

Flood Hazards at Alajo: Causes, Impacts and Adaptations

John Manyimadin Kusimi¹ and Ebenezer Yeboah²

^{1,2}*Dept. of Geography & Resource Development, University of Ghana, Legon, Accra – Ghana*

Abstract - This is a case study on causes, impacts and adaptation to floods, and public institutions' intervention towards reducing flood risk in the community of Alajo, a proletariat suburb of Accra in Ghana. Field data collection involved in-depth interviews and household heads questionnaire survey. Factors identified to be causing floods in Alajo include improper layout of buildings, improper waste management, lack of good drainage system etc. Flood incidents come with great cost to the community. The cost includes loss of property and human lives. Some of the adaptations and coping measures to flood disaster are temporal relocation, building of stone breakwaters, support from families and the government. Construction and de-silting of drains, clearing of buildings on waterways, public education and seminars are some flood mitigation measures being undertaken by government to curtail the problem. Good local governance and the construction of drainage systems are some sustainable approaches towards making the locality safe from floods.

Keywords: Alajo; Flood adaptation; Flooding; Odaw River; Onyasia River.

I. INTRODUCTION

The world is constantly struck by several disasters and these include fire outbreaks, earthquakes, floods and many more. These disasters could be caused by natural and/or anthropogenic factors. Globally, floods are the most frequently occurring destructive natural events, affecting both rural and urban settlements [33]. Flooding is the inundation of land by water due to over saturation of the ground from precipitation, overflows from water bodies or from high tidal waves along coastal zones. One can distinguish four types of flooding in urban areas: localized flooding due to inadequate drainage; flooding from smallstreams within the built-up area; flooding from major rivers; and coastal flooding [24].

Urban flooding in Africa is increasingly beensevere and a more frequent problem for the urban poor. Climate change modelling of Africa show that, informal settlements are highly vulnerable to flooding and the poor urban populations have been found to be the most vulnerable [41]. This is because human vulnerability to hazards increases with low formal education, less secure employment, and low income [1]. Climate change is altering rainfall patterns, tending to increase storm frequency and intensity, thus increasing the potential for floods [37]. Local human factors, especially urban growth, theoccupation of floodplains and the lack of attention to waste management and the poor maintenance of drainage channels are also aggravating the problem of floods. Particularly problematic is the

unwillingness of government at all levels to engage in the provision of integrated drainage systems in informal settlements, which are often regarded as being outside accepted urban regulation and planning systems [24]. Thus, socio-economic conditions and political factors play significant roles in the occurrences of floods and other hazards in informal communities of developing countries owing to their high vulnerability state.

Urbanization and institutional lapses have been regarded as a major creator of urban flood risk [21]. Urbanization restricts infiltration of rainwater by covering large parts of the ground with roofs, roads and pavements, thus obstructing natural infiltration of rainwater, and by building drains that promote rapid transport of run-off into rivers than it did under natural conditions. Large-scale urbanization and population increases have led to large numbers of people, especially the poor, settling and living in floodplains in and around urban areas. Soweto-on-Sea near Port Elizabeth and Alexandra in Johannesburg illustrate this point [48]. Obstruction of drainage channels by silt and garbage also cause floods[5].

The population of the Greater Accra Region has been increasing since 1960. The population has increased about eight-times from 491,817 in 1960 to 4,010,054 in 2010 [26]. This has forced the poor and rural-urban migrants to settle in unauthorised places such as the floodplains and banks of the Odaw River in Accra which lack development plans, physical infrastructure and tenure security. Secondly, the current waste management resources are insufficient to meet the growing needs of urban residents of Accra [5][40]. This situation makes it impossible for urban residents to dispose of their waste appropriately resulting in indiscriminate littering. About 2800 metric tonnes of solid waste is generated per day in Accra. Approximately, 2,200 tonnes is collected leaving a backlog of 600 tonnes which end up in open drains and water bodies which results in flooding during the rainy season[12]. About 60% of the Metropolis live in the catchment of the Odaw River and Korle Lagoon and contribute to the environmental problems which result in flooding. This is a major challenge to city authorities in instituting flood control measures [2]. Over a decade, flood disasters in Accra continue to increase in number and severity. Not only are people displaced and properties amounting to millions of cedis lost, lives of residents are sometimes lost [27][28].Table 1 chronicles the hazards and impacts of major floods of Accra

from 2000 – 2015. The table shows that about a 1 million people have been displaced, 245 killed with the economic cost of the annual floods of Accra since 2000 estimated to be US\$44m[7][25].

The physical landscape or surface relief nature of an area also increases the risk and rate of flooding. Higher landscapes promote faster run-off into channels while

Table 1: Major flood hazards and their impacts in Accra (2000 – 2015)

Date	No. of communities affected	No. displaced	Casualties	Estimated cost of damage (million US\$)
7 May & 5 Jun 2000	49	6,584	12	5.65
1 June 2001	65	41,450	13	10
6 Jan, 9 & 13 Jun 2003	25	2,787	3	2.54
18 Jun 2003	30	3,140	5	1.71
13 Apr 2004	9	250	-	0.61
12 Mar 2005	22	2,370	3	7.35
13 Jun 2007	40	13,140	5	1.14
27 Mar 2008	12	1,456	-	0.91
19 Jun 2009	33	15,616	7	4.12
20 Jun 2010	42	19,833	17	2.78
25 & 26 Oct 2011	149	65,236	14	4.72
Jun & Oct 2012	157	6,888	4	2.18
5 – 12 Jun 2014	4	4,166	3	no data
3 Jun 2015	no data	>8,000	159	0.38
Total	637	190,916	245	44.09

Source: Amoako and Boamah 2014 (data for 2000–2012) and Frick-Trzebitzky (2014)

low-lying areas become receptacles of flood waters. Alajo is one of the low-lying areas in Accra that experiences perennial flooding [36]. Alajo has recently been overwhelmed by rapid urbanization, coupled with low infrastructure development and the ineffective implementation of town and country planning policies and regulations, flood risk level of the community has been very high [36]. Alajo is also within the Odaw River floodplain, consequently over decades the community is constantly plagued by floods. In July 1965, Osagyefo Dr. Kwame Nkrumah, the then President, visited flood victims at Alajo. Again in 1975, the late military ruler, General I.K. Acheampong also visited flood victims at the railway quarters. In 1979 another military ruler, Flt Lt. J.J Rawlings, visited flood victims at Alajo, and in July 4, 1995, it happened again [6]. In view of these perennial floods, residents have developed strategies to dwell in the community.

Targets of Sustainable Development Goal (SDG 11- Sustainable Cities and Communities) include ensuring access

to safe and affordable housing, upgrading slum settlements, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations. It also talks about substantially increasing the number of cities and human settlements adopting and implementing integrated policies and plans towards mitigation and adaptation to climate change, resilience to disasters. Global commitment and goals, such as the SDGs, provide a good basis for measures around the world if global agreements are translated to regional and national levels[49]. This is because there are large global differences in the causes of these problems and solutions will only be effective if they are context specific and if local conditions are considered [30][18].



Fig.1 Map of the Study Area and its suburbs

The design and implementation of effective, efficient and legitimate actions thus needs to be based on a thorough understanding of the local governance context [45] of informal settlements in developing nations where these hazards are predominant. Measures to deal with these problems can be supported by scientific research [47], which include understanding the causes and effects [46] of hazards of informal settlements, adaptation and coping strategies, resilience and the effectiveness of local governance policies. The focus of the study is therefore to investigate the following; the underlying causes of perennial flooding in the community, the socio-economic and environmental ramifications of these disasters, the adaptation and coping strategies of households and public intervention measures towards flood resilience and level of effectiveness of the measures as a prelude to the development of effective local policies towards building sustainable communities in Ghanaian cities.

II. BACKGROUND OF THE STUDY SITE

Alajo is a suburb of Accra which is in Greater Accra Region (Fig.1). It is a small community of about 1 km² located around latitude 5° 35' - 5° 36' N and longitude 0° 12' - 0° 13' W. Relatively, it is located north of Kwame Nkrumah Circle, about 6km from the Central Business District of Accra. The site is a confluence of the Odaw and the Onyasias Rivers about 8km upstream of the Korle Lagoon. Administratively, Alajo is in the Ayawaso Central District [3]. The soils are montmorillonite. These soils have heavy organic content,

clayey hence expand and contract thus can cause major problems with foundations and footings. There are two raining seasons. The first begins in May and ends in mid-July. The second season begins in mid-August and ends in October. The average annual rainfall is about 730 mm, which falls primarily during the two rainy seasons. There is very little variation in temperature throughout the year. The mean monthly temperature ranges from 24.7°C in August (the coolest) to 28°C in March (the warmest) with annual average of 26.8°C [22].

Several decades ago, Alajo was seen as a high income, low population density sector with adequate housing facilities, but the community has recently been overcome by rapid urbanization, with its infrastructure failing to support the influx of residents [11] who include migrants from Northern Ghana and neighboring West African countries. It has a large population with a density of about 30,829.32 people/km² [50]. Alajo is home to families from different ethnic groups and exhibits a variety of housing types. The housing landscape of Alajo is low class, high density development with depressed conditions, over stretched infrastructure services and poor drainage systems. The total number of houses in Alajo is about 1,550 [26]. The average house size is approximately 25 persons per house or approximately 4 – 6 households per house. It is also rated as a low-income housing zone. Alajo is an economically vibrant and socially resilient community but these socio-economic conditions inhibit quality life [11].

The location between two major streams and lack of physical infrastructure present annual flooding problems to the community. During storms, water levels rise particularly along the Onyasia River flooding homes and businesses along the riverbanks. No year passes without Alajo having its share of floods in the city. For instance, in June 2001, five hours of rain caused flash floods that killed six people and drove tens of thousands from their homes in Accra [11].

III. RESEARCH MATERIALS AND METHODS

Data for this research was collected in two folds, secondary and primary. A graphical representation of the research materials and methods of the study is illustrated by Fig.2. Relevant ancillary data on drainage structures of Alajo, waste management system, the planning system and layout, the housing characteristics, damages caused by flood, the kinds of relief support that are given to victims of flood in the community among others were collected from several agencies including the Accra Metropolitan Assembly (AMA),

the National Disaster Management Organization (NADMO), Hydrological Service Department (HSD), and Town and Country Planning Department (TCPD). A digital elevation model to show the topography of the landscape was created from terrain elevation data of an Aster Global Digital Elevation Model (GDEM) image of the study area using ArcGIS 10.3 software (Fig.2).

Primary data was collected using questionnaires and interview guides [13][31][32](Fig.2). Key-informant interviews were conducted with the enumerated state agencies to find out the causes of flood and the role of the state in managing this problem in the community. Interviews were also held with key stake holders such as the Assemblyman, Unit Committee people and the Local Imam about the nature and ramifications of floods and adaptation strategies in the community

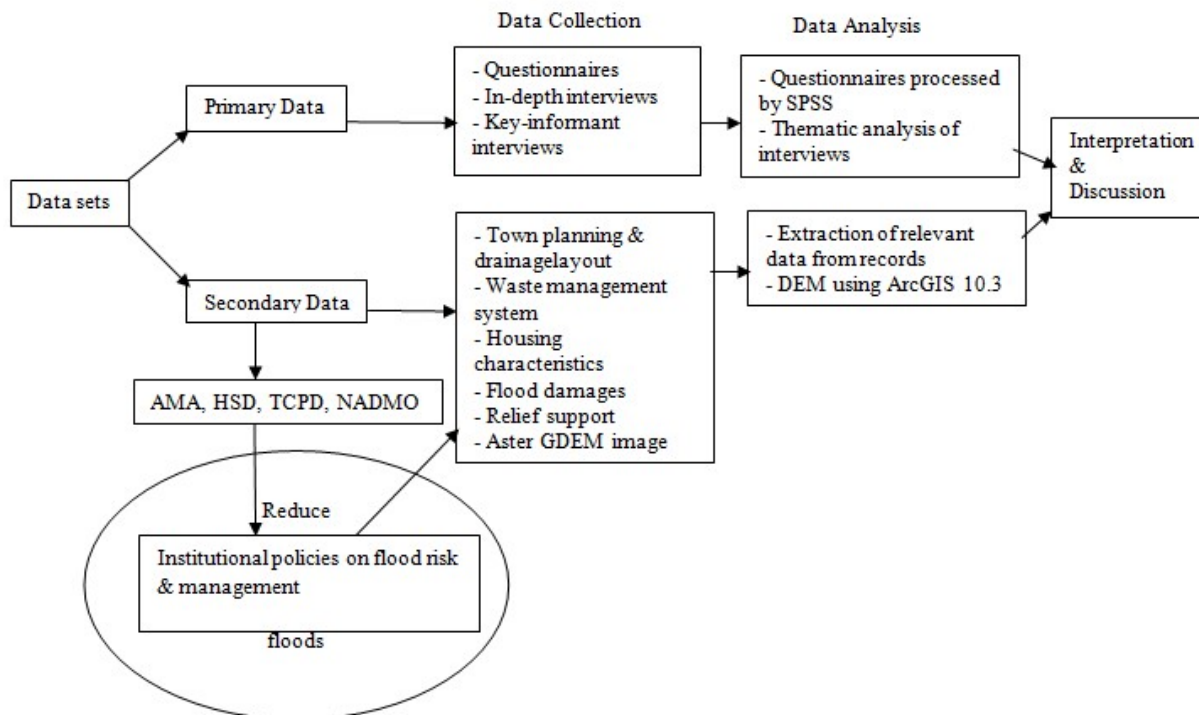


Fig. 2 Flowchart on the research methodology and flood risk control

Also, there were personal observations of the study area throughout the period of the fieldwork. Questionnaires were administered to 120 household heads to elicit information on people's experiences and impacts (socio-economic, environmental), the coping strategies employed to minimize the adverse effects of floods as well as their perceptions on public interventions to flood risk management. Within the community there are differences in exposure to flooding depending on the location. For major floods, structures along

the two rivers are more affected when the rivers overflow their banks as compared to the interior of the community (Fig.1). Consequently, to capture these different perspectives, respondents were systematically selected along three transects across the community. Sampling was done along the Odaw River from the confluence to the Abelenkpe boundary; along the Onyasia River from the confluence to the Kotobabi boundary and along the major road through the town from the Alajo Market through T-junction to Polo-Junction which

boarders Kotobabi (Fig.1). Every 5th household was selected, and the household head was the sampling unit. The target respondents were people who have stayed in the area for a minimum of five years. Where a respondent's length of residency was less than 5 years, that house was skipped. Forty respondents were selected along each transect. Questionnaires were processed using Statistical Package for Social Science (SPSS) software and results presented in tables, interpreted and discussed. Interviews were analyzed on thematic basis (content analysis) to augment findings from the questionnaire survey (Fig.2).

IV. RESULTS AND DISCUSSION

A. Causes of Floods

The causes of flooding in Alajo is an interplay of several physical factors such as the geographical location, topography of the landscape, nature of the soils and a myriad of human elements including poor layout and improper waste management.

Alajo is located upstream of the confluence of Odaw River and one of its tributaries, the Onyasia River (Fig.1 & 3).

Situated between two major streams, overflows of high discharges of the two streams sometimes cause floods in the community. Heavy down pours cause water levels to rise, inundating homes and businesses along the riverbanks particularly backsplashes at the confluence of the two rivers. Garage owners and households at the confluence lamented that, the impact of backsplash is often quite great and disastrous at very high flows. Also being a floodplain makes the area liable to inundation whenever the river is in spate because the locality is generally of low relief (Fig.3). As shown by the digital elevation model (Fig.3), the relief is low between 0 – 50 m above sea level, with only a few spots that are of higher elevations hence, the landscape is quite susceptible to floods with the least heavy down pour. The land is also made up of pockets of alluvial black cotton soils (montmorillonite) rich in clay minerals which are poorly drained. The poor drainage characteristics of the soils reduce infiltration of rainwater which increases runoff velocity and peak discharge in streams [8][17][23] and this has the propensity of causing floods.

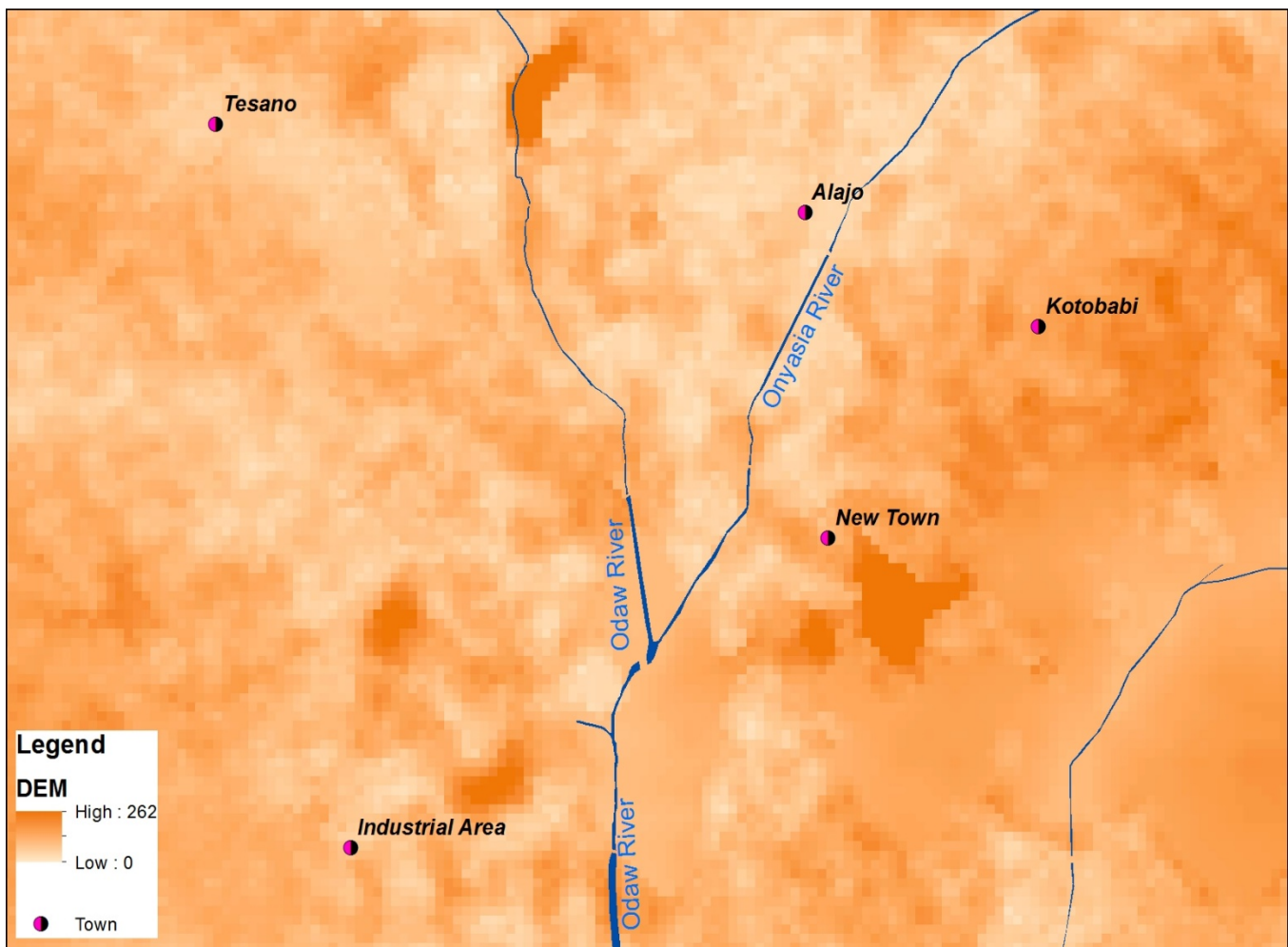


Fig.3 Digital Elevation Model of the Study Area and its environs

Siltation in the rivers/drains by sediments eroded from exposed lands along the banks and the landscape upstream also reduces the water carrying capacity of the river channels (Fig 4a & b). Channels of the rivers are filled with lots of sediments which impede flow and reduce the channel's carrying capacity. The siltation causes drains to easily spill inundating the landscape.

The major human factors causing floods in Alajo enumerated by institutions, residents and observed in the field are; improper layout of buildings, lack of drainage systems, poor waste collection and disposal, and the overflow of small inland drainage channels. Most buildings are not properly laid out and drains are not provided or inadequate hence often get choked. Except along the major roads where wide drains of about 5cm are constructed, most drainage channels within the community are very small; 3cm wide and 2cm deep (Fig. 5a).



Fig.4a Siltation of Onyasia River at the confluence with Odaw River



Fig.4b Siltation of the Odaw River at the bridge from Tesano to Aladjo



Fig.5a Small drainage system

There are other places where the drains are not engineered (Fig. 5b). These small, unconstructed and choked drains easily become filled with run-off, spilling into homes causing floods whenever it rains. According to [5], the stream channels themselves may contain so much debris and urban waste that these channels are effectively smaller than their carrying capacity. Douglas et al. 2008 observed that, in Alajo, there is no room created for floodwater to be properly contained. There is no way for the water to pass hence flooding occurs. However, according to residents and Town and Country Planning Department; *'the construction of some major culverts by Government recently has significantly reduced floods in certain localities where permit has been given for the building of houses. They indicated that, although these major/tertiary drains have been constructed, there has been an emerging challenge. The secondary drains which are supposed to serve as links between the tertiary and the primary ones are yet to be constructed hence the tertiary drains are unable to discharge flows into the secondary drains causing floods whenever it rains heavily'*.



Fig.5b Unconstructed drain filled with rubbish

Urbanization due to natural growth and rural-urban migration has resulted in an increase in population density of Accra, thus land for building gets rare and expensive. Population density of Greater Accra Region has risen from 167 in 1960 to 1,235.8 persons per square kilometer in 2010, a period of 50 years [26]. Those who cannot afford to purchase or rent space in secure environments are forced to move to cheaper places. Consequently, people have illegally settled within the Odaw River floodplain close to the river channel in the community according to AMA and Town and Country Planning Department. And because these are not approved lands for development, such places lack basic infrastructure. Therefore, the environment is prone to flooding because they do not have drainage infrastructure to drain run-off or flood water during rainfall [10].



Fig.6a Rubbish dumped along the Odaw River Bank at Alajo Market

Another major cause of flooding observed and stated by residents and state institutions was improper solid waste disposal. The central container waste management system is practiced in Alajo and waste bins are mostly placed along drains and the rivers. For instance, a public toilet by the Odaw River near Alajo Market and at the confluence of the Onyasia bank near Caprice were dumping sites of refuse of residents around those environs (Fig. 6a & b). As a result of untimely disposal of waste, skips get full resulting in the dumping of wastes around the containers (Fig. 6a & b) which get entrained into the rivers during storms posing high flood risk as the wastes reduce the carrying capacity of the drains or river channels. The reason why bins are often situated close to drains as explained by a Zoomlion Official is that; *'there is a problem of space in the Alajo Township to site the skips due to the unplanned development state of the town. The community complains of bad stench from the waste when skips are situated close to homes. Thus, the waste company is compelled to place the bins along drains which is less hazardous to homes.'*



Fig.6b Skip along the Onyasia River at the confluence

Residents along the river and drains also dispose-off solid waste into the drains particularly when it is raining as they expect the rainwater to carry the waste away. The act is perpetuated as residents do not want to pay for disposing their waste into the skips which cost GHS50p. In an interview with a respondent from the area he indicated that; *'the drains carrying capacities get impeded when people dump waste into the gutters.'* Similar observations were made by [24] that, the floods of Alajo are not always caused by rains. Sometimes, even before the rains begin to fall, the drains are overflowing, and the pathways obscured with waste. So, when it starts raining, things just worsen. The drains of the two rivers were observed to have lots of solid wastes stuck in them and foot bridges across the drains often trap solid waste during floods (Fig.7). Afeku (2005) and Post (1999) observed that, the current waste management resources are insufficient to meet the growing needs of urban residents particularly in Accra and Kumasi. This situation makes it impossible for urban residents to dispose their waste appropriately. Ghana is experiencing a high level of pollution in its water bodies particularly where they are located near human settlements, industrial (including mining) estates and agricultural undertakings.



Fig.7 Trapped rubbish on a foot bridge across the Odaw River from Tesano to Alajo indicative of the amount of waste carried by the river when in spate

NADMO intimated that, *'Alajo experiences annual floods mainly as a result of institutional lapses by the Accra Metropolitan Assembly (A.M.A), Town and Country Planning Department and the Building Inspectors from the Accra Metropolitan Works Department in enforcing regulations related to building in waterways and reservations.'* The Accra Metropolitan Assembly and Town and Country Planning Department however attributed the perennial floods in Alajo to human and natural causes (heavy rainfall). Interaction with Town and Country Planning revealed that; *'the layout of Accra on paper was good and should not bring about this problem but, the major hurdle was the lack of implementation of the layout and the enforcement of building regulations. Thus, the saying that Accra is properly planned but poorly developed.'* They claimed that, residents have encroached reservations along the banks of the rivers and this account for the floods. Landowners sell/lease out flood prone and reserved floodplains to unsuspecting people and the weak institutions' inability to effectively enforce laws results in non-conformity to land use plans. Lack of personnel and political will as well as political interference were some of the reasons assigned for the non-implementation of plans and enforcement of regulations. AMA and Town and Country Planning explained they do not have enough personnel and logistics to monitor physical developments in the city and enforce regulations. For political expediency of winning elections and protecting party members, sometimes leadership turns a blind eye to the development of some structures in unauthorized areas.

B. Effects of Floods

Floods seriously affect livelihoods in Alajo. The cost to the community ranges from loss of property to human lives. Respondents reiterated that, besides loss of property, injury and sometimes loss of lives, their business activities are also affected by floods which impact on their livelihood. Opinion leaders in Alajo and Officials of NADMO indicated that people sometimes get drowned in such floods in Accra, but there were no actual records on death tolls specifically in Alajo from the Hydro-Meteorological Technical Office of NADMO. Available flood statistics however showed that, 4,176 people made up of 2,035 adults and 2,141 children were displaced with 1 death by 2014 floods of Accra. The estimated cost of the floods was GHS720,500[36].

The research showed that respondents usually go to work late or do not go to work when the area is flooded. This according to respondents leads to low business returns and productivity. *'Movement is restricted. People have to stay indoors and sometimes even climb their roofs till the floods subsides...'* (51 years resident). Since majority of respondents interviewed were self-employed, they disclosed that it becomes increasingly difficult in getting raw materials for their work in the event of floods. A 40 year tailor and a resident shared his experience as, *'Personally, I cannot work whenever there is flood since I cannot get materials to work and this leads to loss of income to me and my family which affects the livelihood of the family.'*

Flood water can also destroy structures such as homes, stores, social and economic resources (e.g. furniture, cooking utensils, cars, sewing machines) worth hundreds and thousands of dollars depending on the magnitude of the flood. This brings a lot of financial burden onto individuals as they need to repair destroyed structures and acquire lost items. Government also spend a lot of money on relief items and the reconstruction of destroyed infrastructure such as roads, culverts and pipelines etc. One other adverse effect of floods is sanitation and environmental degradation. Flood water sometimes carry rubbish and silt leaving them at undesirable places after the water has receded making such places filthy (Figs 4a & b and 7). Fecal matter, dirt, stagnant water and rubbish have sanitation and health implications. Stagnant water breeds insects and mosquitoes which promote malaria and other sanitary ailments. Potable water either get contaminated or homes are cut off from water supplies owing to broken pipelines with dire health and economic effects. Following the 2005, 2007, and 2008 floods in Ghana, several cases of diarrhea, dysentery and cholera were reported. Also, since mobility is hindered during floods, it becomes difficult to take people to the hospital, and such delays can result in the death of people in emergency situations [9][24].

C. Adaptation and Coping Mechanisms of Households

The community has different perceptions on the flood disaster and has developed different mechanisms to overcome the floods. Being in a flood prone area, majority of the people are aware of the danger involved and have tried to protect and cope with flood impacts. There are many ways or coping mechanisms employed by the local people to deal with the negative impact of floods. The ability of people to anticipate floods is very critical as it provides them the tool to undertake measures that will minimize their exposure to risks and vulnerability. Household survey results showed that majority of the respondents indicated having adaptation measures to address vulnerability, risk reduction, and coping mechanisms to floods whereas a few individuals indicated they have no adaptation measures hence making them more vulnerable to impending flood events.

Thirty-nine percent (39% - Table 2) of respondents indicated they normally move to safer areas temporarily when heavy rains are expected or during floods as an adaptation strategy. Friends and family members outside Alajo are often a safe abode for these individuals. When the movement is in anticipation of floods, respondents stated that, they do not take along their belongings since they intend to come back to their homes after the rains. Also 34% of households indicated that they have restructured their housing units in terms of raising doorsteps, building high tables/platforms in their rooms on which properties are kept, minimizing the impact of floods on their assets. Additionally, 13% and 14% of household respondents make use of sandbags and stones as breakwaters that block floodwater.

Table 2: Adaptation measures of households

Measure	Percent
Moving to safer areas temporarily	39
Restructure housing unit	34
Build stone breakwaters	14
Use of sandbags to break floodwaters	13

Apart from adaptation measures, respondents also employ various coping strategies as immediate responses to floods (Table 3). Forty-nine (49%) of respondents indicated that after floods, they use family savings as a way of coping with adverse impacts from floods. Twenty-three (23%) indicated that they normally get loan from friends, relatives and other persons who are willing to give them loan to reduce the adverse impact of the flood.

Table 3: Coping strategies adopted by households during and after floods

Coping strategy	Percent
Family savings	49
Loan from friends, relatives, and other persons	23
Relief support from government	18
Support from family/relatives	10

Eighteen (18%) indicated that they normally receive help from government especially from NADMO in the form of relief items, whereas 10% indicated that they are sometimes supported by families after floods.

D. Public Institutions and Flood Prevention and Management Measures

The public institutions the study focused on were grouped under two major bodies; the Accra Metropolitan Assembly and National Disaster Management Organization.

1. Accra Metropolitan Assembly: The Metropolitan Assembly is responsible for the overall development of the metropolis, including planning, infrastructural development and provision of social services, enabling environment for jobs, security and welfare of the inhabitants. The research revealed that flood issues have been incorporated into the Medium-Term Development Plan (MTDP, 2010) of the Assembly as captured in some mitigation strategies such as drains construction, de-silting of drains, clearing of buildings on waterways, and public education. In minimizing the impacts of flood hazards, district assemblies are to ensure the provision of adequate and consistently functioning drainage works as well as enforcing byelaws[35]. AMA indicated that in collaboration with institutions such as Hydrological Services Department and Town and Country Planning Department, they are involved in: the construction of drains, de-silting drains and rivers/streams, ensuring the general management of structures, demolishing of unauthorized structures and ensuring that settlement plans are drawn

according to stipulated guidelines. For instance, in Alajo AMA holds emergency cleanup exercises in partnership with Zoomlion Ghana Limited particularly at the onset of the rainy seasons to tidy up the community to reduce the incidence of flooding in the community. Also, in Alajo there have been situations where buildings put-up at undesirable places have been demolished by AMA to reduce floods in the community.

However, most structures are still left un-demolished owing to lack of political will to demolish the structures, lack of enforcement of laws such as AMA byelaws and building regulations, and indiscipline and attitudinal problems of residents. According to AMA, demolishing completed buildings have negative psychological effects on owners. Sometimes legal battles on demolition of structures delay the demolishing exercises hence such structures continue to pose flood risk in the community. These challenges will hinder the attainment of the SDG 11 by 2030 hence measures must be put in place to address these issues.

2. The National Disaster Management Organization (NADMO): Ghana formed the National Disaster Management Organization (NADMO) in 1996 which is responsible for the management of disasters and emergencies backed by an act of Parliament (Act 517). NADMO performs the following functions: coordination of the activities of various bodies in the management of disasters; rehabilitation of persons affected by disasters; social mobilization, especially at the community level to support various Government programmes, such as poverty reduction as well as those aimed at the management of disasters.

Interaction with the Hydro Meteorological Disaster's Technical Committee official at NADMO revealed the following; they undertake field visits to assess the extent to which residents have put in measures of flood disaster control and educate the populace about flood mitigation and management. It was revealed that, Disaster Volunteer-Groups (DVGs) have been formed in certain communities which serve as early warning elements, channels of community awareness creation and as first responders to disasters in the community. They also organize and sensitize community members on flood prevention activities. Pertaining to Ayawaso Central where Alajo is located, there has always been seminars on disaster management and prevention for residents and the metropolis in general by NADMO. It was indicated that, even in March 2016 prior to field data collection, the organization organized a seminar in Alajo on the theme; "Disaster Prevention and Management: the role of institutions and individuals". The seminar was to sensitize the community on the adverse effects of disaster (*focusing on floods*) and the need for every individual to stick to preventive measures. These annual seminars always serve as a wake-up call to residents to clean up the environment and put their houses for any ensuing floods that year. According to residents, this is a proactive way of attenuating flood disasters in the community.

It was also revealed that material support services are provided by NADMO as first aid to flood victims as relief from hunger, illness, and temporary housing depending on the scale of the disaster. Material support include medical support and medications, food, clothing, cooking utensils, beddings, temporary housing and building materials. The research further revealed that in view of the precarious state of the problem in Alajo, residents heavily depend on NADMO in times of flood disaster for relief because they recognize NADMO as the constitutionally mandated institution to help in flood disaster situation. However, until recently when the organization received some logistics such as cars, trucks, water pumping machines etc from Japan International Cooperation Agency (JICA), the organization was seriously challenged in terms of inadequate finances and logistics to respond rapidly flood distress calls. Inadequate staffing and resources have also been another challenge confronting the organization in the delivery of its statutory obligation. The organization indicated that, due to the untimely release of funds to them, they sometimes run out of relief items so when such disasters strike, they are unable to respond immediately hence they do appeal to organizations, institutions, and the general public for support. Being the main statutory body in charge of disaster management, the problems faced by NADMO needs to be seriously addressed to significantly reduce disasters in our informal settlements in Ghanaian cities to make them safer places of abode that will help in achieving the SDGs.

V. CONCLUSION AND RECOMMENDATIONS

Alajo is one of the destinations of most migrants particularly of northern descent and neighbouring West African countries. Such exodus is resulting in urban sprawl which has expanded the settlement to flood prone areas. The fundamental human induced flood problem is that water courses are being blocked as a result of human activities like building close to the riverbanks and indiscriminate waste disposal. These human factors coupled with geographical factors exacerbate the flooding problem. Even though, adaptation measures are being developed by residents to combat the flood menace, these mechanisms are inadequate to avert the effects of floods. At the institutional level, several interventions have been undertaken by AMA and NADMO as well as TCPD to reduce the impacts of flood risk and disaster in the community; the measures are yielding very little results.

Poor urban land management which is characteristic of developing countries has been the bane of flooding and other disasters in most low-income suburbs in capital cities. This is because structures are erected without proper layouts and basic infrastructure making such localities inaccessible hence vulnerable to disasters. Government institutions responsible for land management need to put their act together to curb this problem by instituting and enforcing policies on flood risk and management (Fig.2). Thus, AMA should ensure that newly built structures are in accordance with building codes/regulations. For instance, people must be encouraged to

build elevated structures on stilts/props to allow free flow of floodwaters. Efforts should also be made to enforce planned layouts of the city which will pave way for proper and effective urban management and the provision of infrastructure and services to communities.

The placement of waste bins at the appropriate places other than close to drains within the community must be done to prevent or minimise the situation whereby people indiscriminately dump refuse. Attitudinal change on indiscriminate dumping of refuse in drainage facilities and flood waters is critical in reducing flood incidents. This calls for enforcement of regulations and education on indiscriminate refuse dumping. Early warning is critical in the preparedness of the community and institutions to impending floods. NADMO needs to be resourced logistically and financially to enable them carry out their mandate without any inhibitions. Exposed landscapes should either be paved or grassed to reduced erosion and siltation into the drains. If these measures are mainstreamed into local governance of our townships, they will significantly promote the attainment of most of the SDGs by Ghana by 2030.

ACKNOWLEDGEMENT

The authors are very grateful to the various stakeholders (AMA, NADMO, Assemblyman etc) who assisted in various ways in providing data for this study.

REFERENCES

- [1]. Aboagye, D. (2012). The political ecology of environmental hazards in Accra, Ghana. *Journal of Environment and Earth Science* 2 (10): 157-172.
- [2]. Abraham, E.M., Drechsel, P., & Cofie, O. (2006). The Challenge of urban flood control: The case of Accra's Korle Lagoon. IWMI: Accra.
- [3]. Accra Metropolitan Assembly. (2014). Millennium City. Summary Profile of Policy Initiatives, Programmes and Projects and Achievements. AMA: Accra.
- [4]. Accra Metropolitan Assembly. (2010). Medium-Term Development Plan 2010-2013: Ghana Shared Growth and Development Agenda". AMA: Accra.
- [5]. Afeku, K. (2005). Urbanization and Flooding in Accra, Ghana. Thesis, Department of Geography, Miami University.
- [6]. Akuffo, S.B. (2001). The floods are here. Available at: <http://www.ghanaweb.com/GhanaHomePage/NewsArchive/The-floods-are-here-15915> (Accessed 23 June 2015).
- [7]. Amoako, C., & Boamah, E. F. (2014). The three-dimensional causes of flooding in Accra, Ghana. *International Journal of Urban Sustainable Development*, OI:10.1080/19463138.2014.984720.
- [8]. Andjelkovic, I. (2001). Guidelines on Non-Structural Measures in Urban Flood Management. IHP-V/Technical Documents in Hydrology. UNESCO: Paris: No. 50.
- [9]. Armah, F.A., Yawson, D.O., Yengoh, G.T., Odoi, J.O., & Afrifa, E.K.A. (2010). Impact of floods on livelihoods and vulnerability of natural resource dependent communities in Northern Ghana. *Water* 2: 120-139.
- [10]. Aryeetey-Attah, S. (2001). Urban Planning and Management under Structural Adjustment. In Konadu-Agyemang, K. (ed) IMF and World Bank Sponsored Structural Adjustment Programs in Africa. Burlington: Ashgate, pp.333-354.
- [11]. Atuguba, A. A., & Amuzu, T. E. (2006). Report on climate change and flooding in Alajo, Accra. ActionAid (International) Ghana.

- [12]. Badoe, C. (2014). The challenges of waste management in Ghana: EPA's perspective. Available at: <http://www.todaygh.com/challenges-waste-management-ghana-epas-perspective> (accessed 12 October 2014).
- [13]. Bawole, J.N. (2013). Public Hearing or 'Hearing Public'? An Evaluation of the Participation of Local Stakeholders in Environmental Impact Assessment of Ghana's Jubilee Oil Fields. *Environmental Management* 52: 385-397.
- [14]. Bronstert, A. (1995). River Flooding in Germany: Influenced by Climate Change? *Physics and Chemistry of the Earth* 20 (5-6): 445-450.
- [15]. Blaikie, P., Cannon, T., Davis, I., & Wisner, B. (1994). *At Risk: Natural Hazards, People's Vulnerability and Disaster*. London: Routledge.
- [16]. Brooks, N. (2003). *Vulnerability, Risk and Adaptation: A Conceptual Framework*. Working Paper 38. Tyndall Centre for Climate Change Research, University of East Anglia, Norwich.
- [17]. Campana, A.N., & Tucci, C.E.M. (2001). Predicting floods from urban development scenarios: Case study of Diluvio Basin, Porto Alegre Brazil. *Urban Water* 3: 113-124.
- [18]. Chen, C.L. (2015). Regulation and management of marine litter. In *Marine Anthropogenic Litter*. Edited by Bergmann M, Gutow L, Klages M. Cham, Heidelberg, New York, Dordrecht, London: SpringerLink, Springer: 395-428.
- [19]. Daily Graphic. (2015). Flood disaster profile of Ghana since 1968. Available at: <http://www.graphic.com.gh/news/general-news/44243-flood-disaster-profile-of-ghana.html> (accessed 4 November 2015).
- [20]. Daily Graphic. (2014). Accra Floods. Available at: www.dailygraphicghana.com/accra-floods (Accessed 1 February 2014).
- [21]. Darteh, B. (2010). Flooding in the City: The Blame Game. Accra Learning Alliance Blog. Available at: <http://switchaccra.wordpress.com/2010/08/> (accessed 3 March 2014).
- [22]. Dickson, K.B., & Benneh, G. (1995). *A New Geography of Ghana*. England: Longman.
- [23]. Diop, M.B. (2000). Problems Associated with Flooding in Dakar, Western Senegal: Influence of Geological Setting and Town Management. *Bulletin of Engineering Geology and the Environment* 58: 145-149.
- [24]. Douglas, I., Alam, K., Maghenda, M., McDonnell, Y., Mclean, L., & Campbell, J. (2008). Unjust waters: climate change, flooding and the urban poor in Africa. *Environment and Urbanization* 20 (1): 187-205.
- [25]. Frick-Trzebitzky, F. (2014). *Riskscape of flooding - Social dynamics and adaptation in a rapidly urbanising wetland: The Densu delta case in Accra, Ghana*. PhD Thesis, Humboldt-Universität zu Berlin. Retrieved from https://www.iri-theses.org/research/doctoral_research/group_13-14/riskscape-of-flooding
- [26]. Ghana Statistical Service. (2013). 2010 Population and housing census. Regional Analytical Report - Greater Accra Region. Accra: Ghana Statistical Service.
- [27]. Government of Ghana. (2001). Flood and Drainage in Accra: A situational Analysis of the June 27, 2001 Floods. Accra: Town and Country Planning Department.
- [28]. Government of Ghana. (2003). Greater Accra Metropolitan Area Anti Flood Committee, Operational Plans. Accra: Accra Metropolitan Assembly.
- [29]. IPCC. (2001). "Climate Change 2001". Synthesis Report, Summary for Policy Makers.
- [30]. Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, T.R., Perryman, M., Andrady, A., Narayan, R., & Law, K.L. (2015). Plastic waste inputs from land into the ocean. *Science* 347:768-771.
- [31]. Kusimi, B.A., Kusimi, J.M., & Yiran, G.B. (2013). Socio-Economic and Environmental Impacts of Mining within the Catchment of Mining Companies at Tarkwa. *Ghana Social Science Journal* 10 (1 & 2): 25-52.
- [32]. Manu, D.A.K. (2011). "The Emerging oil industry in Ghana: Socio-economic and Environmental Impact on the people of Cape Three Points". MSc. Thesis, Norwegian University of Life Sciences (UMB).
- [33]. Mendel, G. (2011). *Cities and Flooding a Guide to Integrated Urban Flood Risk Management for the 21st Century* p.57.
- [34]. Messner, F., & Meyer, V. (2005). Flood Damage, vulnerability and Risk Perception: Challenges for Flood Damage Research. UFZ Discussion Papers, Department of Economics, Leipzig.
- [35]. Ministry of Local Government and Rural Development (MLGRD). (2010). *Environmental Sanitation Policy (Revised 2010)*. Accra: MLGRD.
- [36]. National Disaster Management Organization (NADMO). (2014). *Hydro-Meteorological Records of Accra*. Accra: NADMO.
- [37]. Neumann, J.E., Emanuel, K.A., Ravela, S., Ludwig, L.C., & Verly, C. (2013). Assessing the risk of cyclone-induced storm surge and sea level rise in Mozambique. WIDER Working Paper Series 036, World Institute for Development Economic Research (UNU-WIDER).
- [38]. Olorunfemi, F.B. (2011). *Managing Flood Disasters under a Changing Climate: Lessons from Nigeria and South Africa*. Nigerian Institute of Social and Economic Research (NISER). Discussion Paper No. 1, 201: 4-12.
- [39]. Ogunorisa, E.T. (2001). *An Assessment of Flood Risk in the Niger Delta, Nigeria*. PhD Thesis, University of Port-Harcourt, Nigeria.
- [40]. Post, J. (1999). The Problems and Potentials of Privatizing Solid Waste Management in Kumasi, Ghana. *HABITAT Intl*, 23 (2): 2001-215.
- [41]. Schaeffer, M., Baarsch, F., Adams, S., de Bruin, K., De Marez, L., Freitas, S., Hof, A., & Hare, B. (2013). *Africa Adaptation Gap Technical Report: Climate-change impacts, adaptation challenges and costs for Africa*. UNEP.
- [42]. Smith, K. (1996). *Environmental Hazards*. London: Routledge.
- [43]. Twigg, J. (2004). *Good Practice Review. Disaster Risk Reduction: "Mitigation and preparedness in development and emergency programming"*. Overseas Development Institute, Westminster Bridge Road, London, UK.
- [44]. UN-HABITAT. (2003). *The Challenge of Slums: Global Report on Human Settlements 2003*. London: Earthscan.
- [45]. Van Assche, K., Beunen, R., & Duineveld, M. (2014). *Evolutionary Governance Theory: An Introduction (No. 8876)*. Heidelberg: Springer 95: <http://governancetheory.com/egt/>.
- [46]. Van Franeker, J.A., & Law, K.L. (2015). Seabirds, gyres and global trends in plastic pollution. *Environmental Pollution* 203:89-96.
- [47]. Van Seville, E., Wilcox, C., Lebreton, L., Maximenko, N., Hardesty, B.D., van Franeker, J.A., Eriksen, M., Siegel, D., Galgani, F., & Law, K.L. (2015). A global inventory of small floating plastic debris. *Environmental Research Letters* 10:124006.
- [48]. Viljoen, M.F., & Booysens, H.J. (2006). Planning and management of flood damage control: The South African experience. *Irrigation and Drainage*. 55: S83-S91.
- [49]. Löhr, A., Savelli, H., Beunen, R., Kalz, M., Ragas, A., & Bellegem, F. V. (2017). Solutions for global marine litter pollution. *Current Opinion in Environmental Sustainability*, 28, 90-99.
- [50]. World Bank. (2010). *City of Accra, Ghana – Consultative Citizens' Report Card*. Report No. 55117-GH, The International Bank for Reconstruction and Development/The World Bank.
- [51]. Yeboah, I. (2000). Structural Adjustment and emerging urban forms in Accra. *Africa Today*. 47 (2): 58-89.