Impacts of flooding and riverbank erosion on the environment and socio-economic activities in the Lower Pra River Basin

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Abstract

Floods and riverbank erosion have become global hazards as they impact infrastructure and socio-economic activities of people in riparian zones. The lower section of the Pra River has been subjected to these hazards for the past two decades, which is threatening lives and properties. The impacts of these hazards translate into environmental and socio-economic liabilities that need to be mitigated. The study was thus conducted to assess the environmental and socio-economic activities impacted by the hazards, determine the mitigation and coping strategies of residents and proffer management strategies. Four (4) towns were selected for the study. Data was collected through questionnaire administration, interviews, and field exploration. Information was gathered from household heads, local authorities, and assemblymen. Results showed that riverbank erosion and floods were causing physical destruction to infrastructure and buildings with grave socio-economic impacts on health, commercial and agricultural activities of households. The development and enforcement of land use, water resources management plans, structural engineering projects are some of the key measures needed to manage the hazards.

Keywords:

flooding; hazards; riverbank erosion; livelihoods; Pra River; Ghana.

Introduction

Rivers play a critical role in providing water for industrial and domestic purposes hence riverbanks or riparian zones have been attractive enclaves for human settlement for millennia. Flooding and bank erosion are frequent hazards along riparian zones with serious physical and socio-economic impacts. Riverbank erosion is one of the most worrisome environmental hazards currently (Chatterjee & Mistri, 2013). Although floods and bank erosion are natural occurrences, they become a reason for genuine concern when they surpass the adaptive limits, which create a lot of social, economic, and environmental impacts affecting communities (Abhas et al., 2011; Rahman, 2010).

The Intergovernmental Panel on Climate Change (IPCC) defined flood as the overflowing of the normal confines of a stream or other body of water or the accumulation of water over areas that are not normally submerged (IPCC, 2012). Floods include river floods, flash floods, urban floods, sewer floods, coastal floods, and glacial lake outburst floods. Normal flood enriches arable floodplains with rich alluvial deposits thereby increasing agricultural production, but high magnitude floods are very disastrous (Few, 2003). The degree of the flood depends on several factors such as the intensity and duration of rainfall, ground conditions, drainage characteristics and siltation of the river (Jha et al., 2012).

Riverbank erosion is seen as a disaster when it occurs along inhabited banks as it leads to losses in all aspects of livelihoods (Shamsuddoha & Chowdhury, 2007). Excess water from upstream, meander migration, sudden flood, siltation of riverbed, channel obstruction are the significant reasons for riverbank erosion (Novak et al., 2021; Wohl, 2015). Bank erosion hazard usually causes social problems like displacement and resettlement of inhabitants who live near the riverbank, loss of lives including livelihoods and assets (Best, 2019; Das et al., 2017). According to Rahman (2010), bank erosion and flooding in Bangladesh cause massive unemployment, displacement, and poverty yearly, and they are responsible for the unstable economic conditions in Bangladesh. Physical impacts of bank erosion are damage to infrastructure, loss of fertile land and stream quality (Wohl, 2015; Zaimes et al., 2021).

Globally, flood hazard and bank erosion have many serious challenges causing substantial economic damages and loss of lives. For example, flooding in Cumbria in 2005 and 2009 and England in summer 2007 resulted in high death toll and significant economic loss which aggregated to more than £3.2 billion. Also, between 1980 and 2008, Bangladesh experienced 219 floods and bank erosion hazards, costing them over US $16 billion in total damage (United Nations Development Programme [UNDP], 2010). In recent years, flood-related fatalities in Africa and associated economic losses have risen intensely (Di Baldassarre, 2010). In 2007, floods displaced more than a million people in Uganda, Ethiopia, Sudan, Burkina Faso, Togo, Mali and Niger, and claimed over 500 lives, and

in September 2009 floods affected 600,000 people in 16 West African nations with the worst hit countries being Burkina Faso, Senegal, Ghana and Niger (United Nations, 2009).

Ghana is very prone to flooding particularly urban rivers. Ghana recorded 19 significant flood events between 1968 and 2015 nationwide, causing about 415 casualties with a lot of people displaced (Emergency Event Database [EM-DAT], 2015). This costs the country US$108 million (Emergency Event Database [EM-DAT], 2015). The lower section of the Pra River is subjected to perennial flooding and bank erosion processes which are threatening lives and properties. Areas like Shama and Twifo Praso at the lower Pra basin have been experiencing many flood incidents, exposing residents to a great deal of socio-economic and environmental problems. For instance, in July 2009 the Pra River burst its banks which resulted in the destruction of 60 and 78 houses in Krobo and Anlo Beach respectively; and in July 2011 the river floods again and displaced 625 people at Inchaban (Coastal Resources Centre, 2013). Besides the displacement of inhabitants, these floods also destroyed crops and livestock worth thousands of Ghana Cedis (Coastal Resources Centre, 2013). In 2017, river Pra submerged large acres of farmlands, displaced hundreds of residents of Anlo Beach Town, Bosomdo, Krobo etc. in the Shama District and Twifo Praso in the Twifo Atti-Morkwa District. Over 2000 residents of Twifo-Praso who were rendered homeless battled with hunger (Nyarko 2017; Opoku, 2017). Unlike flooding where a lot has been done on its environmental and socio-economic impacts, literature on bank erosion is more on geomorphological processes which focus on the assessment of retreat rates and the causes in order to develop management strategies (Kusimi, 2017; Novak et al., 2021; Saadon et al., 2021; Zhang et al., 2019) with little focus on the socio-economic impacts of the hazard. Although riverbank erosion occurs gradually, it has long-term socio-economic impacts which are not recoverable easily as it contributes immensely to the marginalization process of many people (Barua et al., 2019). The social vulnerability thesis suggests, poor and marginalised people mostly live in hazard-prone areas hence are more vulnerable to hazards and are also less resilient to the hazards (Akter & Mallick, 2013; Adger, 2006; Brouwer et al., 2007). Therefore, it is important that household resilience approaches resulting from long-term knowledge, familiarity and practices are understood so that policy makers will be assisted to formulate policies targeted at mitigating the effects of the hazards among such vulnerable people (Barua et al., 2019; Preston et al., 2011; Marshall, 2010; Tompkins & Adger, 2004).

Although several policies including the Integrated Water Resources Management Plan (IWRMP) of the Pra Basin have been formed with the aim of addressing water management and curbing riparian hazards like flooding and bank erosion (Water Resources Commission, 2012), these issues persist within the Pra catchment. Also, there is a broad national climate change policy to mitigate climate change impacts, but these

are yet to be mainstreamed into local development policies as prescribed by UNFCCC's Kyoto Protocol (European Environment Agency, 2007; Ministry of Environment, Science, Technology and Innovation 2013). Against this backdrop, this study was carried out to assess the environmental and socio-economic activities impacted by the hazards, determine the mitigation and coping strategies of residents and proffer management strategies to deal with the hazards. Quantifying the impacts of these hazards, creating awareness of the magnitude of the hazards on livelihoods and the environment will engender public discourse to formulate policies to reduce the vulnerability and increase the local adaptation processes of residents.

Study Area

The Pra River basin is the second major river basin after the Volta basin in Ghana. The Pra basin is located between latitudes $5^0$00'N and $7^0$15'N and longitudes $0^0$30'W and $2^0$80'W in south-central Ghana (Fig. 1) (Kusimi et al., 2014). Its principal tributaries are the rivers Ofin, Oda, and Birim, which take their sources from the Mampong-Kwahu and Atewa ridges. According to Kusimi et al. (2014), the Pra basin is generally of low relief with undulating topography with an average elevation of about 450m above sea level. This study focused on the Lower Pra River Basin (LPRB) which stretches from Twifo Praso to the coast at Shama (Fig. 1). The lower section falls within the Twifo Atti-Morkwa, Mpohor Wasa East and Shama Districts. The lower basin drains an area of 6,778 km^2. The LPRB is located between $5^0$0'0''N and $5^0$36'52''N and $1^0$15'0''W and $1^0$53'0''W. The LPRB is situated inside the forest ecological zone of Ghana. Due to farming and illegal small-scale alluvial gold mining activities, the forest has experienced rapid degradation (Kusimi, 2014). Mean annual runoff is estimated to be 4,200 m^3yr^{-1} (Water Resources Commission, 2012)

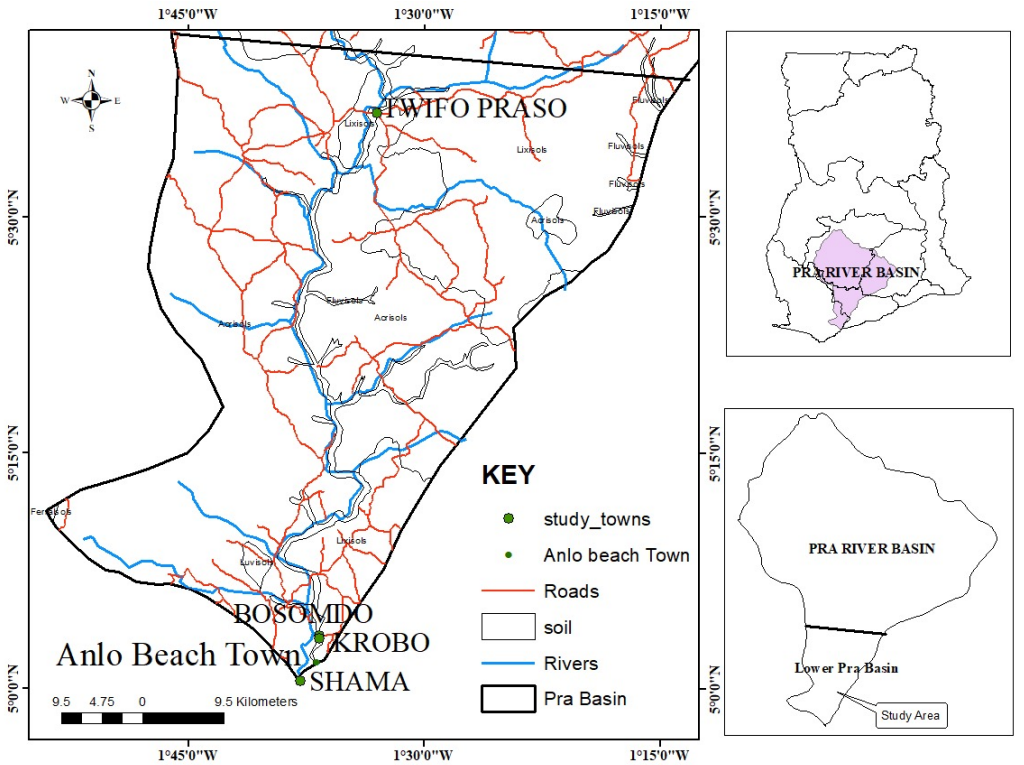

Fig. 1: Map of the Lower Pra River Basin; (Composed by authors)

The landscape of the lower section of the river basin from Twifo Praso downstream has elevation ranging from 0 - 150m above sea level which makes the locality prone to flooding (Water Resources Commission, 2015). The LPRB has two rainy seasons, April-June, and September-November. Total rainfall amounts fluctuate between 1,450mm and 1,900mm with a mean of about 1,600mm. The disparities in the rainfall pattern within the LPRB increases towards the southern part of the basin. The soils in the lower section are weathered from the Tarkwaian and Birrimian geological formations (Dickson & Benneh, 1995). The soil structure is clay in nature; therefore, it can retain more moisture. The primary soil type for this basin is forest ochrosols but that of the lower Pra basin are fluvisols, luvisols, lixisols, and acrisols (Adjei-Gyampong & Asiamah, 2002).

Methodology

The study used both quantitative and qualitative designs in conducting the research (Creswell, 2009; Teye, 2012). The research adopted the case study technique. Case studies investigate properties, actions, attitudes, and social structures of individuals, groups, or institutions by applying one or more methods, such as participant observation,

interviews, and analysis of documents (Baxter & Jack, 2008; Thomas, 2011). This was appropriate because the study required an in-depth investigation of bank erosion and flooding processes, and their impacts on the environment and socio-economic activities in the catchment area.

Methods and instruments of data collection included questionnaire administration using questionnaires, interviewing using an interview guide, field exploration using field note book and camera.

Purposive sampling was used to select the study towns and key informants for in-depth interviews. Towns that were experiencing the hazards particularly those that were most affected by two extreme events in the past two decades - 2009 and 2017 - were selected after reconnaissance survey. The communities are Twifo Praso in Twifo Atti-Morkwa District; Anlo Beach town, Shama and Bosombo-Krobo in the Shama District (Fig. 1). The key informants that were contacted included the District Planning and NADMO officers of the districts and four (4) assembly members of the localities. These informants were selected to expatiate on the people's vulnerability to the hazards, impact on the people's livelihoods, and proposed measures being instituted by the local assemblies to curb these hazards.

Questionnaires were administered to household heads who were living, and/or were undertaking economic activities along the riparian buffer of 100m within the last two decades and have experiences of the hazards. Snowball method was used to reach out to people who had relocated, and the simple random method (lottery system) was used to select those living along the riverbank (Deperso, 2018). The sample size was derived based on Yamane's (1967) formula:

$n = N/(1+N(e^2)$ ..... (1)

Where n = sample size, N= number of households, and e^2= margin of error.

The sample size was calculated at a confidence interval of 95% with a margin of error (e) = 0.07 (Adjei-Mensah and Kusimi, 2019):

$n= 6{,}654/(1+6{,}654(0.07^2)$

$n = 198$.

Table 1: Population of communities and sample distribution

Communities	No. of community Households	Sample unit
Twifo Praso	3110	93
Shama	2646	80
Anlo Beach Town	790	24
Bosomdo-Krobo	108	3
Total	6654	200

Source: Ghana Statistical Service, 2010.

Though a sample size of 198 was obtained from the computation, it was rounded up to 200. Proportional distribution formula was used to determine the sampling unit for each community in relation with the household numbers of each community (Adjei-Mensah & Kusimi, 2019): $S = cH/TH \times n$ ..... *(2)*

Where S = sampling unit, cH= number of community households, TH= Total number of households and n= sample size (Table 1).

Filled questionnaires from the field were sorted, collated based on the communities and analysed using Statistical Package for the Social Sciences (SPSS). The data was processed into frequencies and percentages and presented as tables and charts. The interviews were transcribed into themes to support and explain the responses from the household heads.

Results

Educational and economic characteristics of respondents

The educational level of most respondents was basic (47%), followed by second cycle (26%) with tertiary being the least (4.5%). About 22.5% of respondents had no formal education. This revelation is in line with Ghana Statistical Service's findings in the 2010 population and housing census where illiteracy level of both districts ranged between 20 and 40% (Ghana Statistical Service, 2014a; Ghana Statistical Service, 2014b)

Occupation

The data showed that a larger proportion of respondents were farmers (31.5%). This is followed by fishing which comprised fishers and fishmongers representing 25.5%, and 17.5% were craft and other related jobs, whilst 14.5% of the respondents were into trading. Also, 5% were unemployed and 5.5% were civil servants with pensioners having the lowest percentage of 0.5%. The low educational background of respondents and the

highly rural nature of the study area explains the low level of household leaders being employed in the civil service. Furthermore, most of the communities along the lower Pra basin were rural folks, and agriculture was the primary occupation for the rural settlers; that is why many households were engaged in the agricultural sector. This confirms information provided by the Ghana Statistical Service that agriculture was the mainstay of the economy in the districts, employing between 30 – 70% of the working class (Ghana Statistical Service, 2014a; Ghana Statistical Service, 2014b).

Impact of bank erosion on the environment and socio-economic activities

Environmental impacts

The direct physical impact of riverbank erosion from field discovery was land loss along the riverbank which constitutes environmental degradation. Bank failure resulted in the uprooting of trees along banks into river channels. These logjams enhanced bank wearing at bank full. Other environmental impacts included the destruction of infrastructure and buildings. About 80% and 84% of respondents indicated that bank erosion damages infrastructure and properties, respectively. Infrastructure and personal properties being destroyed by bank erosion included roads and buildings. For instance, a tributary of the Pra River had heavily eroded the edges of a road linking Anlo Beach town and Krobo. When people's buildings collapse, personal belongings such as television sets, furniture and cooking utensils are destroyed. These individuals are dispossessed of their lands and therefore change occupation or become unemployed. Respondents in Bosomdo-Krobo admitted that they are highly exposed to bank erosion (Fig. 2a & 2b), and it is a substantial threat to their livelihoods as it has led to the collapse of their buildings and loss of household properties. Therefore, victims have had to relocate. Literature shows that riverbank erosion has had dire socio-economic ramifications such as loss of lands, rendered people homeless, displaced them and forced them to defer economic life in India and Bangladesh (Dekaraja & Mahanta, 2021, 2021; Islam & Rashid, 2011).

Fig. 2a: Buildings threatened by bank erosion at Bosomdo

Fig. 2b: Building threatened by bank erosion at Krobo

About 6% and 38% of the household heads stated water accessibility was highly and moderately impacted respectively by bank erosion. Respondents who said water accessibility was less impacted explained that their major source of water is borehole which was not seriously affected by the erosion. However, those who were impacted said they use the river water which was polluted by bank erosion; the water becomes very turbid making it unhealthy for consumption. Field assessment revealed that in the dry season the river valley especially bank toe was heavily laden with sediments derived from bank erosion and bank failure (Figs. 2a & 2b). Obviously, some of the valley sediments are from bank erosion as bank erosion is one of the major sources of fluvial sediments for many rivers globally (Saadon et al., 2021; Kessler et al., 2013). This has ramifications on flooding and water quality as fluvial sediments not only cause river sedimentation which decreases flow capacity, but also pollute the water (Kusimi, 2017; Kusimi & Yeboah, 2019; Saadon et al., 2021; Zaimes et al., 2021). This was affirmed by the NADMO officer at Shama District Assembly who said the following:

> *Besides bank erosion, sedimentation of the river channel is another serious concern for us because when we have torrential rains, there is flooding.*

Socio-economic impacts

The socio-economic impacts of riverbank erosion included crop production and storage, livestock production, and health (Table 2).

About 52% of respondents indicated that their crop production was affected by bank erosion. Reports from individuals backed by field exploration showed crops cultivated within the floodplain included cash crops (cocoa, sugar cane) and food crops (rice, maize,

plantain, cassava, and vegetables). For instance, at Twifo Praso (Fig. 1) cocoa and rice farms cultivated along the riparian region are threatened by the incessant bank wearing. Besides farms that are cultivated along the banks, there are also backyard gardens which are washed away by bank wearing. Respondents indicated that the erosion is militating against crop yield and worsening food insecurity in some homes. Residents also explained that crops harvested from farms are stored in their buildings (mostly cereals) and sometimes in the soil (mostly root and tuber crops), which are eroded or attacked by ravaging river currents. A 68-year-old man who was psychologically and emotionally traumatised by his displacement expressed the following sentiments:

> *I have lost my building and most of my agricultural land which is making my life unbearable here. I am now landless and have lost respect because of the loss of my properties due to bank erosion.*

Table 2: Environmental and socio-economic impacts of bank erosion

Level of impact						
Areas	Non		Moderate		High	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Crop production	97	48.5	52	26	51	25.5
Crop storage	101	50.5	82	41	17	8.5
Livestock	91	45.5	73	36.5	36	18
Water accessibility	113	56.5	76	38	11	5.5
Infrastructure	39	19.5	98	49	63	31.5
Buildings	32	16	97	48.5	71	35.5
Health	107	53.5	77	38.5	16	8
Business	132	66	55	27.5	13	6.5

Field survey data, 2019.

Many household heads (45.5%) indicated that their livestock were not affected by bank erosion because they do not rear their livestock along the bank. However, 54.5% of household heads stated otherwise because they are into pig farming. They explained that pigs like slightly wet and cool places and the riverbank provides these suitable conditions all year round and that is the reason why they rear the pigs along the bank. According to a pig farmer at Krobo, the farms are exposed to this danger especially when severe bank erosion occurs in the night after a torrential down pour, they lose some animals.

About 8% of the respondents claimed bank erosion affected their health due to relocation when their buildings collapse. They stated that, they are relocated into temporary structures such as classrooms, neighbours' balconies or in the open where they are exposed to mosquito bites and the vagaries of the weather. Hence, they become vulnerable to diseases. Relocation and destruction of homes by bank erosion also directly affected business activities (6.5%) of petty traders who owned mini shops in their homes. The impact of riverbank land loss resulted in the loss of homestead land, buildings, crops, livestock, trees, and household utensils (Islam et al., 2017).

Impact of flooding on the environment and socio-economic activities

Environmental impacts

Results from questionnaire analysis of the environmental impacts of floods are illustrated in Table 3. On water accessibility, only 15% of respondents' water accessibility was not affected by flooding because their major source of water is bore-hole, sachet water and rainwater which are less impacted by floods as was found under bank erosion. But most (85%) were affected by flood water. These categories of people were those who depended on the river as their major source of water supply. Hence, their water source gets polluted when floods drain waste littered in the environment into the river.

In relation to property and infrastructure, residents were highly impacted by flooding and the proportion of the people who expressed this opinion were 83% and 86% respectively (Table 3). They revealed and it was also observed that floods cause the destruction of buildings and household properties, accounting for immeasurable economic hardships that are very difficult to recover from in the short-term. Household items (television sets, cloths, and furniture) were destroyed by floods. Also, flood waters had damaged buildings in the riparian zone (Figs. 3a & 3b). Respondents also mentioned that during floods, their canoes and fishing gears get destroyed. Women explained that sometimes their fish processing tools, and smoking ovens built of mud/clay are washed away by floods. Also, roads are normally flooded or eroded cutting off flooded communities.

Fig. 3a: Collapsed building at Twansukoda in Twifo Praso

Fig. 3b: Residues of collapsed building at Krobo

Source: Field survey data, 2019.

Socio-economic impacts

Besides business activities, other types of socio-economic engagements of the people were largely impacted by flooding. Apart from 3% of respondents who said their crop production was not affected by flooding, about 97% of respondents said their crop production was affected by flooding. This was affirmed by the Shama NADMO Officer who made the following remark:

> *They are agrarians largely engaged in farming along the river corridor and artisanal fishing. Even though most of them engage in fishing in the sea, they also do fish in the Pra. So, their source of livelihood is farming whether fish farming or arable crops so when the floods occur, those who go into tip rice farming are mostly affected by the destruction of their farmlands.*

Respondents revealed that these flood incidents reduced food production and curtailed food distribution among them causing food shortage in flood-prone areas. Because residents along the basin are heavily dependent on agriculture, when flood destroys farm produce, it indirectly reduces household income and their ability to purchase food and other needs causing starvation and economic hardships. For crop storage, 93% said they were affected by floods with only a few (6.5%) stating that food storage is not affected by flooding. Residents explained that it is only food crops like cassava, sweet potato, and cocoyam stored in the soil that are mostly affected during floods. The food stuffs get inundated by floods and get rotten leading to livelihood challenges.

Table 3: Environmental and socio-economic impact of flooding

Areas	Level of impact					
	Non		Moderate		High	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Crop production	5	2.5	9	4.5	186	93
Crop storage	13	6.5	126	63	61	30.5
Livestock	3	1.5	28	14	169	84.5
Water accessibility	30	15	142	71	28	14
Infrastructure	2	1	32	16	166	83
Properties	1	0.5	28	14	171	85.5
Health	24	12	130	65	46	23
Business	116	58	67	33.5	17	8.5

Field survey data, 2019.

Field exploration revealed that cash crops are also damaged by some flood events. A cocoa farm in Twifo Praso was ravaged by a flood event that occurred on July 10, 2017. Household heads stated that their farm produce that are normally not affected by floods are cereals like rice, maize etc., stored in traditional silos built on props. This allowed flood water to flow away without inundating food stuffs. This was a common practice in almost all the towns.

With respect to livestock, 98% of respondents were affected with only 2% stating no impact of flooding on their livestock. Respondents explained that floods have washed away their livestock like goats, sheep, and chicken. This triggered livestock shortages. Just like food crops, the livestock is sold to complement family income or killed for family consumption. According to one household head at Twifo Praso*, the loss of such assets to floods is really a toll on the finances and wellbeing of families.*

On health, 88% of respondents were affected either moderately or highly, while 12% were not impacted by flooding. Those whose health was affected by floods explained that after flooding, they are housed in temporary structures which exposed them to environmental hazards. For instance, NADMO pitched tents at Krobo Junction for displaced people of the 2009 floods in the Shama District (Ghana News Agency, 2009). Also, the environment becomes polluted and clusters of stagnant water breed mosquitoes and other flies leading to the outbreak of malaria, dysentry, typhoid and sometimes cholera. Consequently,

NADMO comes to supply mosquito nets, medicines and relief items. Cholera occurs because most residents practise open defecation especially residents along the river and the coast (e.g. Anlo Beach Town). Solid waste and animal droppings are dumped along or into the river which cause the outbreak of the diseases. In an in-depth interview with the Twansukoda Assemblyman he stated that:

> *the river Pra has taboos that the people no longer observe. They are Afase (a type of yam), Ankama (lemon), Temina (a type of snail), a Black utensil for cooking and more importantly women who are menstruating should not go to the river, but as we speak, they have dumped a lot of garbage at the banks which include these things that the river prohibits, so the river becomes angry and floods the area.*

With regard to business activities, 58% of the respondents revealed floods do not negatively impact their activities while 42% (Table 3) experienced moderate to high impacts on their businesses. The underlying reasons why businesses are affected is that, road networks in the communities become very muddy and unmotorable making it very difficult for vehicles and humans to commute and engage in commercial activities. For instance, Anlo Beach town located across the Pra estuary at Shama was inaccessible to Shama and other areas like Beposo to transact business activities whenever floods occurred. It was also disclosed that the destruction and restriction of economic activities by flood hazards resulted not only in loss of income but also the disruption of the educational programme of children. This is because schools are used as temporary abodes for residents when floods occur leading to the closure of schools which negatively affects academic work. Investigations showed that residents who were severely impacted by these hazards changed their livelihoods normally from farming into petty trading. Some respondents carried out these changes from their savings while others received help from family members and government agencies such as NADMO.

Mitigation measures against flooding and bank erosion by public agencies

From Table 4, about 97% respondents claimed that the districts do not have any land use and development plans for most parts of their communities, especially the floodable areas. The District Planning Officer of Twifo Atti-Morkwa stated that because of the lack of a development plan, residents were admonished not to build into the 100m buffer for the river. He added that this was however not obeyed by residents and the assembly was unable to ensure compliance with this directive because of logistical and human resource challenges. As a result, residents undertake unplanned developments like building along water courses or the buffer zones of the river exposing themselves to the hazards. Also, 94% of household heads affirmed that they did not apply for building permits and did

Table 4: Measures of public institutions to mitigate flooding and bank erosion

Mitigation Measures	Frequency	Percentage (%)
Land-use control measures by the district		
Yes	6	3
No	194	97
Building permits with specific building codes		
Yes	12	6
No	188	94
Flood forecast warning		
Yes	22	11
No	178	89
Knowledge to agencies that forecast floods		
Yes	53	26.5
No	147	73.5
If yes, mention at least one		
Nadmo	35	66
Ghana Meteorological Agency	14	26.4
Radio Station	4	7.6
Emergency systems to flood hazard and bank erosion		
Emergency rescue	11	5.5
Provision of basic need	154	77
Nothing	35	17.5

Field survey data, 2019.

not build according to building code standards. The buildings of the 94% household heads which were constructed without permits were not supervised during construction. Such structures are not only prone to flooding and bank erosion but might not meet building standards making them vulnerable to the hazards and likelihood of collapsing. As depicted by Figs. 2a, 3a and 3b, the buildings are mud houses with no concrete and/or steel structures and are located within the 100m buffer. Only 6% of households asserted that they obtained building permits for their homes but with low supervision during the development stage.

It was also revealed by respondents that the role of public institutions (local assembly and NADMO) in flood risk management was ineffective. About 60% of the respondents

stated that public institutions were doing very little to help curb flooding while 40% indicated there was some form of engagement from the institutions. Those who were of the view that there had not been effective participation by public institutions said all they do is to provide relief items when the hazards strike, though this was not the best measure to control the hazards. They want to see assemblies putting in place measures to prevent the occurrence of these hazards rather than only providing relief items. The assemblies claimed they have logistical and financial constraints to embark on public education on local level decentralization and governance. Owing to these, most household heads do not see the need to acquire building permits or abide by building regulations. These challenges make it difficult for households to be aware of and understand local governance information vis-à-vis the hazards and risks, making them more vulnerable to flooding and bank erosion (Muller et al., 2011).

Another thing respondents were dissatisfied about was that state agencies (NADMO, Ghana Meteorological Agency and Local Assemblies) do not educate them or give prior warnings on these hazards effectively. About 89% of the respondents expressed this concern. Over 70% of the people did not even know agencies in charge of these activities (Table 4). NADMO was seen to be quite known (66%) among respondents and that could be because they are the agency in charge of providing and distributing relief items to hazard victims (Table 4). This observation was corroborated by Twansukoda Assembly Member in Twifo Praso who said that:

> *There is poor collaboration between us the residents and the state institutions because they only wait for the floods to happen then they will supply us with mattresses and bags of rice, but these measures are just a temporary relief measure which is not a long-term measure to the problems.*

It was unearthed from the questionnaire analysis that emergency rescue (6%) and the supply of relief items (77%) were the emergency systems put in place in response to the hazards (Table 4).

Mitigation measures by communities against flood and bank erosion hazards

Table 5 illustrates mitigations carried by communities to check the hazards. Half of the respondents did nothing personally to mitigate the hazards (Table 5). About 18% indicated they were relocated by the assembly members of their communities, 13.5% revealed desiltation exercises are normally carried out by the community as communal labour to minimise flooding and bank erosion, and 6% pointed out that NADMO has formed community voluntary groups to do public education on hazards management. The Shama-Apo Assemblyman made this affirmation regarding the volunteer group on flood and bank erosion mitigation:

> *We started working on flooding and bank erosion hazards by forming a committee called the Pra Estuary Committee, of which I am the Chairman. Representatives were picked in each community along the Pra. We started educating residents on the need to protect the vegetation especially the mangroves along the river and delta that were heavily harvested. Through this committee, residents have started growing mangroves to prevent further erosion of the riverbanks and flooding in the communities.*

Those who were willing to be relocated indicated they did not have the means to do that and want the district assemblies to intercede. Other measures include the provision of working gears by assemblymen for environmental cleaning and other communal activities (9%), the construction of drainage systems by the communities (1.5%) and flood embankments by households around their houses using sand, stones, and blocks (2%).

Table 5: Mitigation measures of communities against flood and bank erosion hazards

Measures	Frequency	Percentage (%)
Relocate us	36	18
Desilting or dredging of river channels	27	13.5
Education	12	6
Proper drainage	3	1.5
Provision of basic needs	18	9
Nothing	100	50
Provision of river defense	4	2
Total	200	100

Field survey data, 2019.

Coping strategy of residents to flooding and bank erosion

Besides relocation, respondents indicated that they did not have any coping strategies for bank erosion because such plans are quite cumbersome and expensive. Flood coping strategies are illustrated in Table 6. About 50% of the respondents revealed that they relocate, 40.5% had no coping strategies to the hazard, and 9.5% of the respondents claimed they move their items to safer places. The relocation is in two forms, permanent and temporary. The permanently relocated people were those who have relocated to safer grounds in the neighbourhoods. Some also revealed they relocate temporarily to family members in nearby towns and return when the floods subside. Other respondents

indicated they move their belongings to acquaintances when they predict floods will occur. The relief of the twin towns Bosomdo-Krobo is different. Whereas Bosomdo is located on a highland, Krobo is located on a low-lying area so is floodable. Therefore, during floods, residents in Krobo move to Bosomdo till the flood is over. Some residents have been relocated permanently at Bosomdo. These measures are also adopted by residents of most flood prone areas in the country (Kusimi & Yeboah, 2019).These coping strategies used by households are short-term plans which are not sustainable.

Table 6: Coping strategies of households to flooding

Coping Strategies	Frequency	Percentage (%)
Relocation	100	50
Moving items to safer places	19	9.5
Nothing	81	40.5
Total	200	100

Field survey data, 2019.

Discussion

Results of the study revealed that, residents are seriously impacted by the natural hazards. The physical damage and socio-economic losses negatively affected their livelihoods. The impacts of flood and bank erosion on livelihoods are considered critical issues, especially in rural areas where livelihoods depend on agriculture and other landed economic activities. A very worrying issue regarding the fate of these household heads is that there is not much support from government except some pittance relief items that are presented to victims. Secondly residents do not insure their properties to merit some compensations hence are unable to cope and recover from the hazard. Though they wish to relocate to safer areas in the neighbourhood, victims lacked the financial capability to bear the cost of relocation. The lack of capacity on the part of some victims to mitigate and cope with the hazards increases their vulnerability which needs intervention from the state, NGOs and Civil Society Organizations. The underlying reason for the inability of victims to cope and build resilience to these hazards is their poor economic background as most of them are farmers hence do not have the capacity to relocate, put up buildings that could withstand the hazards, among others. These findings are in line with the proposition of the social vulnerability theory which says poor people are more vulnerable to hazards and are also less resilient to the hazards (Akter & Mallick, 2013; Adger, 2006; Brouwer et al., 2007). Therefore, long term strategies should be initiated by

the districts as lasting measures to the hazards. Such individuals need to be assisted to locate or protected from these hazards.

Water resources which used to be managed traditionally using taboos are now managed by acts and by-laws such as the integrated water resource management plan (IWRMP) (Water Resources Commission, 2012). Though the hazards investigated have been captured in the IWRMP of Pra River, much has not been done to mitigate the hazards in the basin. The modern local governance system is saddled with several challenges making it difficult to effectively implement the modern water resource management regulations such as the IWRMP of Pra to curb the problems.

One key responsibility of a local authority is to develop a land use and development plan for a locality to which all developments must conform (Local Governance Act 936, 2016). The lack of building plans and enforcement of building regulations which is encouraging unplanned development of buildings does not augur well for environmental safety and in dealing with the hazards. This situation should not be encouraged by local authorities. People should either not be allowed to develop in unauthorized places or when they flout the law, they should be sanctioned according to the dictates of the act. However, this is not done so individuals are emboldened to continue to develop their properties illegally in unauthorized places exposing themselves and the public to these hazards.

The lack of engagement and education of residents on development policies by the assemblies does not promote participatory democracy as enshrined in the Local Governance Act 936 (2016) clauses 40 and 46 which stipulate that a District Assembly shall enable the residents and other stakeholders in the district to participate effectively in the activities of the District Assembly; it shall also create awareness on local level decentralisation and governance and establish mechanisms to facilitate public communication and access to information. Though logistical and financial constraints were given by the assemblies for their inability to fulfil this mandate, this could however be addressed if the problem is given priority in the annual programmes of the assemblies and budgeted for.

Conclusion

In conclusion, bank erosion and flooding are major environmental hazards plaguing the riverine zones of the lower basin of the Pra. The hazards pose serious environmental and socio-economic effects to people living in this zone with poor coping strategies. Among the environmental impacts are bank wearing, sedimentation and inundation of river channels while the socio-economic impacts are loss of properties, destruction of economic activities and the outbreak of diseases. The repercussions of the impacts of

the hazards have been changes in economic activities, loss of self-esteem, psychological trauma among others. In view of the ramifications of these hazards on the physical environment and socio-economic activities, a number of measures are needed to control and manage the hazards. These include the development and enforcement of land use and development plans, effective implementation of the Integrated Water Resources Management Plan (IWRMP) of the Pra, the resourcing of appropriate offices of the local governments to be able to discharge their responsibilities creditably, and strong collaboration between the local assemblies and traditional leaders in local governance. Other measures that should be introduced include the dredging of river channels, building river embankments and educating and sensitizing residents to desist from activities that expose them to these hazards.

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References

Abhas, K. J., Bloch, R. & Lamond, J. (2011). Cities and Flooding; A Guide to Integrated Urban Flood Risk Management for the 21st Century.

Adger, W. N. (2006). Vulnerability. Global environmental change, 16(3), 268-281.

Adjei-Gyapong, T. & Asiamah, R.D. (2002). The interim Ghana soil classification system and its relation with the World Reference Base for Soil Resources. Rapport sur les Ressources en Sols du Monde (FAO).

Adjei-Mensah, K. & Kusimi, J. M. (2019). Dwindling water supply and its socio-economic impact in Sekyere Kumawu District in Ashanti Region of Ghana: public opinion on the role of climate change. GeoJournal, 1-18.

Baxter, P. & Jack, S. (2008). Qualitative Case Study Methodology: Study Design and Implementation for Novice Researchers. The Qualitative Report, 13(4), 544-556.

Barua, P., Rahman, S.H. & Molla, M.H. (2019). Impact of river erosion on livelihood and coping

strategies of displaced people in South-Eastern Bangladesh. International Journal of Migration and Residential Mobility, 2(1), 34–55.

Best, J. (2019). Anthropogenic stresses on the world's big rivers. Nature Geoscience, 12, 7-21.

Brouwer, R., Akter, S., Brander, L. & Haque, E. (2007). Socio-economic vulnerability and adaptation to environmental risk: a case study of climate change and flooding in Bangladesh. Risk Analysis, 27(2), 313–326.

Chatterjee, S. & Mistri, B. (2013). Impact of river bank erosion on human life: a case study in Shantipur Block, Nadia District, West Bengal. Population, 66(26), 7-17.

Coastal Resources Center. (2013). Shama District Integrated Coastal Management Toolkit. Integrated Coastal and Fisheries Governance Initiative (Hen Mpoano) Narragansett, RI: Coastal Resources Center at the Graduate School of Oceanography, University of Rhode Island 62 pp. Retrieved April 20, 2021 from http://www.crc.uri.edu.

Creswell, J. W. (2009). Research Methods: Qualitative, Quantitative and Mixed Method Approaches, Thousand Oaks CA. Sage.

Das, T. K., Haldar, S. K., Sarkar, D., Borderon, M., Kienberger, S., Gupta, I. D. & Guha-Sapir, D. (2017). Impact of riverbank erosion: A case study. Australasian Journal of Disaster and Trauma Studies, 21(2), 73-81.

Dekaraja, D. & Mahanta, R. (2021). Riverbank erosion and migration inter-linkage: with special focus on Assam, India. Environmental System Research, 10(6), 2-10.

Deperso, G. (2018). Using Simple Random Sampling to study larger population. Investopedia.com/ask/answer/what are the advantages of using simple random sampling. Retrieved 12/08/2020.

Di Baldassarre, G., Montanari, A., Lins, H., Koutsoyiannis, D., Brandimarte, L. & Blöschl, G. (2010). Flood fatalities in Africa: From diagnosis to mitigation. Geophysical Research Letters, 37, L22402. DOI:10.1029/2010GL045467.

Dickson, K. & Benneh, G. (1995). A new geography of Ghana. UK: Longman.

Emergency Event Database [EM-DAT]. (2015). The OFDA/CRED International Disaster Database, www.emdat.be, Université catholique de Louvain.

European Environment Agency. (2007). Climate Change Policies. Retrieved April 14, 2019 from http://www.eea.europa.eu/themes/climate/policy-context.

Few, R. (2003). Flooding, vulnerability and coping strategies: Local responses to a global threat. Progress in Development Studies, 3(1), 43-58.

Ghana News Agency. (2009). NADMO presents relief items to Shama flood victims. Retrieved April 4, 2019 from https://www.modernghana.com/news/228187/1/nadmo-presents-relief-items-to-shama-flood-victims.html

Ghana Statistical Service (GSS) (2010). Population and housing census: Final Report. Ghana Statistical Service.

Ghana Statistical Service. (2014a). 2010 Population and Housing Census: District Analytical Report—Shama District. Accra: Ghana Statistical Service.

Ghana Statistical Service. (2014b). 2010 Population and Housing Census: District Analytical Report-Twifo Atti-Morkwa District. Accra: Ghana Statistical Service.

IPCC. (2012). "Summary for Policymakers. In: Intergovernmental Panel on Climate Change. In Field, C. B., Barros, V., Stocker, T.F., Qin, D., Dokken, D., Ebi, K.L. (eds.), Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation.

Islam, M. A., Parvin, S. & Farukh, M. A. (2017). Impacts of riverbank erosion hazards in the Brahmaputra floodplain areas of Mymensingh in Bangladesh. Progressive Agriculture, 28(2), 73-83.

Jha, A. K., Bloch, R. & Lamond, J. (2012). Cities and flooding: a guide to integrated urban flood risk management for the 21st century. The World Bank.

Kessler, A. C., Gupta, S. C. & Brown, M. K. (2013). Assessment of riverbank erosion in Southern Minnesota rivers post European settlement. Geomorphology, 201, 312-322.

Kusimi, J. M., Amisigo, B. A. & Banoeng-Yakubo, B. K. (2014). Sediment Yield of a Forest River Basin in Ghana. Catena, 123, 225-235.

Kusimi, J. M. (2014). Sediment yield and bank erosion assessment of Pra River Basin. Doctoral dissertation, University of Ghana.

Kusimi, J. M. (2017). The contribution of bank and surface sediments to fluvial sediment transport of the Pra River. West African Journal of Applied Ecology, 25(1), 69-85.

Kusimi, J. M. & Yeboah, E. (2019). Flood Hazards at Alajo: Causes, Impacts and Adaptations. International Journal of Research and Innovation in Social Science, 3(8), 268-278.

Local Governance Act. (2016). Act 936. GPCL, Assembly Press, Accra. Retrieved April 20, 2021 from https://ghalii.org/gh/legislation/act/2016/936.

Marshall, N.A. (2010). Understanding social resilience to climate variability in primary enterprises and industries. Global Environmental Change, 20(5), 36–43.

Ministry of Environment, Science, Technology and Innovation. (2013). Ghana National Climate Change Policy. Accra: Ministry of Environment, Science, Technology and Innovation (MESTI).

Müller, A., Reiter, J., Weiland, U. (2011). Assessment of urban vulnerability towards floods using an indicator-based approach: A case study for Santiago de Chile. Natural Hazards Earth System Sciences, 11, 2107–2123.

Nyarko R. K. (2017). Hunger strikes in River Pra flood disaster. Retrieved 3 April 2019 from myjoyonline.com.

Novak, P. A., Fairfield, C. A., Miloshis, M., Knight, Z. C., Lindsay, R. & King, A. J. (2021). Bank erosion in a macrotidal tropical river: Exploring the relative impact of boat wash on riverbank erosion. River Research & Applications, 37, 3–16.

Opoku E. (2017). Residents Displaced As River Pra Floods - DailyGuide Network. Retrieved April 3, 2019 from https://dailyguidenetwork.com/residents-displaced-river-pra-floods/

Preston, B. L., Yuen, E. J. & Westaway, R. M. (2011). Putting vulnerability to climate change on the map: a review of approaches, benefits, and risks. Sustainability science, 6(2), 177-202.

Rahman, M. R. (2010). Impact of riverbank erosion hazard in the Jamuna floodplain areas in Bangladesh. Journal of Science Foundation, 8(1-2), 55-65.

Saadon, A., Abdullah, J. & Ariffin, J. (2021). Streambank Erosion Prediction. IOP Conference Series: Earth and Environmental Science, 685, 012007. doi: 10.1088/1755-1315/685/1/012007.

Shamsuddoha, M. & Chowdhury, R. K. (2007). Climate change impact and disaster vulnerabilities in the coastal areas of Bangladesh. COAST Trust, Dhaka.

Teye, J.K. (2012). Benefits, Challenges and Dynamism of Positionalities Associated with Mixed Method Research in Developing Countries: Evidence from Ghana. Journal of Mixed Methods Research, 6(4), 379-391.

Thomas, G. (2011). A typology for the case study in social science following a review of definition, discourse, and structure. Qualitative inquiry, 17(6), 511-521.

Tompkins, E.L. & Adger, W.N. (2004). Does adaptive management of natural resources enhance resilience to climate change? Ecology and Society, 9(2), 10-20.

United Nations Development Program [UNDP]. (2010). Reducing Disaster Risk: A Challenge for Development. UNDP, Geneva, Switzerland.

United Nations. (2009). Water in a Changing World., UNESCO, Paris, pp318.

Water-Resources-Commission. (2012). Pra River Basin; Integrated water resources management plan. Water Resources Commission, Accra.

Water Resources Commission. (2015). About River Pra. Retrieved November 15, 2018 from http://www.wrc-gh.org/about-us.

Wohl, E. (2015). Legacy effects on sediments in river corridors. Earth-Science Reviews, 147, 30–53.

Yamane, T. (1967). Statistics: An introductory analysis: Elementary Sampling Theory. Englewood Cliffs, New Jersey: Prentice-Hall, Inc. Pp. x–405.

Zaimes, G. N., Tamparopoulos, A. E., Tufekcioglu, M. & Schultz, R. C. (2021). Understanding stream bank erosion and deposition in Iowa, USA: A seven year study along streams in different regions with different riparian land-uses. Journal of Environmental Management, 287, 112352.
Doi: org/10.1016/j.jenvman.2021.112352.

Zhang, Z., Shu, A., Zhang, K., Liu, H., Wang, J. & Dai, J. (2019). Quantification of river bank erosion by RTK GPS monitoring: case studies along the Ningxia-Inner Mongolia reaches of the Yellow River, China. Environmental monitoring and assessment, 191(3), 140.