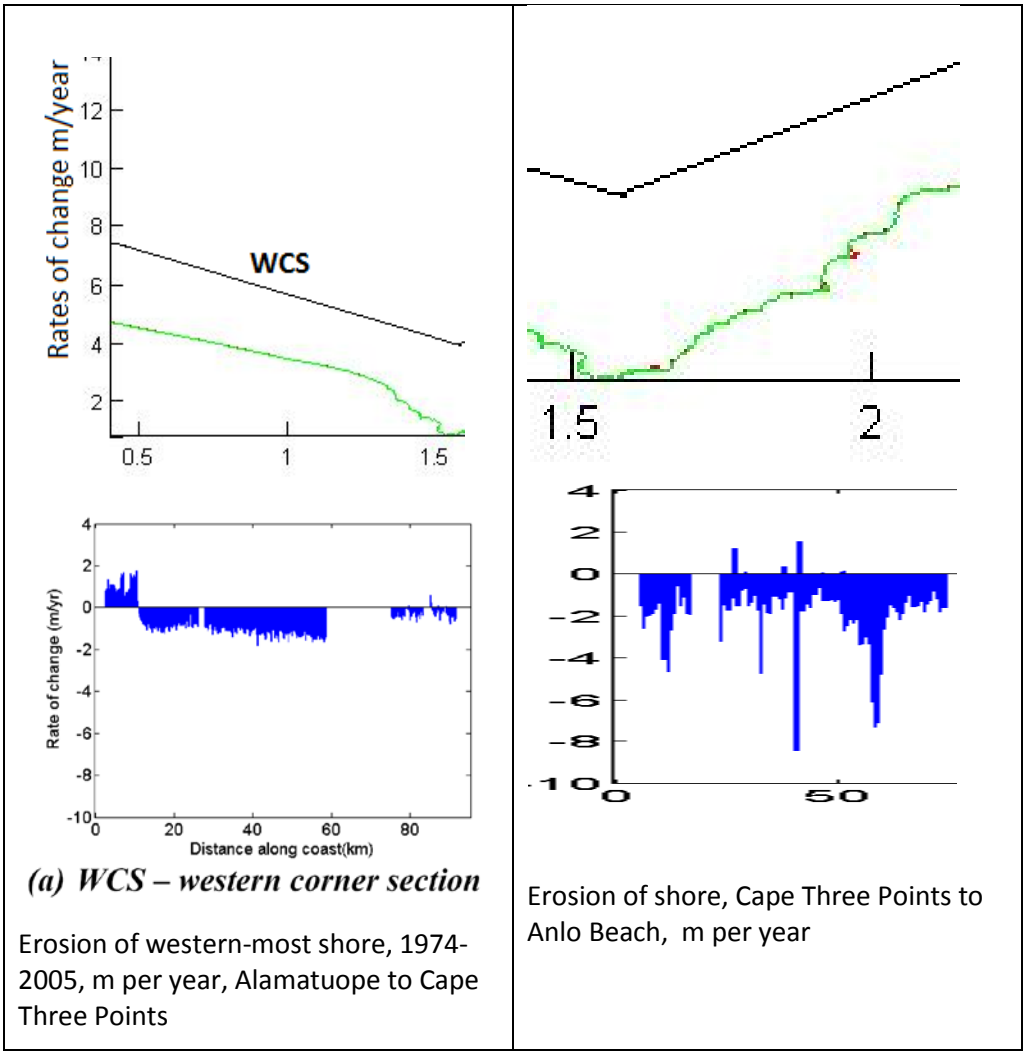
Coastal erosion

The shoreline in Western Ghana is made up of sandy beaches broken up by small rocky outcrops. The loose sediment of the beaches is constantly shifting under the energy of waves and wind, and in this area it has been eroding for many years. Coastal erosion is greatest in areas where sandy beaches are exposed to waves and lack a supply of incoming sediment. Areas around river mouths and barrier inlets are particularly dynamic and reactive to flooding events.

As technology and research methods advance, current studies are not always directly comparable to earlier work, but can be informative about changes in shoreline position and erosion rates. Between 1974 and 2005 shorelines in Western Ghana retreated at an average rate of 1m per year (Wiafe, 2011) with considerable variation along the coast, as Figure1 illustrates.

This rate varies by shoreline type and the direction of the coast. A more detailed analysis for one segment of Ellembelle's coast is shown in Figure 2, indicating rates between 0.5 and 2.5 meters per year along a 7 km part of the shore. A longer term view on shore erosion is provided in Figures 3 and 4. Over the past century, one estimate of shoreline change shows that from Cape Three Points to Anlo Beach, the shore has experienced a loss of 1.6 m per year. While the studies are not directly comparable, both indicate that the south-western facing coast from Cape Three Points at least out to the Ankobra estuary has changed less dramatically than the section between Takoradi and Anlo Beach.

Sea defenses meant to protect the shoreline have failed in many locations, often due to their improvised nature or inadequate design and construction, or the fact that natural buffers such as mangroves or dunes have been removed. Vital infrastructure can be protected using engineered structures, but alternatives such as siting them away from risky areas to begin with, or relocating them as part of managed retreat are strategies that can be cost effective and should be considered.



(a) WCS – western corner section

Erosion of western-most shore, 1974-2005, m per year, Alamatuope to Cape Three Points

Erosion of shore, Cape Three Points to Anlo Beach, m per year

Figure 1 Erosion in Western Region Coast

Source:Wiafe G (2011) Coastal and continental shelf processes in Ghana. Department of Oceanography and Fisheries, University of Ghana.

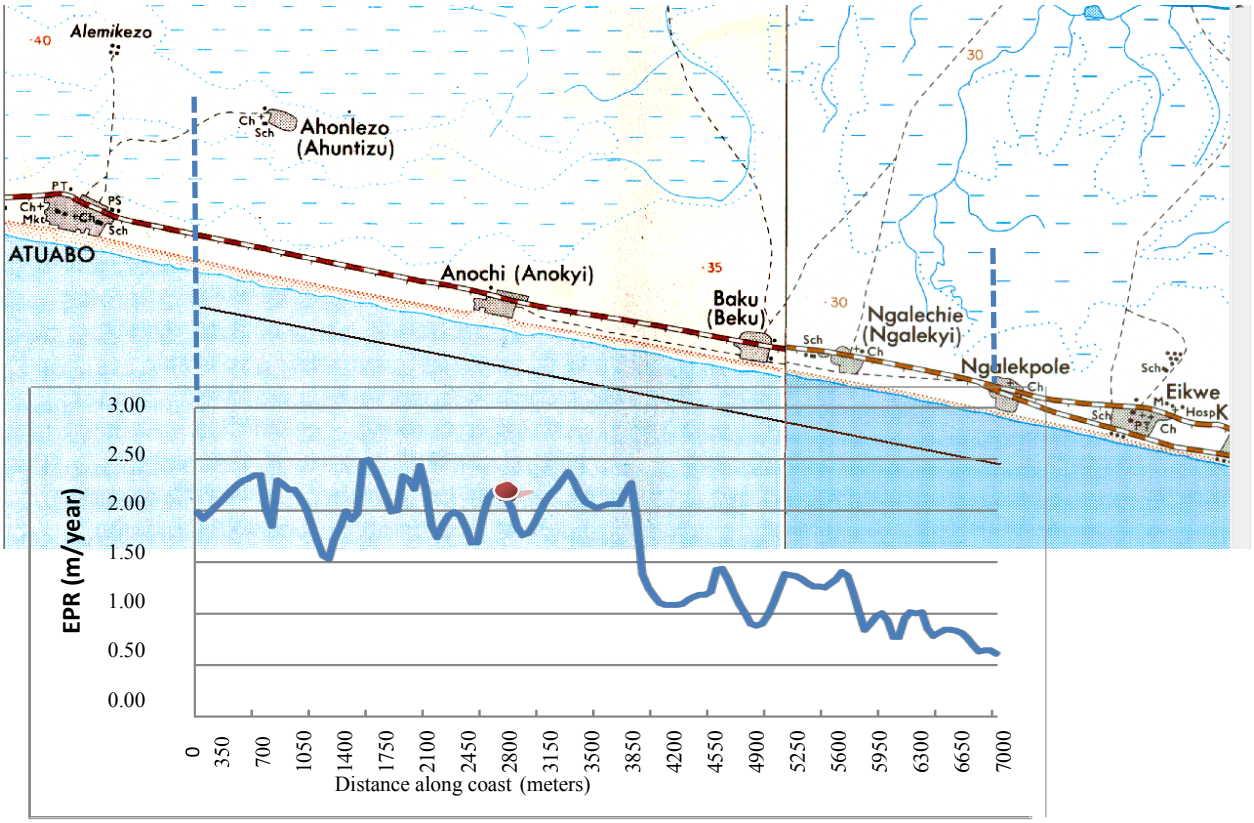


Figure 2 Annual erosion rates for a 7 km stretch of shoreline in Ellembelle District,

The point shows the location of Anochie, meters per year

Source: Wiafe G (2012) Potential Impact Of Construction Of Port Facility At Anochie, Western Region Of Ghana. Report by the Coastal Processes and Maritime Sensing Unit, Department of Marine And Fisheries Sciences, University of Ghana

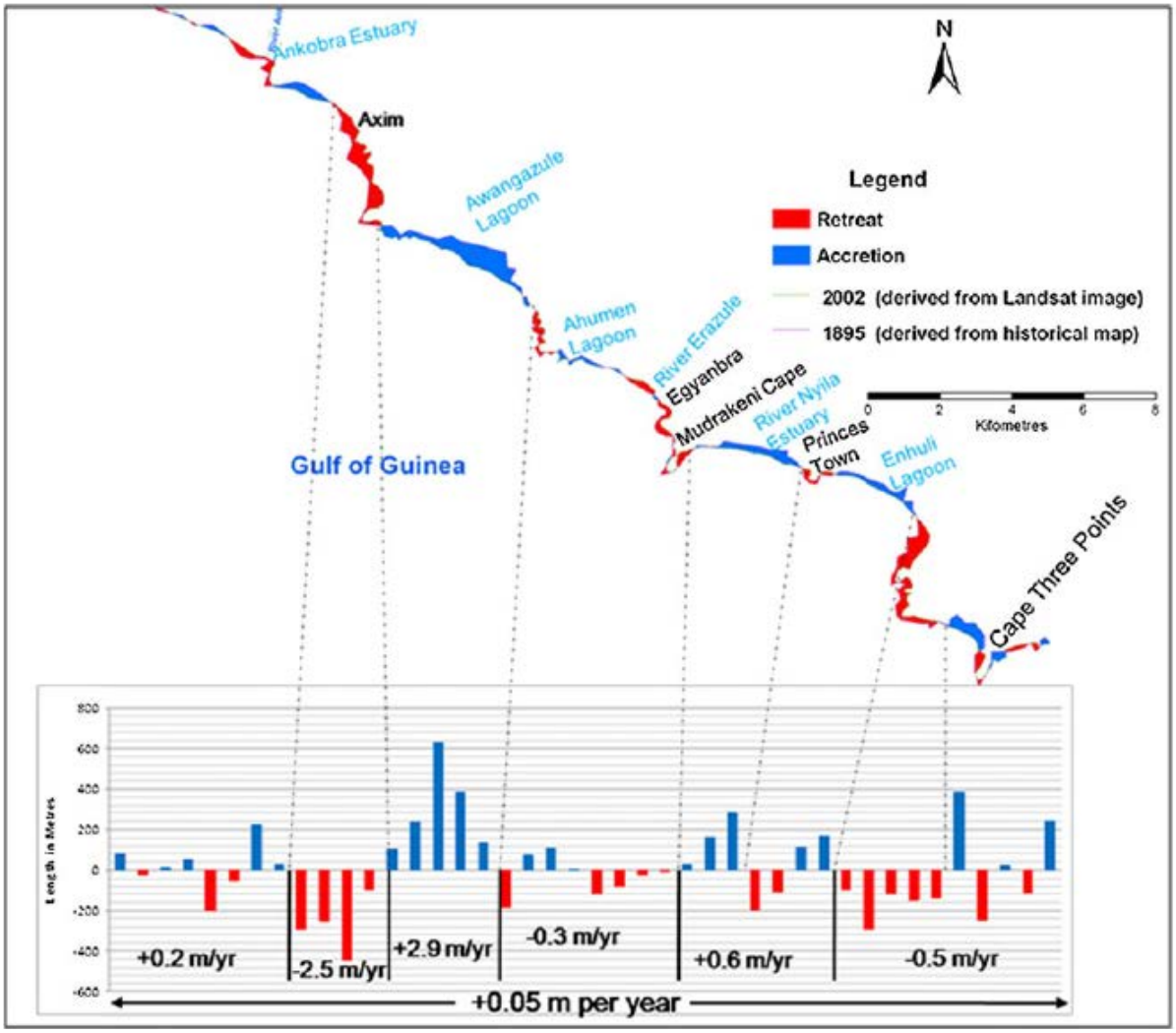


Figure 3 Coastline change in the Western Region's southwest facing shore.

Source: Boateng, I (2012) An application of GIS and coastal geomorphology for large scale assessment of coastal erosion and management: a case study of Ghana. Journal of Coast Conservation (2012) 16:383–397

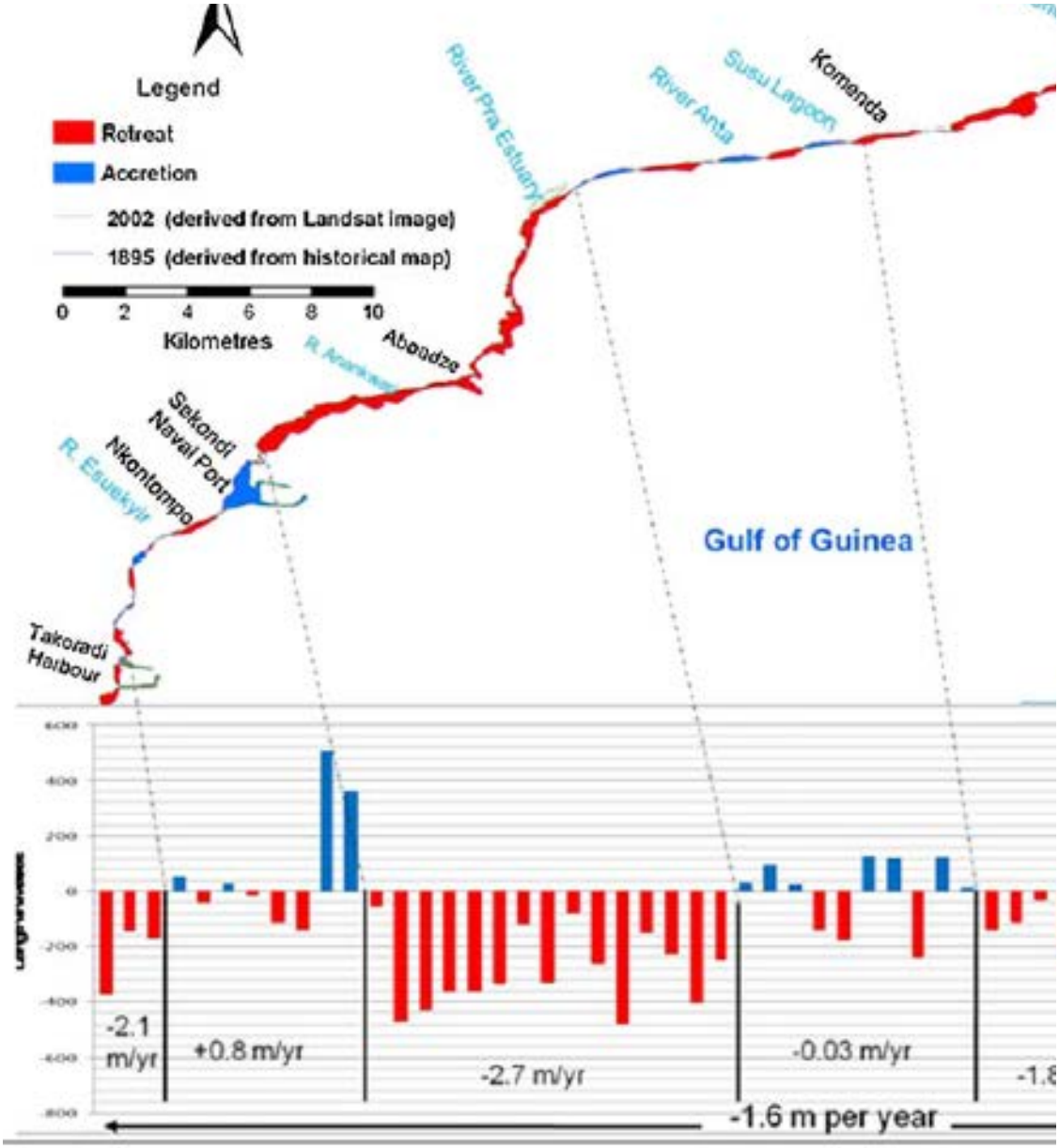


Figure 4 Coastline change in the Western Region's southeast facing shore.

Source: Boateng, I (2012) An application of GIS and coastal geomorphology for large scale assessment of coastal erosion and management: a case study of Ghana Journal of Coast Conservation (2012) 16:383–397

Coastal flooding

The Western Region receives on average a higher amount and intensity of rainfall than most other parts of Ghana. The Rain Forest Zone is hot and humid with a mean annual rainfall >2,000 mm per year (Stanturf et al., 2011). The rainfall in the Western Region occurs in two main periods; the major season, with the highest intensity rainfall, occurs between May - July, and a minor season, with less intense rainfall occurs between September – October.

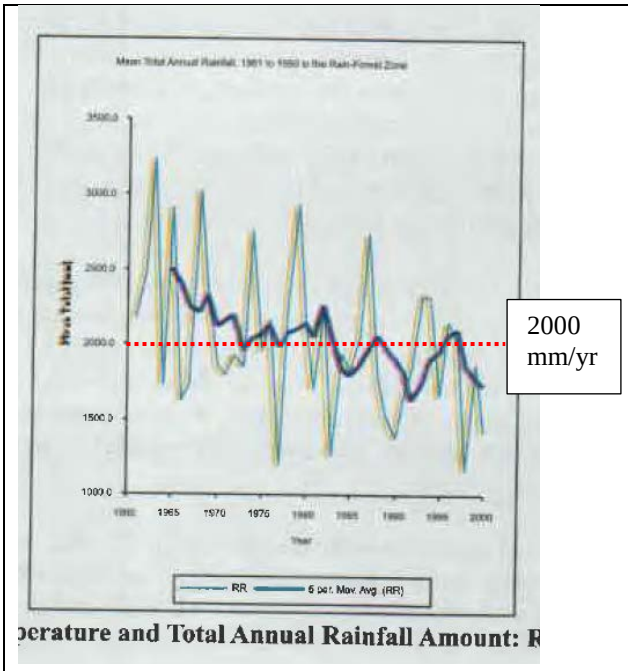


Figure 5a: Trend in annual precipitation in "rain forest zone" 1950-2000 (EPA/NCAP, 2008, p. 9)

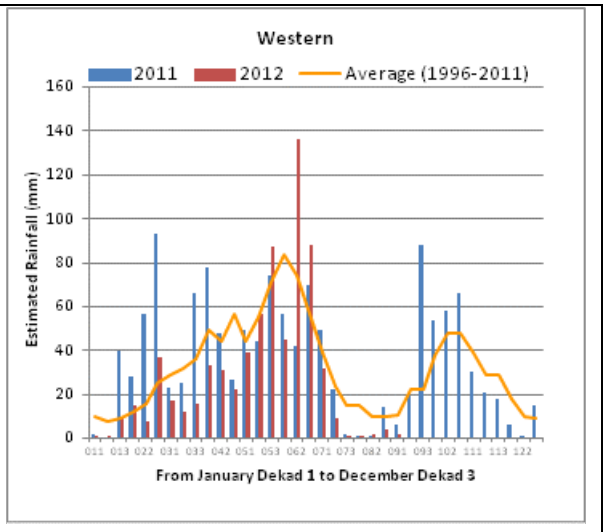


Figure 5b: Recent trends in the annual precipitation pattern in the "Western region" (NOAA/FEWSNet, FAO/NRCB, 2012) Time interval is dekads (10 days)

Figure 5 Trend in annual precipitation

Sources for Figure 5:

Environmental Protection Agency. (2008) Ghana Climate Change Impacts, Vulnerability and Adaptation Assessments. The Netherlands Climate Assistance Programme (NCAP). Accra, Ghana.

NOAA/FEWSNet; FAO/NRCB-Agrometeorology Group (2012) Interpolated Estimated Dekadal Rainfall - By Region/Province Ghana Quantitative estimate of rainfall combining METEOSAT derived Cold Cloud Duration imagery and data on observed rainfall (GTS-Global Telecommunication System by the NOAA Climate Prediction Centre) Source: http://www.fao.org/giews/english/ierf/list.asp?code=94

Freshwater bodies rise to flood stage during heavy rainfall events. The Anankwari River in Shama District has experienced intense, damaging flooding that displaced hundreds of families. As more land is built on and paved over, the amount of water running off the land increases. Installing proper drainage in built up areas is usually an afterthought and most coastal districts do not have drainage master plans. When channels are constructed to deal with an immediate problem they often just speed up the flow of water and create a worse problem elsewhere. For example, people living along the Anankwari River downstream of the Inchaban Dam in Shama district are now threatened every year by the peak rainfall in June that sees increased runoff flooding businesses, houses and farmlands. Some settlements along the shore and tidally influenced rivers such as the Pra have already begun to relocate to safer areas.

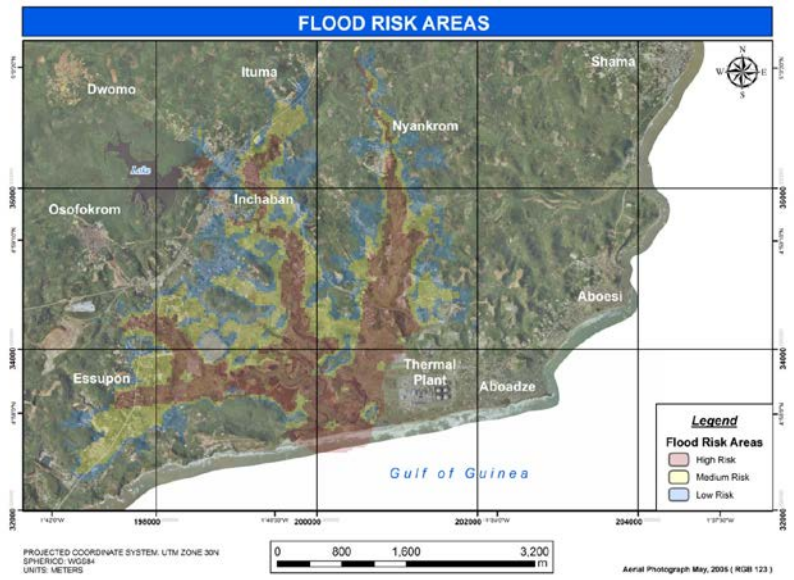


Figure 6: Anankwari River flood risk area extends far beyond the river bed and permanent wetlands (Department of Geography, University of Cape Coast. (2011) REPORT ON PHASE II TASKS I, II, III and IV ICFG/CRC-GHANA and DGRP UCC Collaboration. Cape Coast: University of Ghana Department of Geography and Regional Planning.)

Figure 6 Anankwari River flood risk area

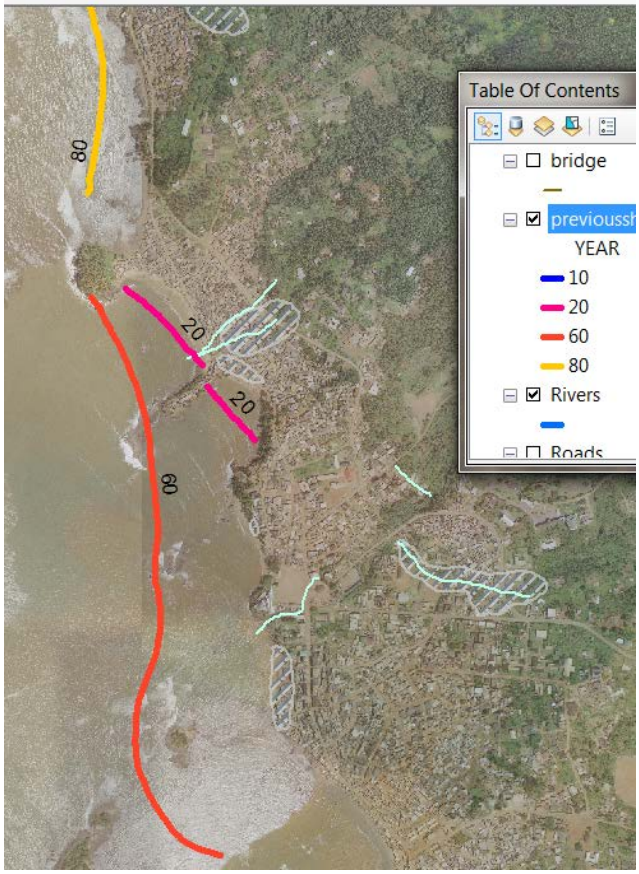


Figure 7 Axim fishing port is experiencing significant shoreline change as well as flood-prone areas

Fish landing sites such as Akwidaa and Axim are located in low-lying areas affected both by shore erosion and increasing flooding from coastal sub-basins. Fishing camps and landing sites were once temporary and moved as the shoreline changed. However many are now large permanent settlements, placing both people and infrastructure at risk. Along the ocean-facing edge of the Amanzule Wetlands, many communities face multiple threats from shore erosion, periodic flooding of the wetlands, and the loss of roads, bridges and buildings along the streams where floodwaters drain out to the sea.

Shoreline and flood plain alterations

People living, working and recreating in shore areas seek the advantages of being located near the water but often unknowingly take on a great deal of risk. Poor people in coastal districts often are squeezed into the riskiest locations. Building houses, hotels and waterfront facilities on the shore compounds risk since each new alteration of the shoreline or flood plain, especially "sea defenses" can make things worse for those uses already in place.

Poor siting decisions are not the only way infrastructure ends up in harm's way. Sand winning removes material from the natural system that keeps beaches replenished, thus accelerating the process of erosion. Docks, piers, bridges and building foundations may be improperly designed to resist the forces of waves, wind and water. The installation of groins aimed at trapping and retaining sand unfortunately often has the effect of starving adjoining beach segments of sand, so that the erosion problem is simply moved from one location to the next.

The coastal districts do not have a thorough inventory of the location, condition and effectiveness of existing structures exposed to erosion and flooding. Hen Mpoano with the assistance of the University of Cape Coast estimates that 1.12 km of the shoreline in the Shama District consists of man-made structures and sea defenses of various types ranging from piles of garbage and rubble to partially engineered riprap, sea walls and breakwaters. Many of these structures are not serving their intended purpose and have become a hazard.

Districts need to determine how to deal with the challenges of flooding in a rapidly developing coastal zone through a combination of selective construction or maintenance of shore protection, adapting buildings and infrastructure design, or retreating completely from high hazard areas through resettlement, restoration of waterways, wetlands protection, and prohibiting all but water-dependent uses from risky areas.

Relocation of settlements away from high hazard areas is a complex and delicate issue that raises many concerns, including the demand for appropriate land and social justice throughout the process. In order to be successful, relocation requires identification of a safer area that meets the needs of residents, including proximity to fish landing site, agricultural lands, and existing infrastructure such as transportation corridors and water supply facilities. Relocation should also address the needs of the increasing migrant population without secured access to land for settlement. The needs of these communities must be handled with sensitivity. Identifying appropriate lands for relocation is an important step, as well as having enough resources available for the resettlement process. Districts must plan how and where infrastructure such as electricity is provided to avoid creating inducements for families to remain in a hazardous location, as has occurred at the fish landing site in Akwidaa.

Future coastal development in the Western Region

According to the Western Region Spatial Development Framework coastal districts of the Western Region are now in the early stages of a development boom driven by oil and gas, mining, agro-industry, energy, tourism, population growth and in-migration. The expansion

of land development and urbanization is being accompanied by demand for improved infrastructure including roads and bridges, port facilities, fish landing sites, hotels and resorts, utilities, water supply, and waste disposal. This growth needs raw materials including sand, gravel, quarry rock and will result in additional land clearing. Competition for space and resources is already pushing more development to marginal lands affected by flooding and erosion.

Shama:	Beachfront hotels, industrial and energy generation, pipelines and processing, commercial development, upgrading fishing harbor, urban encroachment into wetlands, construction of airstrip.
STMA:	Upgrading the Takoradi Port to handle oil and gas, mining and agricultural exports, energy processing and oil & gas operations, upgrading fisheries harbor.
Ahanta West:	Development of tourism facilities in coastal communities, upgrading fishing ports in Dixcove, power generation, energy processing and oil & gas operations
Nzema East:	Expansion of fishing port in Axim, tourism development in fragile shore areas, energy facility siting, highway and water transport on the Ankobra River
Ellembelle:	Oil and gas development, industrial development along pristine coastline centered at Atuabo, new port facilities, roads and bridges, mining and landscape alteration
Jomoro:	Oil and gas development, river transport through Amanzule wetlands, in-migration to small coastal communities, upgrading fishing facilities

Development trends are seeing more coastal and flood plain development including in high risk areas, as well as new proposals to expand waterfront infrastructure, harden the shoreline, and fill in low-lying areas. While some of these projects do depend on a waterfront location, many other projects gain some benefit from being near the water but do not require it. The combination of existing exposed facilities and new coastal development is increasing the amount of property and people in harm's way, which in turn will increase the demand for costly and potentially ineffective shore protection and flood control investments by the public sector. Now is the time to identify ways in which economic development can flourish and infrastructure improved without incurring high financial costs or accelerating damage to coastal areas.

THE WAY FORWARD: SMARTER COASTAL DEVELOPMENT AND SAFER COMMUNITIES

The Western Region's shoreline is attractive, valuable, dynamic, and potentially dangerous. The natural and engineered drainage ways which bring rainfall and wastewater from coastal hillsides to the sea respond to intense rainfall by sending large pulses of water downstream, usually overflowing river banks. People and development are increasingly in harm's way because of poor choices made by themselves or others, which in turn is due to a weak understanding of natural systems and disregard for the possible impacts of our development choices. There is much work to be done to improve coastal community safety and reduce exposure to erosion and flood damage for the development and uses already in place. It is urgent that better choices be made for the new investments being proposed in coastal and flood plain areas so that they avoid creating additional problems for their neighbors and the environment.

Better Understanding of Shorelines and Coastal Drainage Systems

In order to better manage coastal erosion and flooding, district governments need better information about erosion rates and flood-prone areas. Coastal districts can follow the example of Shama by working with traditional authorities, builders, and local residents to record the location and risks associated with hazardous shore areas. Good data about erosion rates within each district will help determine how far away structures need to be kept from the shore, and which areas need to be kept free of all structures. This is usually calculated by multiplying the number of years the investment needs to last, by the annual rate of erosion.

New large scale shorefront developments are being proposed and are already in construction that includes significant alterations to shore and wetland areas. The current Environmental Impact Assessment (EIA) review process for large facilities will not by itself eliminate impacts since sand supply, currents, erosion and sedimentation require continued regional research and monitoring. Case by case decisions on coastal development need to take into account an understanding of the larger system, as well as impacts beyond the boundaries of a particular project.

It is also important to examine the man-made shoreline where buildings, seawalls, piers, drainage pipes, roads and bridges are already located. Many of these installations are damaged or being undermined. Most sea defenses that are not part of larger, well-engineered installations such as the ports in Takoradi and Sekondi are in disrepair or not serving a protective function. They pose a safety hazard, may exacerbate erosion, and should be repaired or removed

Districts need to create maps of areas that are periodically flooded and identify businesses and people that are already in harm's way. These maps will guide district plans for future growth and development in the most appropriate areas. Shama District worked with the University of Cape Coast to create computer predictions of how a given rainfall will impact its area. The findings indicate how large an area will be inundated and how fast. This information is valuable in emergency response as well as helping justify restrictions on where houses, businesses, and public buildings can be located.

Improve and coordinate District policies, plans and decisions

Information about coastal and flooding hazards can be used in a number of ways to improve District policies through bye-laws, spatial development plans, and for incorporating hazards management in to Mid-Term Development Plans.

Common policy across districts

Each of the six coastal districts can contribute to a model bye law or policy statement that can be adapted and used by the others. In some cases all of the coastal districts might want to use the same policy, for example a general setback or buffer policy and regulations that would also be incorporated into the regional development framework, as well as district structure and local plans. This would discourage investors from 'shopping around' to find a more lenient district. Flood plain mapping and setbacks from high hazard areas are needed for each district but should also follow a common approach across the region to make rules and local decisions more predictable and accepted. Priorities need to be set as well depending on whether an activity actually requires a waterfront or riverfront location or serves a clear public benefit. Local plans can specify priorities for siting coastal construction so that the cumulative impact of developing an area keeps risks low.

Standard building codes that include hazard reduction

Districts, municipalities and coastal communities also need access to a standard building code that addresses the special requirements for constructing buildings, roads, docks and piers, protective structures and needed infrastructure in hazard-prone areas.

Eliminate damaging practices such as sand mining by finding alternatives

The need for construction materials is growing, and it is convenient to take them from eroding shore areas without regard for the economic and environmental losses the practice causes. Districts need to determine where building materials can be safely extracted within their borders, and to recognize that extractive uses of the shore will be more costly in the long run than the immediate cash value of the sand which is removed.

Build local capacity for implementation

Effective implementation can only happen when Districts have the capacity to properly evaluate projects and enforce policies. District officials will need more technical capacity to prepare bye-laws, understand and review projects, and negotiate modifications. The design, engineering and development communities must then contribute to, endorse and accept the policies and codes, and follow through by submitting proposals that comply with those rules. The decision process for land development and major projects will need to be robust with effective legal backstopping of local decisions by regional and national authorities where necessary.

Improve Emergency Response

Emergency response capacity, as well as the awareness of causes and effects of hazards is very low across most of the Western Region districts. Earlier warnings about flood emergencies by the National Disaster Management Organization (NADMO) need to be accompanied by good communications and better local organization. Local authorities need a greater ability to support rapid response, rescue and relief efforts during and after major events, as well as damage assessment. Emergency response also needs to be seen in the context of hazard mitigation and risk reduction.

Incorporation of Best Practices into coastal defenses

Engineered shoreline stabilization is sometimes necessary to protect valuable infrastructure, particularly in heavily developed areas. However, these kinds of construction projects are expensive and can cause increased erosion in adjacent areas if not designed properly. Therefore, proper design and planning of new construction of sea defenses in the context of the entire shoreline is vital to their success in protecting targeted shoreline resources without causing unintended problems elsewhere.

Increased collaboration with national agencies such as the Ministry of Water Resources, Works and Housing, for installing shoreline protection systems would be helpful in making sure that the impacts of breakwaters, groins, and sea walls are planned and evaluated. While large port projects benefit from professional engineering studies and design, this level of expertise is out of reach for most protective works and shore rehabilitation for smaller projects. The same holds true for storm water drainage in the rapidly urbanizing districts of Ahanta West and Shama for example. A systematic and regional approach need to be taken to address this challenge. Districts must decide on performance standards such as no net-impact, or compensation policies that trade-off, allowing some shoreline alterations for environmental protection or improvement in another area of concern. This will encourage the application of proactive measures for minimizing off-site erosion and flooding impacts of oil and gas or large port facilities.