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Flood risk management in Ghana: A case study in Accra

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ABSTRACT

Several natural disasters have occurred from the days of biblical Noah until now. These natural disasters have taken various forms like; floods, earthquakes, volcanic eruption tsunamis, tornadoes, landslides, hurricane, and among others. Within the past decades, flooding has become a global pandemic which hampers economic and social development. This global phenomenon has affected 4 million people, loss of lives and economic damages of approximately US$ 780,500,000 in Ghana. It is therefore necessary to ascertain the causes of flood in Ghana and propose an approach that can be helpful to mitigate the flood impacts and save lives and properties. A case study in Accra, the capital of Ghana, will be employed in this paper since it has recorded the highest flood frequency, and how best it can be managed using the Integrated Flood Risk Management approach for the 21st Century.

Keywords: Accra, Ghana, Flood Risk, Flooding, Management.

INTRODUCTION

Flooding was defined by Hague: 1997 as “a natural hazard which displaces people by destroying their land, houses and other tangible goods and assets” [12]. In global level, the devastation effect of flood is de facto. A recent example is the 2005 and 2009 flooding in Cumbria and the widespread flooding across England in summer 2007 which resulted in loss of lives and major impacts on the health and well-being of people living and working in the areas affected. The cost of the summer 2007 floods amounted to more than £3.2 billion, with the floods in Cumbria in 2005 causing economic damage of £450 million [2].

Within the last decades, Accra has experienced periodic floods. Between 1955 and 1997, about GH¢300 billion worth of properties have been destroyed, 100 lives have been lost either during the flood period or after the floods and 10,000 people have been displaced from their homes [3].

Even though, the Government of Ghana has inaugurated statutory supervisory agencies such as Ministry of Works and Housing, City Engineers of Accra Metropolitan Assembly and Lands Department [4] to see to the reduction effects of flood on human lives and properties but the methods employed by these agencies such as; identifying watermarks on structures, media reports and aerial photographic interpretations [5] are not enough to tackle these flood events, mutatis mutandis, as new areas periodically experience floods.

It is therefore necessary to explore new ideas and approaches that can be incorporated to existing structures to manage this problem. This paper will propose new approaches to manage this environmental hazard which continually irritates the populace of Accra.

In 1968, Ghana experienced its first flood which affected about 25,000 people including loss of properties and lives [6]. Flood constitutes the majority of natural disasters that affect the Republic of Ghana. According to report on natural disasters and hazards in Ghana, Flood is number two after epidemics with regards to lost of lives (Table 1). About 409 people out of almost 3.9 million people have been killed between 1968-2014 as a result of flood events.

According to EM-DAT: 2014, Economical loss caused by flood in Ghana is roughly US$ 780,500,000 (See Table 1).

Table 1. Natural Disasters in Ghana from 1900 to 2014

Disaster	№ of Events	Killed	Total Affected	Damage (US$)
Drought	3	0	12,512,000	100,000
Flood	17	409	3,884,990	780,500,000
Eidemic	19	875	33,799	-
Wildfire	1	4	1500	-
Earthquake	1	17	-	-

Source: EM-DAT: The OFDA/CRED International Disaster (Adapted)

Ghana Red Cross Society in collaboration with United Nations office for Coordination of Humanitarian Affairs report showed that; the flood that occurred in June 2010 affected 33,602 with almost 15,000 people living in temporary shelters as a result of displacement by the flood whiles 36 died [7]. The flood destroyed properties which include; houses, bridges, washed away roads, among others to the extent of affecting the educational, agricultural, health, water and sanitation sectors.

The city for the case study is the Accra Metropolitan Area. Accra is the capital city of Ghana and also capital for Greater-Accra Region which makes it the seat of Government. Ghana is one of the fastest growing economies in West-African. Ghana's population is roughly 25 million people with a corresponding per capita GDP of GH₵ 24,187.30 million [8]. The administrative, political and commercial capital of the Republic of Ghana takes place in this city. Accra has a total population of almost two million people and has being recognized as the largest and fastest growing metropolis in Ghana with an annual growth rate of 3.1 % [9].

Accra Metropolitan Area consists of many sub-metropolitan areas which include; Kpeshie, Osu-Clottey, Central Ayawaso, East Ayawaso, West Ayawaso, Ashiedu-Keteke, Okai-koi North, Okai-koi South, Ablekuma South and Ablekuma North [10]. Accra covers a land mass of about 1,261km^2 and lies geographically within Longitude 0^o 03' and 0^o 25' West and Latitude 5^o 30' and 5^o 53' North and It stretches from Botianor to Sakumo, and James Town to Oyarifa. Tema bounds it on the East, on the South by the sea, West by the Weija dam, and North by the Akwapim hills (Figure 1).

Figure 1. Map of Accra, the capital of Ghana

According to SWITCH Accra City Story, characteristics of Accra are lowlands, and hilly areas that runs out into the sea as a result of rain from the city. Accra consists of eight drainage basins which include; Kpeshie, Korle, Densu, Sakumo, Lafa, Osu, Songo Mokwe and Chemu Basins [14]. As a result of these basins, storm water runs out from the city through it (Figure 2).

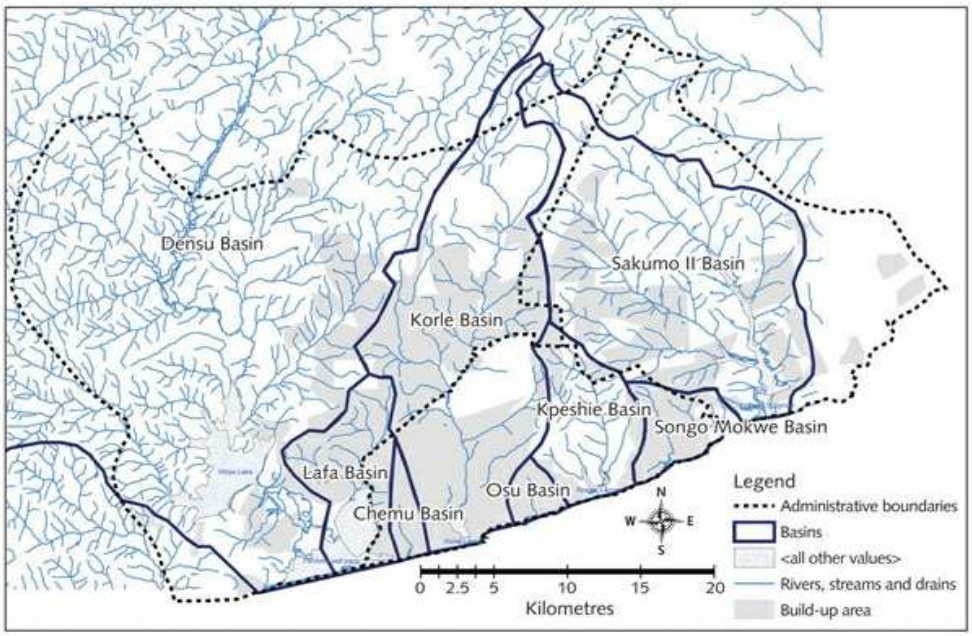

Figure 2. Basins in Accra, the capital of Ghana

MATERIALS AND METHODS

Integrated Flood Management (IFM) incorporates water and land resources management in a basin within the framework of Integrated Water Resources Management (IWRM), with a view to maximize the efficient use of floodplains and minimize loss to life (Figure 3). Hence, an Integrated Flood Management plan addresses the following six key elements that follow logically for managing floods in the context of an IWRM approach [13]:

• Manage the water cycle as a whole;
• Integrate land and water management;
• Manage risk and uncertainty;
• Adopt a best mix of strategies;
• Ensure a participatory approach; and
• Adopt integrated hazard management approaches.

According to World Meteorological Organization: 2006, the adoption of a strategy critically depends on the hydrological and hydraulic characteristics of the subject river system and region [13]. Three factors are interrelated to ascertain which strategy or combination of strategies would likely be appropriate in a particular river-basin in Accra: the climate, the basin characteristics and the socioeconomic conditions in the region. The nature of the region's flood, and the consequences of that flood are a function of these linked factors. Optimal solution depends on knowledge that is complete, precise and accurate.

In light of the uncertainties about the future, flood management plans should adopt strategies that are flexible, resilient and adaptable to changing conditions. Such strategies would be more effective with a mix of options. In Table 2, the strategies and options that can be employed in Accra-Ghana for flood risk management are given.

A secondary data on the size of basins in Accra, the run-off coefficient, storage coefficient and the rainfall intensity was derived from Ghana Meteorological service. From these data, water run-offs within the basins in Accra were deduced using the modified rational model by Viessman & Lewis, 1996; and Mannaerts, 1996 to calculate individual discharge for each section in the entire catchment areas [11].

In the calculation of the discharge of each basin, the formula below was employed;

$$\boldsymbol{Q_p} = 0.278 \times C_s \times C \times i \times A \quad (1)$$

Where: Q_p= run-off rate (m^3/s),
C= Run-off Co-efficient,
C_s= Storage Coefficient,

i= Rainfall Intensity (mm/hr) and
A= Area of Drainage (km^2)

Run-off coefficient of urban areas ranges between 0.7 and 0.95.

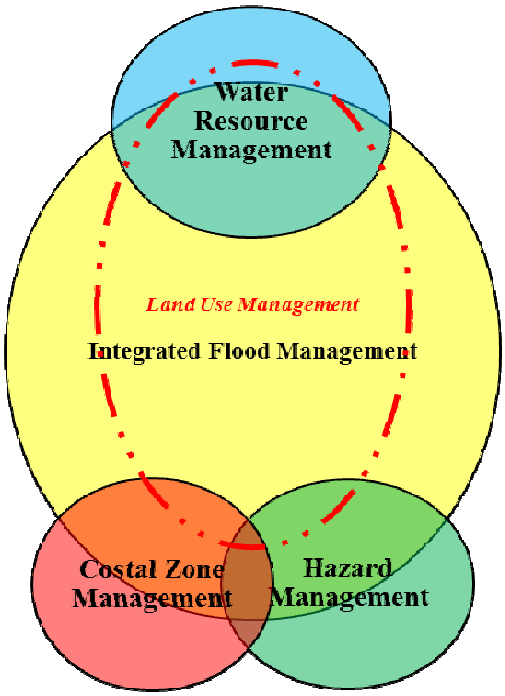

Figure 3. Integrated flood management model, Adapted from WMO, 2006

Table 2. Strategies and Options for Flood Management

STRATEGY	OPTIONS
Reducing Flooding	Dams and reservoirs Dikes, levees and flood embankments High flow diversions Catchment management Channel improvements
Reducing susceptibility to Damage	Floodplain regulation Development and redevelopment policies Design and location of facilities Housing and building codes Flood proofing Flood forecasting and warning
Mitigating the impacts of flooding	Information and education Disaster preparedness Post-flood recovery Flood insurance
Preserving the Natural Resources of Flood Plains	Floodplain zoning and regulation

RESULTS AND DISCUSSION

In Ghana, raining season starts from April and ends in July with heavy rainfall and thunderstorms mostly in May (Figure 4). High rainfall intensities can have an effect on the storm hydrograph. Heavy storms result in more water entering the drainage basin which results in a higher discharge leading to flood over a long period of time. In July 1995, the flood that occurred in Accra had a return period of 50 years, which led to several fatalities, damage to properties, infrastructures and affected several communities like; Nima, Abelemkpe, Labadadi, Alajo, Chorkor, Kaneshie, South Industrial Area, Achimota, Adabraka, Laterbiorkoshie, Agbogbloshie and Asylum Down.

In Figure 4. The Average Monthly Rainfall Intensities in Accra are given.

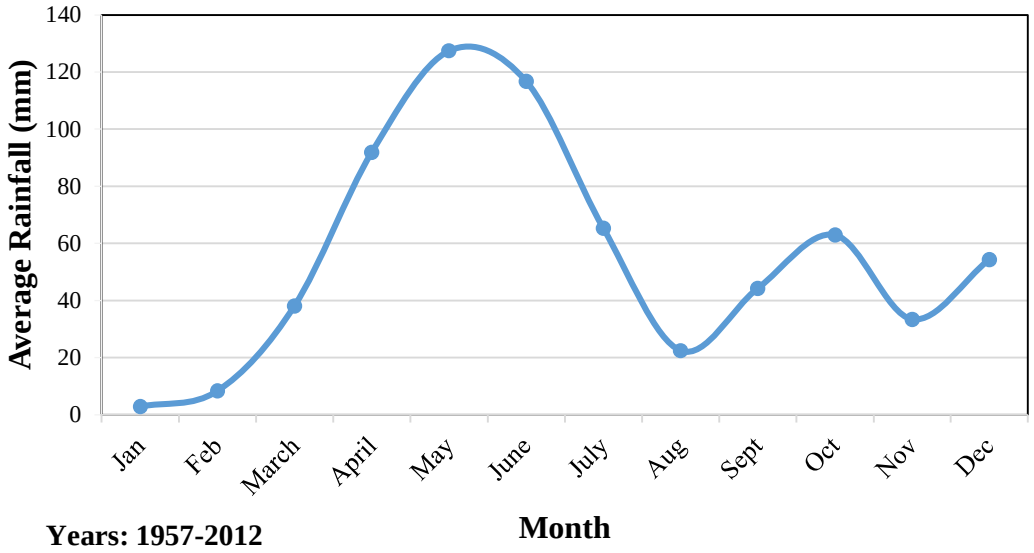

Figure 4. Average Monthly Rainfall Intensities in Accra

Figure 4 confirms the month of May as the peak rainfall intensity in Accra. As a result of this, flood disaster losses can be minimized if early warning systems are put in place to alert the populace within this month to fully prepare and equip themselves for an upcoming flood. Early warning mechanism like SMS can be sent via mobile phones about 2-3 hours prior to the flash-flood in order to remind the populace and also to save lives from perishing during the flood.

From the Figure 5, it can be deduced that, as the area increases peak discharge also increases. This is because large drainage basins catches more precipitation and so, have a higher peak discharge compared to smaller basins. Smaller basins generally have shorter lag time because precipitation does not have far distance to travel. This is the reason why Middle Sakumo basin continues to experience that highest flood events in Accra. As a result of increased urbanization, the drainage basins; the run-off coefficient; as well as the peak run-off will increase leading to more flood events in Accra.

In Figure 5, the peak run-off of the various basins in Accra are given to ascertain how likely an area would experience flood at a discharge rate.

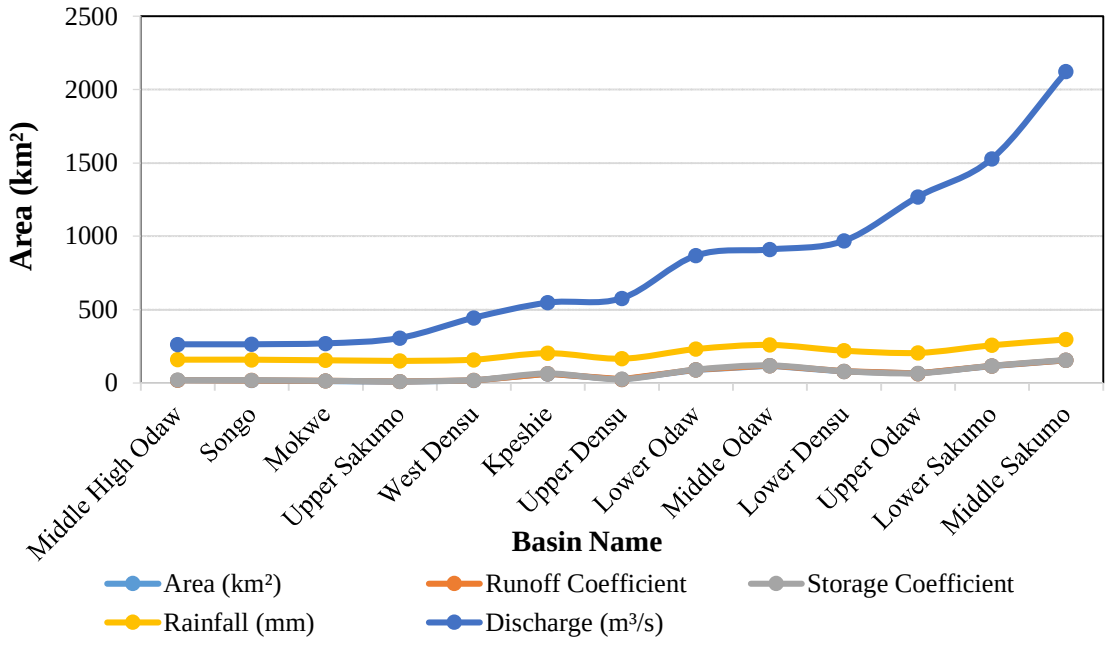

Figure 5. Peak run-off of the various basins in Accra

CONCLUSION

Flooding as a natural disaster cannot be eradicated in Accra but however, its effect can be minimized by undertaking the Integrated Flood Management approach which promotes the coordinated management and development of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.

Our study suggests an improvement in the management of waste collection and disposal in Accra to reduce the risk of flood since choking of basins, rivers, and culverts have been established to have a positive correlation with flooding in Accra. De-silting gutters, river channels, and culverts that are frequently taken up by solid waste will provide additional storage which will improve the hydraulic performance of drains and increase the carrying capacities that will directly reduce peak discharge.

An enforcement of building regulations that prevents people from building in flood prone areas and floodplains will help to reduce flood frequencies in Accra.

As stated in Table1, employing the Integrated Flood Management mix options into already existing strategies will help curb the frequent menace of flood in Accra and make the capital city of Ghana a better place to live in.

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